TAXONOMIC STUDIES ON TURKISH GRAMINEAE

by

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I would like to dedicate this thesis to the memory of Prof. Dr. Hikmet Birand of Ankara University Science Falculty.

DECLARATION

I hereby declare that the work presented in this thesis has been carried out by me.

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ABSTRACT

The thesis has been divided into two main parts.

In Part I, an attempt has been made to reveal taxonomically useful morphological characters. Internal morphological features of the vegetative organs have proved to be extremely useful for distinguishing infrageneric groups as well as species. Apart from this, vegetative and floral morphological characters of grasses have been investigated in detail. Especially, microscopical features of the caryopsis, lemma, glume, pedicel, awn, palea and callus have been found to have great taxonomic value. For the investigation of such characters, Scanning Electron Microscope (S.E.M.) has been used for the first time in the group revised here.

23 chromosome counts have been made on the basis of Turkish material, most of them for the first time.

The three biggest genera, Helictotrichon, Alopecurus and Phleum, have been studied in their world range and an infrageneric grouping made, including all the Turkish species.

In Part II, within the area covered by the Flora of Turkey (Davis 1965-), 129 species belonging to 37 genera in the tribes Aveneae (incl. Agrostideae), Milieae, Phalarideae and Phleeae have been critically revised.

Synonymy, descriptions, flowering time, habitat, type citation, general distribution inside Turkey, phytogeographical elements, specimen citations on a grid basis and general distribution outside Turkey, have been given for each species. Along with general descriptions, keys to species have been given under their genera.

One new genus, Pseudophleum, and four new species, Apera baytopiana, Apera triaristata, Gaudinopsis huber-morathii ans Gaudinopsis sorgerii, have been described (cf. Appendix).

Phytogeographical regions, climate types, topography and endemism in Turkey is described.

Previous tribal classifications concerning only Turkish tribes have been revised and a tribal synopsis drawn up for all Turkish genera of Gramineae.

In the final part, two types of generic keys, Formula (Multi-access) and Indented Dichotomous keys, have been produced for all the known Turkish Gramineae.

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Contractions used in Figures

A. Axis

B. Bulliform Cells

H. Hair

I.C. Interstomatal long cell

I.S. Inner vascular bundle sheath

L. Lemma

L.C. Long cell

L.G. Lower glume

LO. Lodicule

O. Ovary

O.S. Outer vascular bundle sheath

P. Palea

RH. Rhachilla

S. Stomata

S.C. Short cell

Sp. Spikelet

St. Stamens

U.G. Upper glume

Key to shading in Anatomical line drawings

(after Metcalfe 1960)

 Sclerenchyma

 Parenchyma

 Phloem

 Xylem

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Chapter I

1. Introduction

1.1. Background: Exploration of the Turkish Flora

From an economic viewpoint, the Gramineae Juss. (Poaceae Barnh.) is the most important family of flowering plants. In Turkey it includes staple food plants in the following genera: Zea, Oryza, Avena, Triticum, Hordeum, Sorghum and Saccharum. It also provides most valuable forage for domestic animals. According to Harlan and D. Zohary (1966) some of these cereals were cultivated as early as 7000 B.C. by early settlers in S.E. and C. Anatolia.

Our present knowledge of Turkish grasses has gradually grown with the exploration of that country's flora. As only very few collectors took a specialized interest in the wild grasses, a short account of the botanical exploration of Turkey is given below. It is in these general collections, made over nearly 280 years by a succession of botanists, that our present knowledge of Turkish grass flora is primarily based.

Botanical research concerning the Turkish flora started early in the 18th Century when, for the first time, some European botanists travelled as far as Turkey for botanical exploration. During these visits the richness of the Turkish flora soon became apparent; ever since then there has been a series of botanical explorations to explore the extremely rich Anatolian flora.

With the exception of Albania, Turkey has been the last country in the Mediterranean to be botanically explored - and there is still a lot more to be found.

There have been a number of botanists who have spent considerable time on the plant life of Turkey. Their numerous publications have been collated by Davis and Edmondson (1979). We can recognise here four major periods in the exploration of the Turkish flora.

The First Period covers botanical exploration from the beginning of the 18th Century to Boissier's visit to Turkey in 1842. During this period a number of botanists visited various places in Turkey, such as Tournefort (1700-1702), Uludag (Bursa), Izmir, Efes, Trabzon, C. Anatolia, Erzurum, Mount Ararat, Kars; Sibthorp (1876-1794), Istanbul, Bursa, Izmir; Clarke (1799-1802), N.W. Anatolia; Fleischer (1827), Izmir; Aucher-Eloy and Montbret (1830, 1832, 1836), Istanbul, Uludag (Bursa), Izmir, Mugla, Erzurum and Amanus; A. Grisebach (1839, publ. 1843-1846), Thrace, Uludag (Bursa); C. Jaubert (1839), Istanbul, N. of Mugla, Uşak, Kütahya, Bursa; Thirke (1839-1842), Uludag (Bursa) and Trabzon. These early botanists collected a substantial amount of material, but most of the journeys were aimed at exploring W. Anatolia. This was of course because of the difficult, hazardous and limited transport facilities in those days. Only three of these early collectors, Tournefort, Aucher-Eloy and Montbret, visited areas outside W. Anatolia.

The Second Period covers botanical exploration from Boissier's trip to Turkey in 1842 to the completion of his 'Flora Orientalis' (1888). During this period botanists travelled deeper into Anatolia and collected an enormous amount of material. Boissier's monumental floristic work, covering Turkey, Greece, Crimea, Caucasia, Syria, Palestine, Iraq, Cyprus, Iran, Afghanistan, Arabia, Egypt and Baluchistan, was published by E. Boissier between 1867 and 1884, and after the author's desth a Supplement was added by R. Burser (1888). Boissier himself visited Izmir, Aydin Da., Menderes valley, Manisa, Bozdag, Honaz Da. (Denizli) and Uludag (Bursa). In his 'Flora Orientalis' he cited his specimens from W. Anatolia as well as other collections by various botanists.

T. Kotschy's major period of exploration was undertaken during the preparation of 'Flora Orientalis'. Between 1841 and 1859 he set

out on long tiring journeys in E. Anatolia; he visited the Taurus Mountains, Muş, Varto (Bingöl Da.), Trabzon, Erzurum and Palandöken Dag.

During this period many other botanists went to Turkey and collected from various parts of the country. These collectors and their collecting areas are as follows: Pinard (1842) W. Anatolia; C. Koch (1844) N.E. Anatolia; Noë (1844-1846) Istanbul, Harput (Elazig); Heldreich (1845-1851) Antalya, Burdur, Isparta, Konya, Izmir; Tchihatcheff (1847, 1849, 1853, 1858, publ. 1860) W. and N. Anatolia; Clementi (1849-1850) Istanbul, Uludag (Bursa); Huet de Pavillon (1853) Erzurum, Bayburt, Ispir; Balansa (1854, 1855, 1856, 1857, 1866, publ. 1874) Izmir, S.E. Taurus Mountains, Erciyas Da. (Kayseri), Uşak, Murat Da. and N.E. Anatolia; Bourgeau (1860, 1863) Antalya, Elmali, Gümüşhane, Bayburt; Haussknecht (1865) Urfa, Gaziantep, Berit Da. (Maraş), Harput (Elazig), Diyarbakir; F. Luschan (1881-1882) Mugla, Antalya (publ. O. Stapf 1885-1886).

The Third Period covers botanical exploration from the completion of Flora Orientalis in 1888 (Supplement) to the Second World War. During this period some major expeditions to explore E. Anatolia were organized. This is the period in which Russian botanists were active in the E. and N.E. Anatolian flora. Many botanists collected from various parts of Turkey, such as N. Albov (1891, publ. 1893a, 1893b, 1895) Trabzon, Artvin; Manissadjian, Amasya; Aznavour (1897, 1917, 1918) Bosphorus (Istanbul) publ. Rechinger 1938); F.E. Wimmer (1905-1910) Istanbul, Bursa; Warburg and Endlich (1901-1902) Eskişehir; W. Siehe (1895-1928) Taurus Mountains (publ. Hayek 1914); Sintenis (1889-1890) N.E. Anatolia, Gümüşhane, C. Anatolia, Çanakkale; Penther and Zederbauer (1902 publ. 1905) Erciyas Da. (Kayseri); B.V.D. Post (1906, 1910, 1913, 1918) Rize, Ararat Mountain, Konya, Istanbul, Bolu; G.E. Post (1906) S. and E. Anatolia, particularly Hatay, Gaziantep, Maraş, Mardin (publ.

Post, G.E. and Dinsmore, J.E. 1932-34); Handel-Mazetti (1907, 1910 publ. 1909, 1912-14) Istanbul, Ordu, Trabzon, N.E. Anatolia; Haradjian (1905-1915) Hatay, Maras, Gaziantep - extensive collection publ. by Rechinger in Ark för Bot. 5(1), 1959; J. Andrasovszky (1911, publ. 1914) Ankara, Konya; Nabelek (1910, publ. 1923-29) Van, Hakkari, Siirt, Mardin; Saposhnikov and B. Schischkin (1915-16 publ. 1929) Muş, Erzurum, Kars; E.G. Koenig (1903-1905) Kars; Woronow (1907, publ. 1908) Artvin etc.

During this period the outstanding taxonomist J. Bornmüller spent about 50 years studying the Turkish flora, collected in numerous places in W., C. and N. Anatolia between 1889 and 1929. Among the areas he visited were Bursa, Sultan Da. (Akşehir), Izmir, Manisa, Aydin, Mudanya, Uludag (Bursa), Bilecik, Ankara, Çankiri and Amasya, (publ. 1900, 1908, 1909, etc.)

After the First World War botanical exploration continued in Turkey. The first Turkish botanist, Ali Riza Bey (1920), investigated plant life around Zonguldak. Between the two major war periods many other botanists visited various places in Turkey, such as K. Krause (1914, 1925, 1926, publ. 1915, 1926-32, 1937) Ankara, W., C. and N. Anatolia, Trabzon, Samsun, Giresun, Taurus Mountains; H. Czeczott (1925, publ. 1938-39) Istanbul, Hendek, Ankara, Çankiri, Ilgaz Da. (Kastamonu); K.O. Müller (1931-33) Ankara; W. Kotte (1931-33) Ankara; R. Görz and Werth (1931-33) Ankara; O. Schwarz (1932, publ. 1934) Izmir; E.K. Balls (1935, publ. 1935) N.E. Anatolia, Taurus Mountains,

Towards the end of this period K.H. Rechinger (1943) published his '<u>Flora Aegaea</u>' in which he cited numerous specimens from the E. Aegean Islands and provided keys to species. Though Rechinger (publ. 1939, 1951, 1952, 1959) published numerous papers concerning the Flora of Turkey area, he himself collected little in Anatolia.

The Fourth Period covers botanical exploration after the Second World War and might be termed the 'Modern' or 'Flora of Turkey' period. During this period extension of road facilities allowed more intensive exploration of inner Anatolia, particularly mountainous E. Anatolia. In this period the first Flora of Turkey (1965-) is still being produced by P.H. Davis. Davis and his colleagues I.C. Hedge, M. Coode, O. Polunin, etc. have collected from almost all parts of Turkey, providing much basic material for the Flora.

Turkish botanists were active in the exploration of Turkish plant life during this post-war period. Among these botanists H. Birand (publ. 1952), B. Kasapligil (publ. 1947), K. Karamanoglu, A. Baytop (1966, etc. paying particular attention to Turkey-in-Europe and the Gramineae), T. Baytop, F. Yaltirik, H. Demiriz, R. Çetik, Y. Akman, T. Ekim, H. Peşmen, O. Seçmen and E. Yurdakulol are the most important ones. A number of foreign botanists became interested in the Turkish flora, notably Huber-Morath (who discovered and described a great many new species), K.P. Buttler, K. Tobey, F. Ehrendorfer, F. Sorger, Bocquet, P. Quezel and the cytologist Contandriopoulos, etc.

Though 281 years have passed since the first botanical journey made to Turkey by Tournefort, at least three quarters of our present total collections were made in Turkey during the post-war period. This was made possible by the extension of the road network in Turkey and to interest stimulated by the production of the Flora. As our basic knowledge of the Turkish flora consolidates, it is hoped that we shall be able to enter a more biosystematic phase of taxonomy. Indeed, so far as the cereals are concerned, this has already begun, i.e. F. Albers (1980). General biosystematic information on the Turkish grasses is, however, still very limited.

1.2. Scope of the thesis

Since Boissier's Flora Orientalis (1857-1884), an enormous amount of material has been collected from all over Turkey. Species either new to science or new for Turkey have been discovered, and the known distributions of other species have been greatly extended.

Internal morphological characters as well as external ones have been used to support the various taxonomic delimitations accepted in this thesis. These characters include reproductive morphology (general inflorescence structure, spikelet, caryopsis), vegetative internal morphology, and cytology. Some of the information already available has in fact been overlooked by various botanists. For example, the affinities of the genus Beckmannia Host were assessed by Reeder (1953) on the basis of its embryo type, as a result it was separated from the Chlorideae and placed with the Festucoid grasses (tribe Phleeae). The genus Zingeria has always been placed within the tribe Milieae (e.g. by Smirnov, 1946; Bor, 1970) but this treatment was completely overlooked or ignored by Tzvelev (1976) who related it to Agrostis L.

To supplement and strengthen the basis for this new classification, Scanning Electron Microscopy (S.E.M.) has been used in this group of grasses for the first time. Taxonomically useful and diagnostic characters were found in various parts of the grasses, such as leaf blades, pedicels, glumes, rhachillas, lemmas, awns and caryopsis.

The most recent work on internal vegetative morphology of grasses is that by Metcalfe (1960). Alopecurus myosuroides, A. alpinus, A. geniculatus, A. pratensis, Helictotrichon pratense, H. planiculme, H. pubescens, Phleum alpinum, P. arenarium, P. nodosum and P. pratense are described anatomically in Metcalfe's work. St.-Yves (1931) examined a number of Helictotrichon species. Very few other species have been examined anatomically.

Phleum, Alopecurus and Helictotrichon have been studied by me throughout their total distribution range. All Turkish species have been placed in their appropriate infrageneric groups. I have examined the internal leaf morphology of eighteen Alopecurus species, viz. A. pratensis, A. creticus, A. geniculatus, A. bulbosus, A. rendlei, A. glacialis, A. aucheri, A. laguroides, A. aequalis, A. textilis, A. myosuroides, A. gerardii, A. arundinaceus, A. davisii, A. setarioides, A. utriculatus, A. lanatus and A. vaginatus.

For Helictotrichon s.l. I have examined the internal leaf morphology of twenty-five species including eight Turkish species. These are H. sempervirens, H. parlatori, H. sedense, H. convolutum, H. decorum, H. filifolium, H. setaceum, H. sedenense, H. desertorum, H. pubescens, H. versicolor, H. pratense, H. blavii, H. armeniacum, H. argaeum, H. compressum, H. marginata, H. albinervis, H. scellianum, H. praeusta, H. dahuricum, H. bromoides, H. cincinnata, H. planiculme and H. heckelii. At the same time I have tried to justify my inclusion of the perennial "Avenas" under a single genus Helictotrichon, instead of the two genera accepted by Holub (1977).

I have recognised thirty-eight genera in the tribes Aveneae (incl. Agrostideae), Phleeae, Phalarideae and Milieae within the area covered by the Flora of Turkey. Thirty-seven of these genera have been revised in this thesis. The revised genera and their species in Turkey have been listed in Table 1 in as natural manner as a linear sequence allows.

Ecogeography of Turkish grasses is discussed. Climate, topography and altitude are fully discussed in relation to distribution patterns. Almost all the revised species have been investigated throughout their distribution range outside Turkey and a Table showing their distribution has been compiled. Endemism in the area covered by Flora of Turkey is discussed.

For the preparation of a tribal synopsis of the Turkish Gramineae, all one hundred and thirty-seven genera belonging to twenty-nine tribes have been examined. Tribal classification of the grasses in Turkey has changed over the years. I have compared various systems devised during the past 113 years by a number of botanists such as Dumortier (1868), Hackel (1887), Bews (1929), Bor (1970), Tzvelev (1976) and Tutin et al. (1980).

I have tried to bring together all relevant literature and arranged it according to genera. Two kinds of generic keys have been constructed for the identification of Turkish Gramineae; one a Formula (multi-access) Key which may be used by those who have little knowledge about grasses; and the other, a Dichotomous Indented Key to be used by those who are more familiar with grass terminology. The meanings of the technical terms used in the Formula Key, and for the recognition of major groups in the Dichotomous Key, have been illustrated.

1.3. Taxonomic History of the grass genera revised

Linnaeus was the first to circumscribe Agrostis, Aira, Phleum, Alopecurus, Holcus, Milium, Cornucopia, Lagurus, [illegible] Anthoxanthum and Phalaris in his Species Plantarum (1753). Since then, the limits of these genera have not undergone any major revision and have been accepted by most taxonomists. Linnaeus, however, did not realise that some of his genera were heterogeneous; this was presumably due to the limited amount of material (and probably time) available for study. For example, the superficial resemblance of certain species led him to place Calamagrostis epigejos and Ammophila arenaria under Arundo; Beckmannia eruciformes under Phalaris; Crypsis schoenoides under Phleum; Apera spica-venti under Agrostis; Lopochloa cristata under Aira and Trisetum sibirica, Trisetum flavescens, Arrhenatherum elatius,

Gaudinia fragilis and Helictotrichon pratensis under Avena. Since then many new genera based either on Linnæan species or new ones, have been described in order to reach a more consistent level regarding generic concepts in the Gramineae. These more recent genera are Calamagrostis Adans. (1763), Apera Adans. (1763), Trisetaria Forssk. (1775), Polypogon Desf. (1798), Ventenata Koel. (1802), Beckmannia Host. (1805), Koeleria Pers. (1805), Trisetum Pers. (1805), Ammophila Host. (1809), Hierochloe R. Br. (1810), Corynephorus Beauv. (1812), Gaudinia Beauv. (1812), Gastridium Beauv. (1812), Deschampsia Beauv. (1812), Deyeuxia Beauv. (1812), Arrhenatherum Beauv. (1812), Rostraria Trin. (1820), Helictotrichon Besser ex Roemer & Schultes (1827), Triplachne Link. (1833), Avellinia Parl. (1842), Maillea Parl. (1842), Rhizocephalus Boiss. (1844), Antinoria Parl. (1845), Molineriella Rouy (1913), Gaudinopsis Eig (1929), x Agropogon P. Fourn. (1935), Zingeria P. Smirnov (1946) and Parvotrisetum Chrtek (1965).

There has been a difference of opinion over the generic status of Helictotrichon s.l. Boissier, in his Flora Orientalis vol. 5, had a relatively broad generic concept and accepted all perennial species as a separate section of the genus Avena L. This view was also adopted by St.-Yves (1931). In fact these perennial species of Avena s.l. had already been given generic status as Helictotrichon Besser ex Roemer & Schultes (1827). The latter treatment has been accepted by many botanists, such as Potztal (1951), Paunero (1959), Bor (1970), Tzvelev (1976) etc.

Holub (1962) divided the specific contents of the genus Helictotrichon Bess. (Avenastrum C. Koch, nomen superfl.) into two genera, viz. Helictotrichon Bess. 1827 restr. Holub 1962 (type: Avena sempervirens Vill.) and Avenochloa Holub 1962 (type: Avena planiculmis (Schrad.). According to Holub's account in Flora Europaea vol. 5 (Tutin et al. 1980)

Helictotrichon (Bess.) Bess. differs from Avenula (Dum.) Dum. mainly in having leaf blades ribbed on the upper surface, in which there are usually more than two lines of bulliform cells. The proposed new genus Avenochloa covered the subgenera Pratavenastrum and Pubavenastrum which had been accepted by Holub (1958). Holub (1976) gives a detailed historical review of the genera Helictotrichon and Avenochloa. This division has found support from several authors, such as Gervais (1973) and in the list of Central European flora (Ehrendorfer et al. 1967; Ehrendorfer [ed.] 1973).

On the basis of the change in Art. 63 of the Code accepted by the XII International Botanical Congress (Leningrad, 1975), the currently used generic name Avenochloa, corresponding at the time of its publication to all rules of the previous Code, has been replaced by Avenula (Dum.) Dum. 1868. This new name has also found some support, e.g. by Sauer and Chmelitschek (1976). In one of his latest publications, Holub (1977) used the name Avenula (Dum.) Dum. (1868) instead of Avenochloa Holub, and synonymised various illegitimate names.

The genus Koeleria was first described by Persoon (1805). Later annual species of Koeleria were separated from this genus and accepted as a new genus Lopochloa by Reichenb. (1830). Boissier (1884) recognised Lopochloa as a section of Koeleria. Domin (1907) wrote a monograph of Koeleria and treated the genus Lopochloa as a subgenus of it. It was discovered recently that these annual species of Koeleria had already been given generic status under the name of Rostraria by Trinius (1820). In his monograph of Koeleria, Domin recognised a number of subspecific as well as varietal taxa in some species, but many of these new infraspecific groups have so far not been accepted. Recently, Ujhelyi (1972) recognised a number of new species, including two from Turkey (K. pilatii, K. kurdica), but so far his species treatment has not been adopted by other botanists.

Parlatore (1842) described a new genus, Maillea on the basis of Phalaris crypsoides D'Urv. Certainly, P. crypsoides seemed to be wrongly placed in Phalaris by D'Urville, because it had only 1 floret and two stamens in each spikelet, but its winged glumes lead to a misinterpretation of its affinity. Hackel (1892) rightly incorporated this species in Phleum, a view also accepted in Flora Europaea vol. 5 by Humphries and in Flora Aegaea (1943) by Rechinger.

The genus Deyeuxia was first described by Beauvois (op. cit.), following a manuscript name attributed to Clarion. A detailed historical review of the genus Deyeuxia is given by Vickery (1940). According to Vickery, the genus Agrostis has usually been confined to species in which the hairs at the base of the lemma are absent or very short and the rhachilla is not or scarcely prolonged beyond the floret. Calamagrostis, on the other hand, has been described as possessing long hairs on the callus exceeding the length of lemma, but the rhachilla is not prolonged. Deyeuxia has been distinguished by the presence of a distinct, usually hairy prolongation of the rhachilla, and by the hairs on the callus usually not exceeding the lemma in length. Bentham and Hooker (1883) accepted Deyeuxia and Calamagrostis as separate genera but admitted the presence of intermediate species between the two genera. Vickery (op. cit.) supports the acceptance of Deyeuxia as an individual genus. Bor (op. cit.) also treated Deyeuxia and Calamagrostis separately. In most recent works, including 'Poaceae' of U.S.S.R. (Tzvelev 1976) and Flora Europaea these two genera have been put together under the name of Calamagrostis. This is the policy adopted here.

TABLE 1

No.	Genera	Species no.	No.	Genera	Species no.
1	Avena	8	20	Ammophila	1
2	Helictotrichon	8	21	Apera	5
3	Arrhenatherum	3	22	Agrostis	9
4	Gaudinia	1	23	x Agropogon	1
5	Ventenata	3	24	Polypogon	3
6	Gaudinopsis	4	25	Lagurus	1
7	Trisetum	5	26	Gastridium	3
8	Trisetaria	2	27	Triplachne	1
9	Parvotrisetum	1	28	Milium	4
10	Avellinia	1	29	Zingeria	3
11	Rostraria	4	30	Anthoxanthum	3
12	Koeleria	5	31	Hierochloë	1
13	Deschampsia	2	32	Alopecurus	18
14	Molineriella	1	33	Cornucopiae	1
15	Antinoria	1	34	Beckmannia	1
16	Aira	3	35	Phleum	12
17	Corynephorus	1	36	Pseudophleum	1
18	Holcus	2	37	Rhizocephalus	1
19	Calamagrostis	5			

Chapter II

2. Comparative Vegetative Morphological Characters and their Variation

2.1. Material and Methods

The methods used here have already been described by Metcalfe (1960), but for practical reasons these have been slightly altered. Certainly there are far more advanced techniques today for the investigation of fine structures of tissues and organs composing a plant (i.e. see Araldite technique 3.1). For practical taxonomic reasons, the fine structure of cells or tissues does not concern us here.

Leaf blade and stem sections

For the preparation of the leaf blades and stem sections, well preserved lower cauline leaves and the lower half of the stem were carefully dissected from herbarium sheets and boiled gently in water with 1-2 drops of 'Teepol' until the leaves had been restored as nearly as possible to their natural shape; stems required longer boiling. These boiled specimens were placed in a beaker of cold water for a few minutes and then transferred to labelled bottles containing Formalin Acetic Alcohol (F.A.A.) for a minimum period of 48 hours. After F.A.A. treatment all specimens were washed in water for 6 hours with several changes of water and transferred to labelled bottles containing 70% alcohol.

Approximately the middle regions of the leaf blades were taken and all the sections were cut free-hand at 10-20 μ, using a single-edged blade. The material to be sectioned was placed in pith which had been cut lengthwise with the material placed between the two halves. For establishing an appropriate technique a few different types of microtome were used and a number of sections were made according to the wax technique after Johansen (1944).

The sections were cleared in undiluted 'Parozone' (a commercial bleach) for a few minutes and washed several times in order to get rid of the 'Parozone'. These cleared and carefully washed sections were transferred to 50% alcohol for 5 minutes and finally placed in the staining mixture.

The over-night staining technique was used and Delafield's haematoxylin was employed as the stain. The stain was received in standard 100 ml bottles (Product No.35016, BDH Chemicals Ltd Poole, England) and used undiluted and unprocessed. All the sections were placed in numbered 'solid'watch glasses filled with the stain, carefully covered with wax paper to prevent evaporation and finally left over-night.

The following alcohol series was used for destaining, dehydrating and also differentiating the tissues:

a) 50% alcohol for a few minutes

b) Acidified alcohol (made by adding a few drops of concentrated HC1 in 50% alcohol) until tissue differentiation took place

c) 50% alcohol (for stopping the action of acidified alcohol)

d) 70% alcohol for 2-3 minutes

e) 95% alcohol for 2-3 minutes

f) Absolute alcohol for 5 minutes

After the dehydration series, the sections were placed in xylene for 5 minutes and mounted in Canada Balsam. All the slides were carefully numbered and left on a Photax Dishwarmer 2 for at least 48 hours, for drying at a very low temperature. All drawings have been made from these permanent slides with the PZO Camera Lucida, MNR-1.

Surface view preparations of leaf blades and stem epidermis

Stored leaf blades and stems in 70% alcohol were taken and placed on a glass, with their adaxial epidermis facing downwards. The cells and tissues were gradually scraped away with a sharp blade and at the

Fig. 1. Ligule apex types

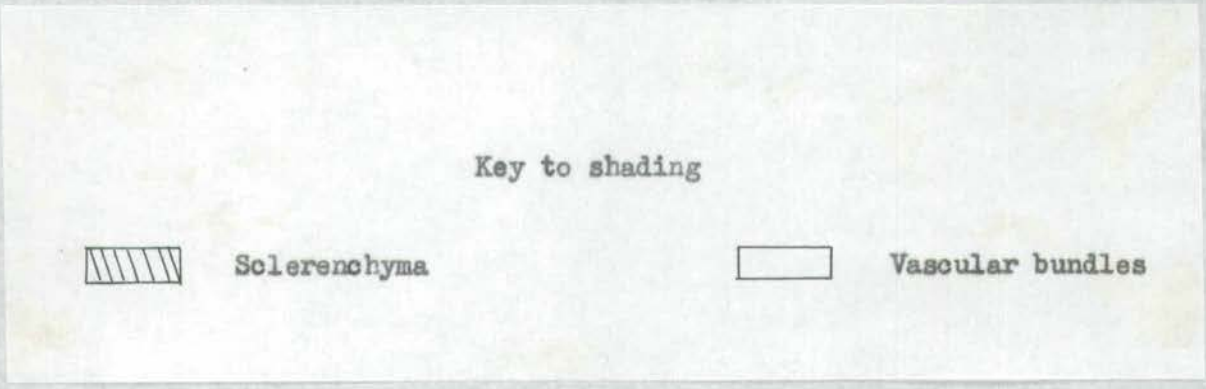
a) Acuminate

b) Acute

c) Obtuse

d) Truncate

Fig 2. Schematic illustration of sclerenchyma types at the vascular bundles in the lemma (transverse section) of the representatives of the family Poaceae (after Vukolov, 1929)



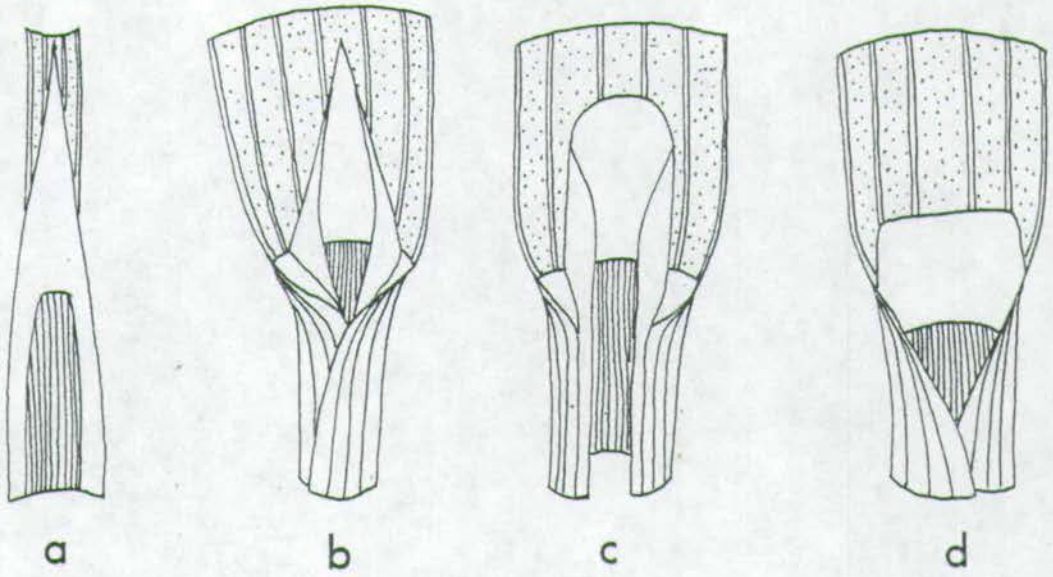


Fig.1

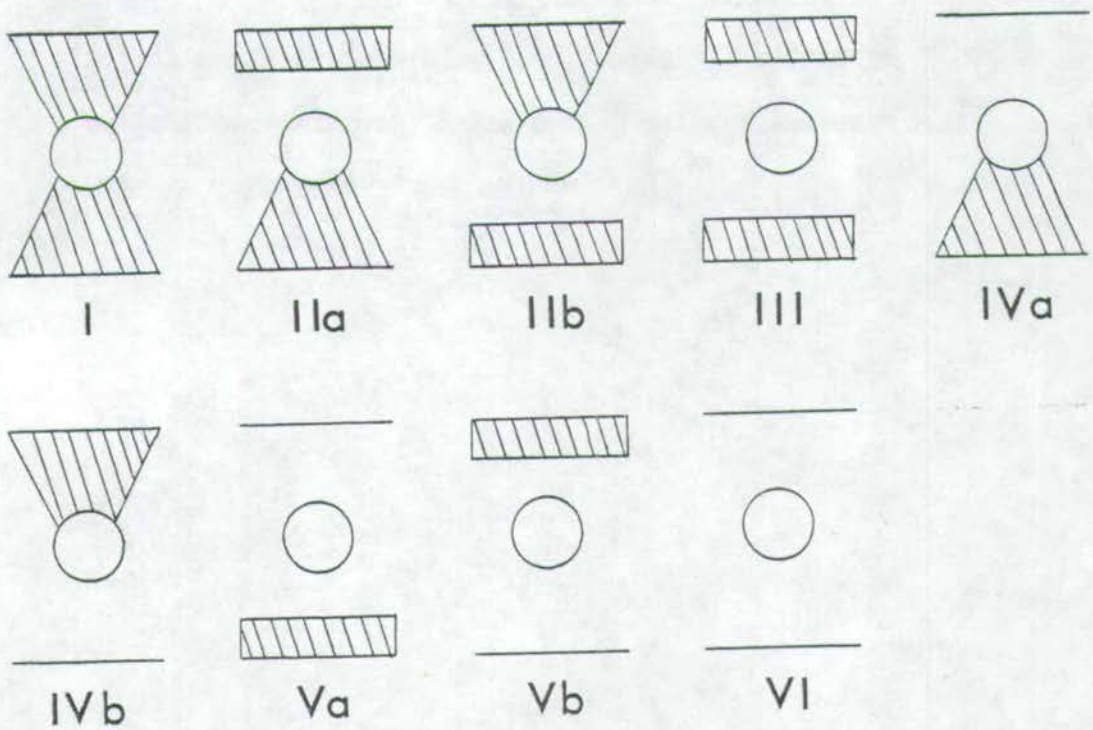


Fig. 2

same time undiluted commercial Parozone was used to clear adhering tissues from the adaxial epidermis. All epidermal cell strips were washed in several changes of and stained according to the over-night staining technique. Finally, the specimens were embedded in Canada Balsam, with the outer side of the adaxial epidermis facing upwards.

2.2. Growth Forms

As far as the revised genera are concerned, tufted and rhizomatous species are equally common in grasses. In general, tufted grasses are mostly annual and the rhizomatous ones are common among perennials. It is often difficult to establish the habit of grasses from herbarium specimens. The annual species have fibrous roots and lack rhizomes, but in the perennial species there are usually rhizomes or sometimes a bulb at the base and non-flowering shoots are often present. Perennial species are mainly common in high mountains where they usually have a rather thickened root-stock at the base, as in Alopecurus lanatus, Alopecurus gerardii, Alopecurus aucheri, etc. These perennial species may owe their presence in high mountains under rather unfavourable conditions to their thickened root-stock and growth forms. In perennial species one or more stems grow together and are often connected to each other through a rhizome. The density of branching gets affected by the soil, such as Alopecurus arundinaceus which has a very dense form on high mountains where the soil is very shallow over rock, but when it is investigated in the lowlands where the soil is rather deep and loose, this species has a loose, long-rhizomatous form. The growth form is also affected by whether the shoots are intravaginal or extravaginal.

2.3. Internal Structure of Root

Arber (1934) investigated the internal root structure in a number of grass species, but the main discovery towards recognising major taxonomic groupings in grasses was first worked out by Sinnott & Bloch (1939). They recognised two distinct types of epidermal cells in the developing grass root. In the first type, 'Type A', long and short cells alternate in the epidermis of the root and these short cells form the root hairs. This type of epidermal cell is found in Festucoid grasses (i.e. Agrostis, Phleum, Poa, etc). In the second type, 'Type B', cells are nearly equal in size in the epidermis of the root and are all capable of producing root hairs. This type of epidermal cell is found in Panicoid grasses (i.e. Chloris, Sporobolus, etc.). Later Reeder & von Maltzahn (1953) recognised two types of cell pattern on the basis of eleven species, and explained the correlation between the cell patterns and other anatomical and cytological characters. Row & Reeder (1957) studied germinating seeds of 82 species belonging to 68 different genera and discovered long- and short-cells, with only the latter producing a root hair (festucoid type), in contrast to equal-sized cells, any of which may provide a hair (panicoid type). Metcalfe (1960) investigated internal structure of roots in some grass species and illustrated a number of them. Jirasek and Chrtek (Jirasek 1964; Chrtek & Jirasek 1965) have established in their works two types of cells in the endodermis of the root: cells of the 'O-type' and those of the 'U-type', but as both types of cell are present in the same tribe this character cannot be used to distinguish one tribe from another.

2.4. Stem

The stem is usually divided into two parts; a) an unbranched leaf-bearing lower part, b) and a branched upper part which is called

Fig. 3. Leaf anatomy types (after Jacques-Felix, 1962, 1964.
In: Tzvelev 1976 p. 31)

a) Bambusoid anatomy (Guadua oblonga)

b) Festucoid anatomy (Phalaris tuberosa)

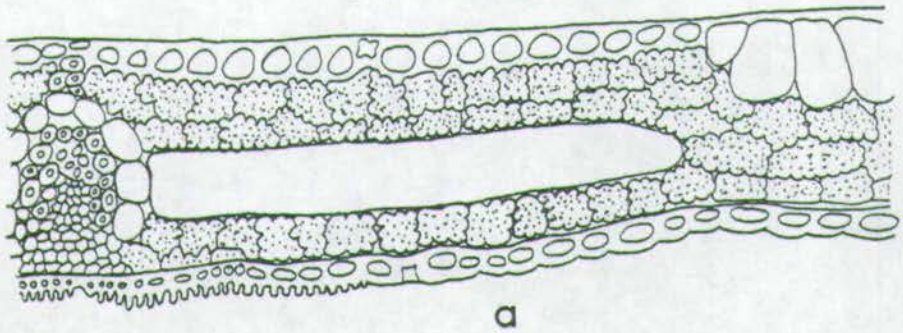
c) Panicoid anatomy (Panicum coloratum)

List of Contractions

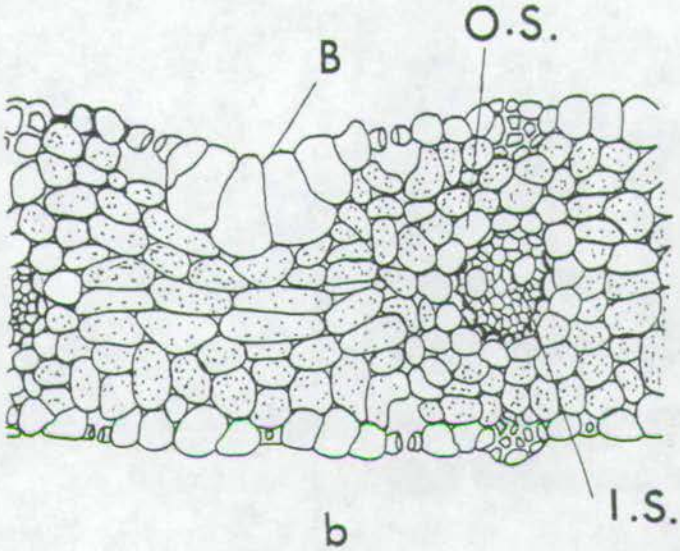
B. Bulliform Cells

I.S. Inner vascular bundle sheath

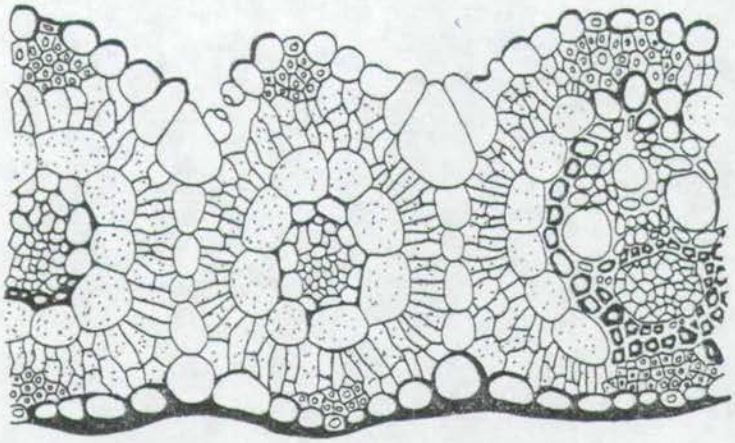
O.S. Outer vascular bundle sheath



a



b



c

Fig. 3

the inflorescence. The length of stem (including the inflorescence) is always given in species descriptions, but it does not provide very much specific information. The stem is sometimes very tall in certain genera, such as Arundo, Phragmites, Ammophila, Cortaderia, etc., but in some others the stem is very short and provides diagnostic characters, as in Rhizocephalus, Phleum crypsoides, etc.

The stem has one or more nodes which interrupt its hollow appearance at least in the revised genera. The number of nodes increases towards the base and internodes get shorter in the lower half of the stem.

The formation of "bulbs" is common in grasses and often provides very much useful taxonomic information and can be used for distinguishing certain species from the others, but it does not have any taxonomic value at generic level as far as the revised genera are concerned. The presence of a bulb at the base of the stem is observed in a number of different species belonging to different genera, such as Phleum, (P. pratense, P. bertolonii), Alopecurus (A. bulbosus), Arrhenatherum (A. palaestinum, A. kotschyi), etc. This bulb formation stores food and makes it available for the production of new shoots.

Internal structure

As the fine internal structure of the stem in its cross section has been investigated and illustrated by a number of botanists, such as Schwendener (1874), Arber (1934), Metcalfe (1960), Booth (1964), Esau (1965), etc., there is no need to describe it once again. De Wet (1960) investigated the stem anatomy in 96 genera belonging to 19 tribes to reveal taxonomically useful characters, and recognised 4 types of stem anatomy: 1) Parenchymatous sheath lacking (the Festucoid type); 2) Parenchymatous sheath composed of small cells (the panicoid-arundinoid type); 3) Parenchymatous sheath composed of very large cells

(the Eragrostoid type); 4) Parenchymatous sheath composed of small cells, which are often furnished with thickened walls and appear to have no chlorophyll; in addition to the above, there is a very distinct inner sheath composed of schlerenchyma (the aristidoid type).

In order to demonstrate the possible usage of internal stem structure, at least in the revised genera, from a taxonomical point, I have examined all species of Alopecurus in Turkey along with one or two species from each of the other genera revised using different species. In these genera all previously published observations were confirmed.

Epidermis

The stem epidermis certainly provides some information in its surface view, but turned out to be more or less uniform in Alopecurus (A. pratensis, A. creticus, A. geniculatus, A. bulbosus). There are three kinds of cells as in the leaf: stomata, long-cells and short-cells. The short cells are usually composed of two cells: silica-cells and cork-cells. Among all the investigated species only Holcus lanatus was found to have epidermal hairs. Whenever there is sclerenchymatous tissue extending outwards, at their attachment point the epidermal cells get smaller.

Sclerenchyma

These lignified cells are clearly visible by their red colour after being treated with HCl during the preparation of slides. This is the tissue situated in the peripheral part of the stem, where it provides strong rigidity, resisting outside presure. In all the investigated four tribes, Aveneae, Milieae, Phleeae, Phalarideae, the sclerenchyma forms a cylinder immediately below the epidermis.

Chlorenchyma

The chlorenchyma appears to be placed just below the epidermis and in the form of longitudinal columns. It is surrounded by fibres internally. It contains cells in which chloroplasts are present and gives green colour to the stem. Chlorenchyma is usually in the form of a cylinder just below the epidermis, but is often interrupted by rays of sclerenchymatous fibres that extend outward from more centrally located sclerenchymatous tissue.

Vascular bundles

In all the investigated genera there is no bundle sheath around each vascular bundle. All vascular bundles are arranged in 1-2 well defined circles, the number of which varies within same species. The number of vascular bundles also varies greatly according to the thickness of stem.

Ground tissue

The ground tissue is made of parenchymatous cells. In the revised genera, in the early stage the cells are intact but are later broken down and leave a hollow in the internodes. Ammophila arenaria is supposed to have a hollow stem, but in my investigation it turned out to be solid and the cells intact, but this may be due to immaturity.

2.5. Leaf sheath

In the revised genera the leaf sheaths are all open, but in some other genera, like Melica, Bromus, Festuca, they form a tube around the stem. This character is very much used in taxonomic studies.
In some of the perennial species, old leaf sheaths are often attached to the main stem and protect it against unfavourable conditions.

When the leaves die off, the sheaths either remain as a whole or are irregularly torn, but occasionally rather characteristically disintegrate into reticulate fibres (i.e. Alopecurus aucheri).

The hairiness of the sheaths is also a quite valuable taxonomic character and often used for distinguishing some of the species. Examples of hairy leaf sheaths are Alopecurus davisii, A. lanatus, A. vaginatus, Holcus lanatus, etc.

Very occasionally the uppermost leaf sheath gets very much inflated, as in Cornucopia (C. cucullatum), Alopecurus (A. setarioides, A. rendlei).

2.6. Ligule

The ligule can either be membranous or hyaline and is sited at the top of the leaf sheath, where it protects the leaf sheaths against any fungal and bacterial attack. In some other grasses the ligule is represented by a fringe of hairs (i.e. Crypsis, Eragrostis, Danthonia, etc.) or completely missing (i.e. Echinochloa crusgalli).

The length of the ligule is quite valuable taxonomically. For example, Agrostis capillaris (Syn. A. tenuis) can be distinguished from Agrostis gigantea by its very short ligule which is even shorter than its width. The shape of the ligule apex provides much useful information in the revised genera. As illustrated in Fig. 1, it can be acuminate, acute, obtuse or truncate.

2.7. Leaf blades

Leaf blades are arranged distichously around the stem and their shape remains linear as far as the revised genera are concerned, but in some other genera (i.e. Oplismenus, Arthraxon, etc.) they are lanceolate. The leaf shape presents some difficulties in certain species in which leaves are either folded lengthwise or variously rolled.

Characters Observed in Transverse Sections

2.7.1. Shape in transverse section

A detailed study concerning the various types of ptyxis was undertaken by Cullen (1978) and previously accepted definitions by De Jussieu, Linnaeus, Lindley and Gray have been discussed carefully. There is therefore no need to enter this controversy once again. The only term which I adopted is 'convolute' (including 'supervolute') as used by the previous workers (i.e. Linnaeus, De Jussieu, Gray). In cross-section four major types of leaf shape are recognised in the revised genera: a) curved; b) conduplicate; c) flat; d) convolute. Whenever the leaf blades are flattened completely, this is termed 'flat' and is very common in grasses, such as Helictotrichon versicolor (Fig. 5, c), H. argaeum (Fig. 4, b), H. compressum (Fig. 4, a), Phleum phleoides, Alopecurus aucheri (Fig. 9, b), Hierochloë odorata (Fig. 9, d), etc. Sometimes the leaf baldes are 'curved' and present a ± semicrescent form. This is basically like the first type, but the margins are curved on both sides of the mid-vein, as in Helictotrichon armeniacum (Fig. 4, c), Molineriella minuta (Fig. 8, g), Gaudinopsis macra (Fig. 8, b), Koeleria cristata (Fig. 9,e) etc. When the leaf margins form an angle of 90° or less, this is called 'conduplicate'. According to the degree of angle, two types are recognised by Cullen (op. cit.), 'conduplicate' and conduplicate-flat', but this is found to be difficult to apply in the grasses since these two types can be found in the same species. However, I have here used the term 'conduplicate' to cover these two types. The conduplicate leaf shape is very common in grasses, particularly the ones in which there is only a couple of bulliform cells which are arranged one on each side along the mid-vein, as in Helictotrichon planiculme: (Fig. 4, d), H. pratense (Fig. 5,a), H. pubescens (Fig. 5, d), H. schellianum (Fig. 6, c), H. marginiata

Fig. 4. Leaf blade sections (cross section) of Helictotrichon

a) H. compressum (x 25) (T. Ekim 932)

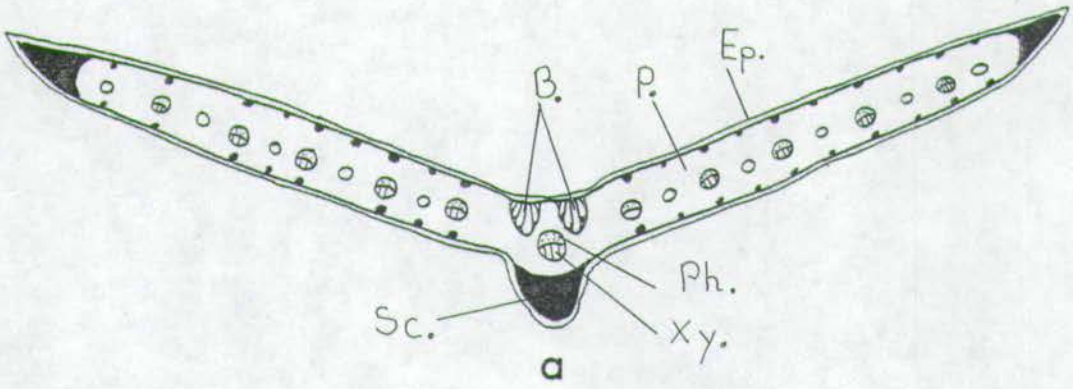
b) H. argaeum (x 25) (D.20546)

c) H. armeniacum (x 25) (D. Litvinov 5202)

d) H. planiculme (x 25) (F. Holtz 1129)

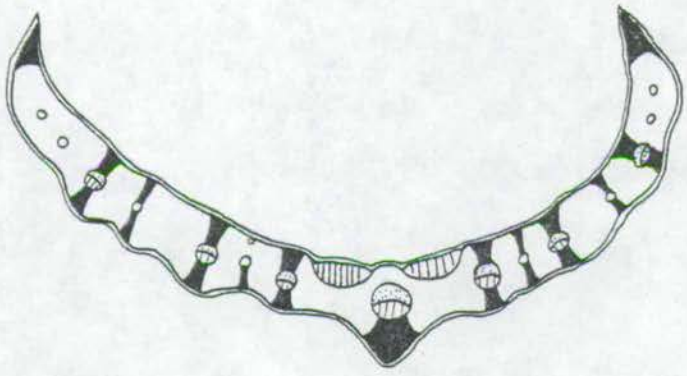
List of Contractions

B. Bulliform Cells	Ph. Phloem
Ep. Epidermis	Sc. Sclerenchyma
P. Parenchyma	Xy. Xylem



a

b



c

d

Fig. 4

Fig. 5. Leaf blade sections (cross section) of Helictotrichon

a) H. pratense (x 25) (A. Tatli ISTE 31299)

b) H. blavii (x 25) (K.F.J. Maly 234)

c) H. versicolor (x 25) (A. Düzenli 414)

d) H. pubescens (x 25) (D.37401)

e) H. convolutum (x 25) (Y. Akman ISTE 12238)

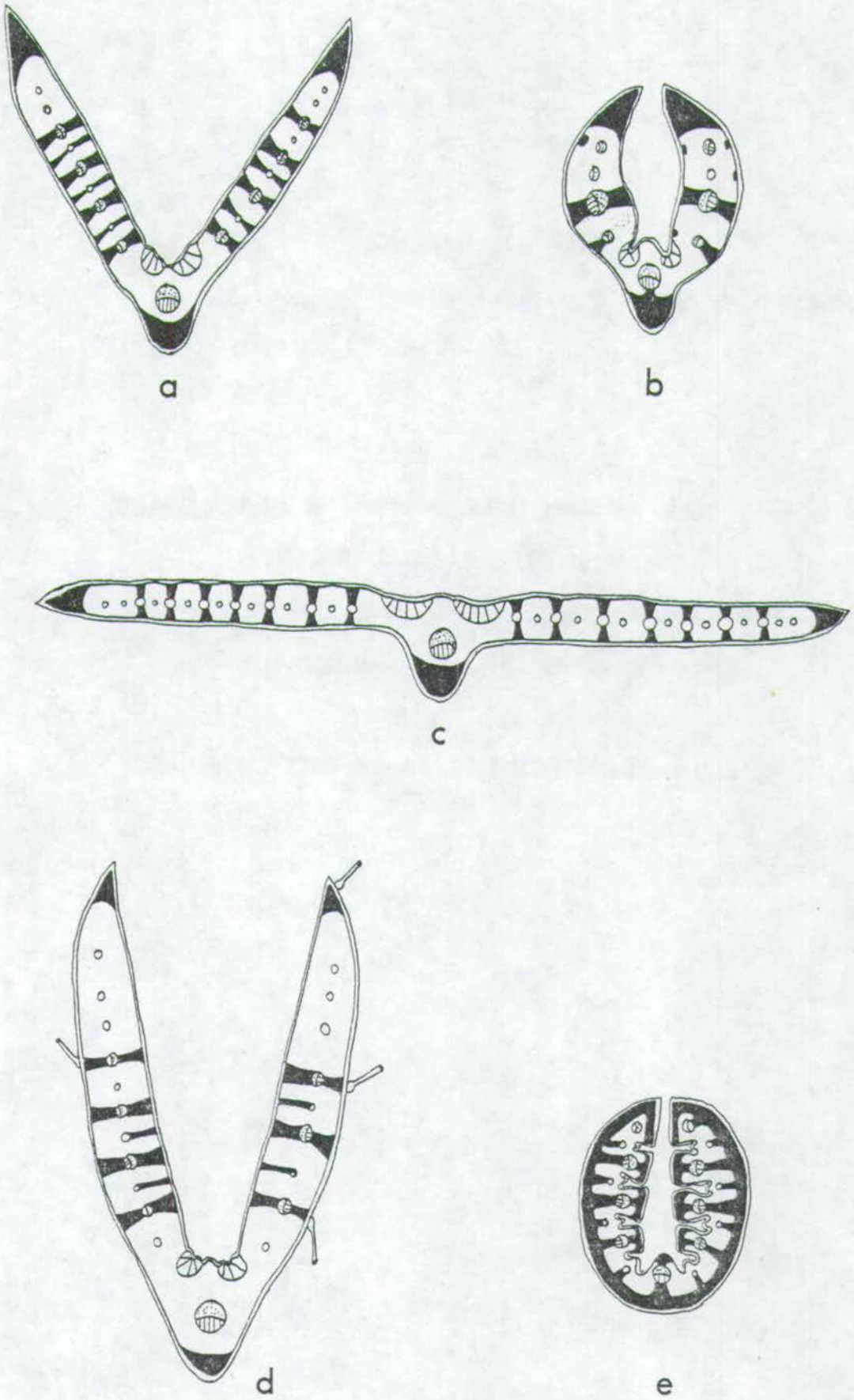


Fig.5

Fig. 6. Leaf blade sections (cross section) of Helictotrichon

a) H. marginiata (x 25) (M. Ferreira 108)

b) H. albinervis (x 25) (M. Ferreira 233)

c) H. schellianum (x 25) (16 vi 1970, I. Krylova)

d) H. sedense (x 25) (vii 1868, Burdey)

e) H. praeusta (x 25) (Vierhapper 3496)

f) H. dahuricum (x 25) (O. Kuzeneva & N. Prochorov 5201)

g) H. setaceum (x 50) (19 vii 1877, E. Reverchon)

h) H. bromoides (x 25) (C. Bicknell 109)

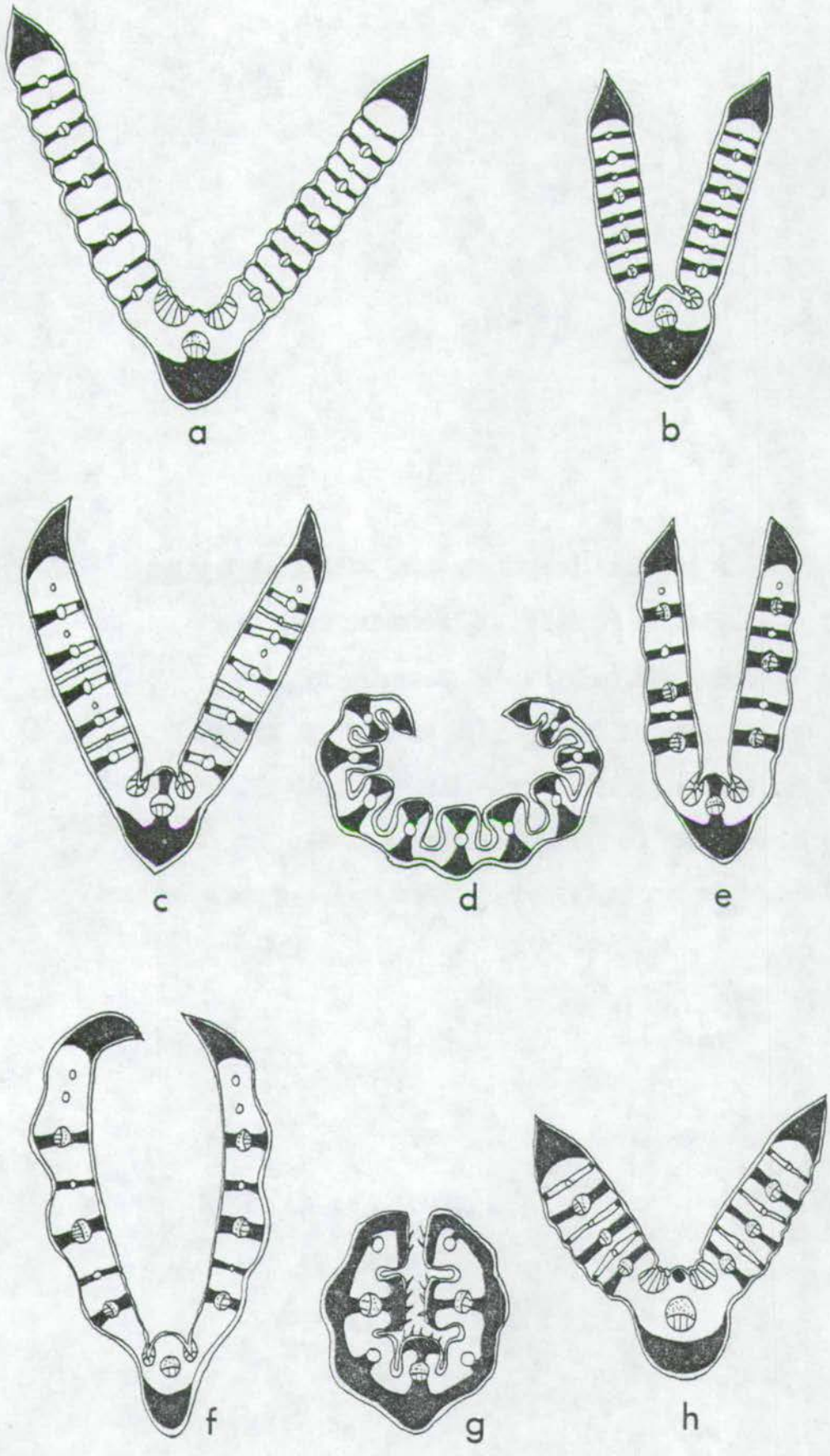


Fig. 6

Fig. 7. Leaf blade sections (cross section) of Helictotrichon

a) H. cincinata (x 25) (Todaro 307)

b) H. filifolium (x 25) (13 vii 1879, E. Levier)

c) H. sedenense (x 25) (1882, Reuter)

d) H. hackelii (x 25) (J.A. Henriques 578)

e) H. desertorum (x 50) (K. Domin 444)

f) H. parlatorei (x 50) (Hayek 256)

g) H. sempervirens (x 50) (8 vii 1886, E. Reverchon)

h) H. decorum (x 50) (A. Richter 4977)

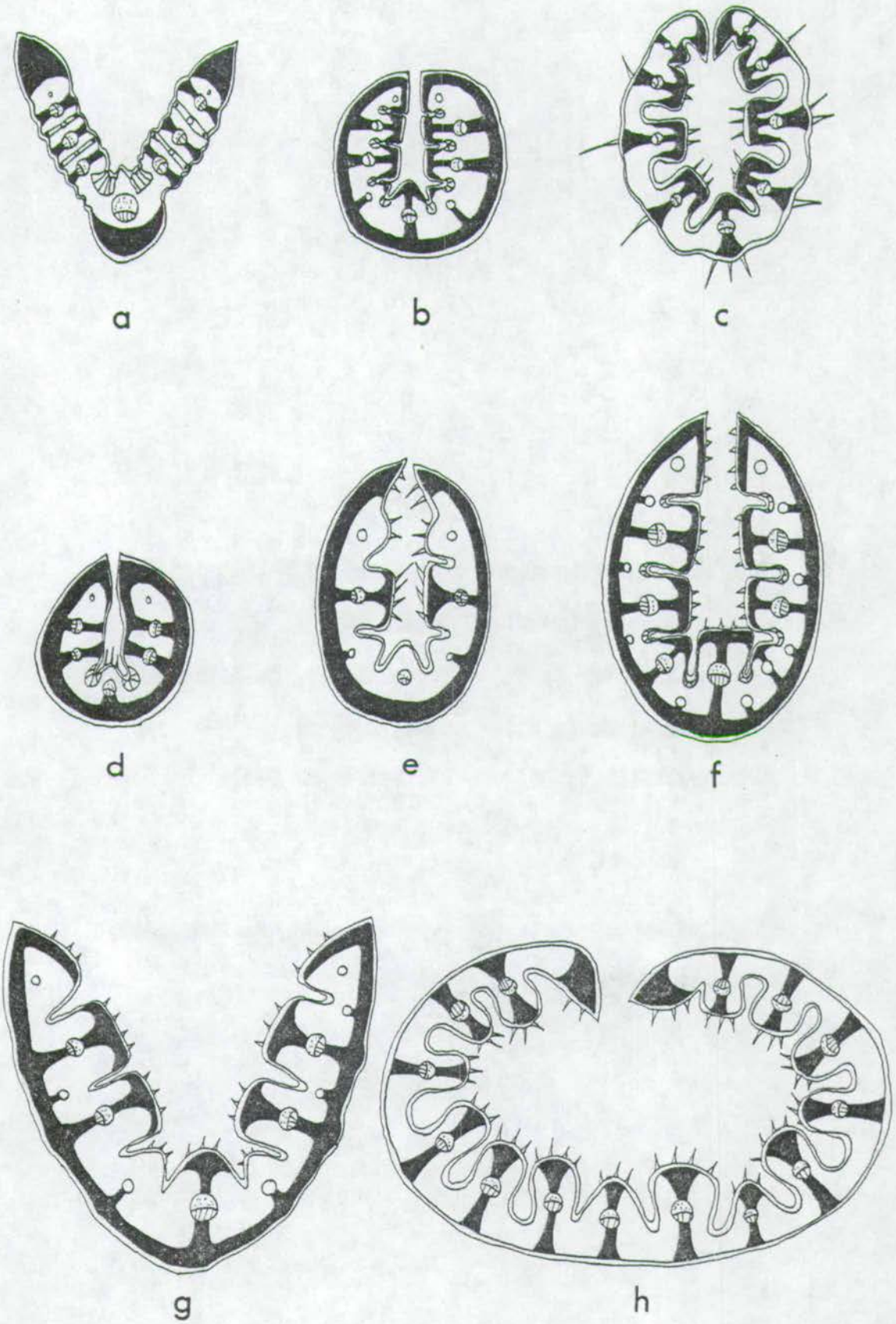


Fig. 7

Fig. 8. Leaf blade sections (cross section) of revised genera

a) Parvotrisetum myrianthemum (x 50) (20 vi 1885, Heldreich)

b) Gaudinopsis macra (x 25) (D.43606)

c) Trisetum flavescens (x 25) (D.20638)

d) Ventenata subenervis (x 50) (S. Oflas 58)

e) Anthoxanthum odoratum (x 25) (Peşmen & Güner 1312)

f) Zingeria trichopoda (x 25) (Coode & Jones 2202)

g) Molineriella minuta (x 50) (P.E. Gibbs et al. 80569)

h) Triplachne nitens (x 25) (iv 1883, G. Ruhmer)

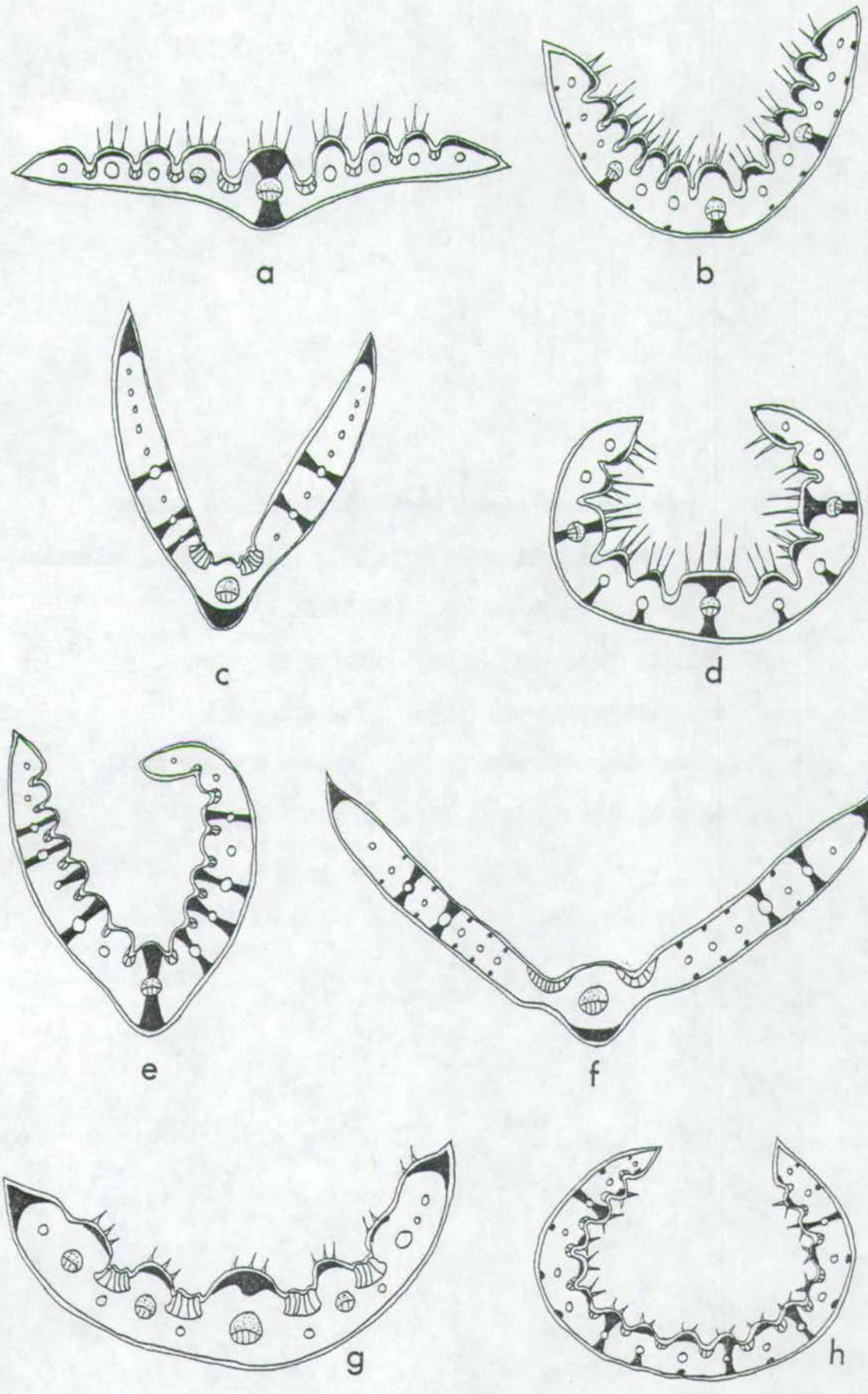


Fig. 8

Fig. 9. Leaf blade sections (cross section) of revised genera

a) Ammophila arenaria (x 25) (T. Uslu 3926)

b) Alopecurus aucheri (x 25) (Stn. & Hend. 5285)

c) Deschampsia caespitosa (x 25) (F. Holtz 945)

d) Hierochloe odorata (x 50) (P. Smirnow 6023)

e) Koeleria cristata (x 25) (Y. Akman 8275)

f) Alopecurus laguroides (x 25) (D.24664)

g) Alopecurus davisii (x 25) (Seçmen & Peşmen EGE 16357)

h) Alopecurus lanatus (x 25) (Coode & Jones 1352)

i) Alopecurus vaginatus (x 25) (D.21091)

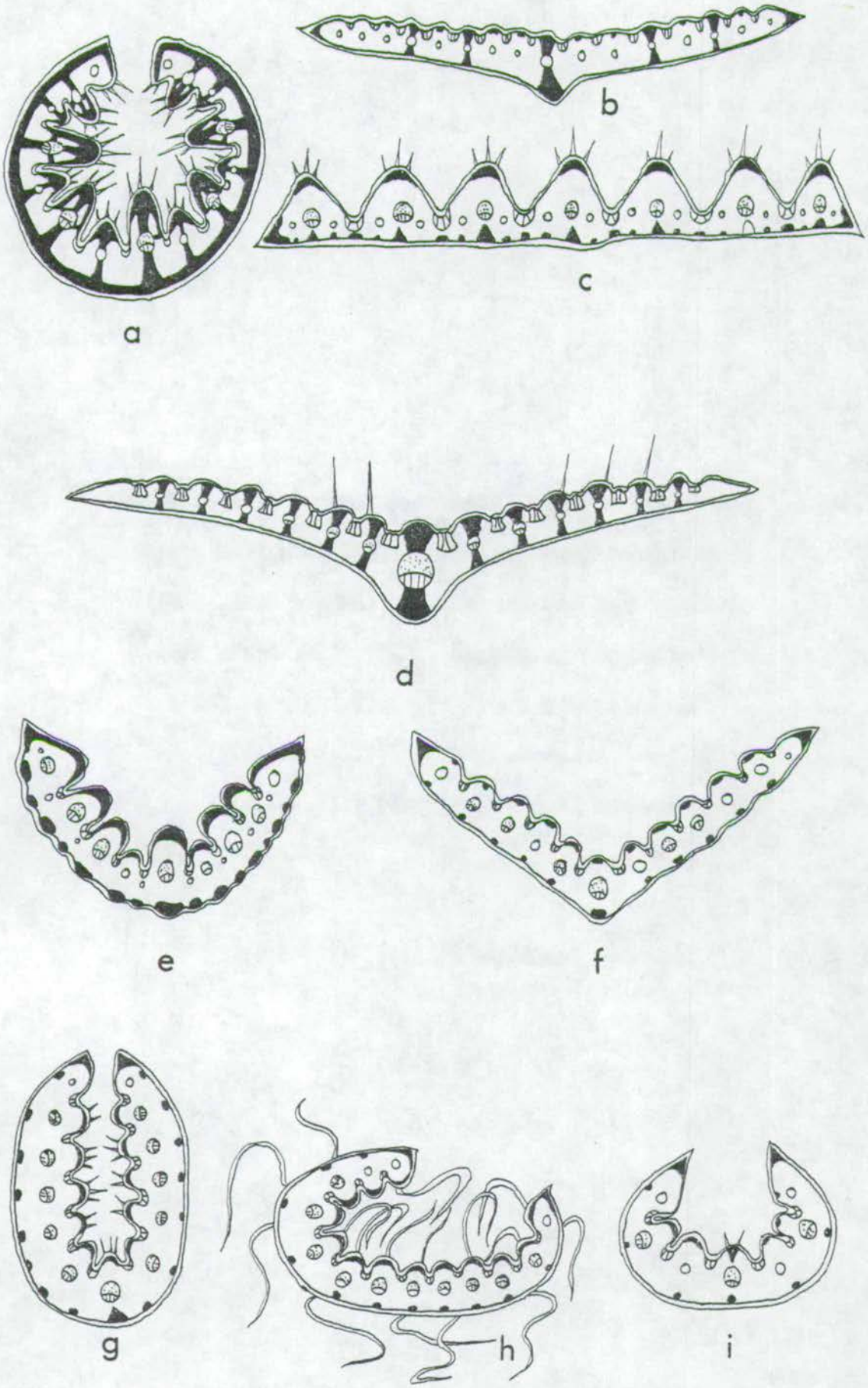


Fig. 9

(Fig. 6, a), Trisetum flavescens (Fig. 8, c) etc. Whenever both margins of leaf blades are very much curved, forming a ± rounded outline, this is called 'convolute' and is very common in grasses in which there are usually 2 or more lines of bulliform cells attached to adaxial side of leaf epidermis. Some examples of this type of leaf shape are Helictotrichon convolutum (Fig. 5, e), H. blavii (Fig. 5, b), Ventenata subenervis (Fig. 8, d), Triplachne nitens (Fig. 8, h), Ammophila arenaria (Fig, 9, a), Alopecurus davisii (Fig. 9, g) and A. lanatus (Fig. 9, h).

2.7.2. Internal structure

The taxonomic importance of internal leaf structure in grasses has long been recognised. The most important work concerning leaf anatomy of grasses is published by Duval-Jouve (1875). He even distinguished 'panicoid' and 'festucoid' grasses on their chlorenchyma and vascular bundle sheath. Stebbins (1956) added two more types of leaf, 'chloridoid' and 'bambusoid'. Later, Brown (1958, 1961) added another two types, 'arundinoid' and 'aristidoid'. The internal fine structure of leaf blades has been explained fully in a number of works by various authors, such as Hackel (1887), Arber (1934), Brown (1958), De Wet (1958), etc. Metcalfe (1960) published a monumental piece of work, in which he tried to standardise the terminology of grass anatomy. Recently, Ellis (1979) standardised the terminology of taxonomically useful internal leaf characters and illustrated each character state.

I have investigated the internal leaf structure of all the revised four tribes namely, Aveneae (incl. Agrostideae), Milieae, Phleeae and Phalarideae, and confirmed their 'festucoid' anatomy in which there is a well developed inner schlerenchymatous sheath around the vascular bundles, the outer parenchymatous sheath being well developed and not segregated from the diffuse chlorenchyma (see Fig. 3, b).

2.7.3. Unicellular hairs on the adaxial and abaxial surface

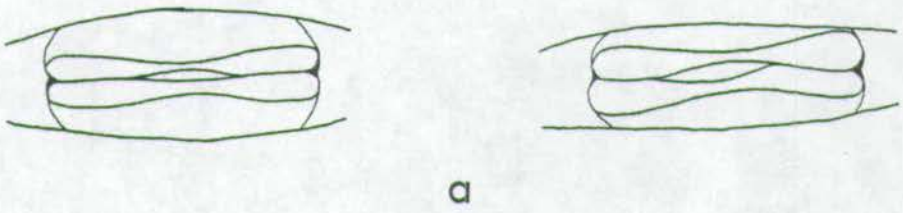
In some of the species there are no hairs either on the adaxial surface or on the abaxial one, as in Helictotrichon versicolor (Fig. 5, c), H. planiculme: (Fig. 4, d), H. argaeum (Fig. 4, b), H. compressum (Fig. 4, a), Alopecurus aucheri (Fig. 9, b), A. laguroides (Fig. 9, f), A. gerardii, etc. Whenever unicellular hairs are present, their length can be compared with the height of the epidermal cells. In some species the hairs are 1-2 x as long as epidermal cell height, as in Helictotrichon hackelii (Fig. 7, d), H. setaceum (Fig. 6, g), H. sempervirens (Fig. 7, g), H. parlatorei (Fig. 7, f), Alopecurus pratensis, A. bulbosus, A. creticus, A. textilis, etc. Occasionally unicellular hairs are more than twice as long as epidermal cell height, as in Alopecurus davisii (Fig. 9, g), A. lanatus (Fig. 9, h), Helictotrichon pubescens (Fig. 5, d), H. sedenense (Fig. 7, c), H. decorum (Fig. 7, h) and H. desertorum (Fig. 7, e).

2.7.4. Ribbing of adaxial surface and rib shape

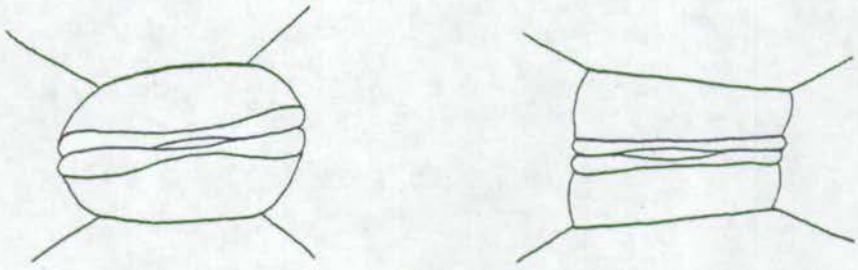
In some species both surfaces of the leaf blades are parallel to each other and in particular the adaxial surface does not form ribs as in Helictotrichon blavii (Fig. 5, b), H. hackelii (Fig. 7, d), H. pubescens (Fig. 5, d), H. versicolor (Fig. 5, c), H. pratense (Fig. 5, a), H. armeniacum (Fig. 4, c), H. argaeum (Fig. 4, b), etc.

Whenever the adaxial surface forms ribs, the shape of each rib is more or less consistent in each species. The shape of ribs can be ± rounded, '⌒-shaped' (i.e. Alopecurus pratensis, A. rendlei, A. utriculatus, etc.), obtuse ' ∩ -shaped' (i.e. Helictotrichon decorum, Alopecurus vaginatus, A. davisii, A. lanatus, A. arundinaceus, etc.), acute ' ∧ -shaped' (i.e. Alopecurus creticus, A. geniculatus, A. bulbosus, A. aequalis, A. myosuroides, etc.), or truncate, ' ⊓ -shapes'

Fig. 10. Stomata types in genera revised (after Ellis 1979)



a



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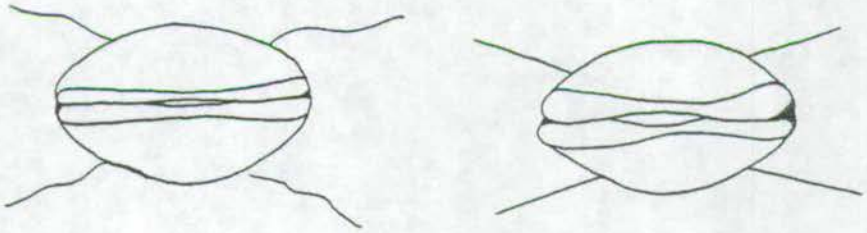

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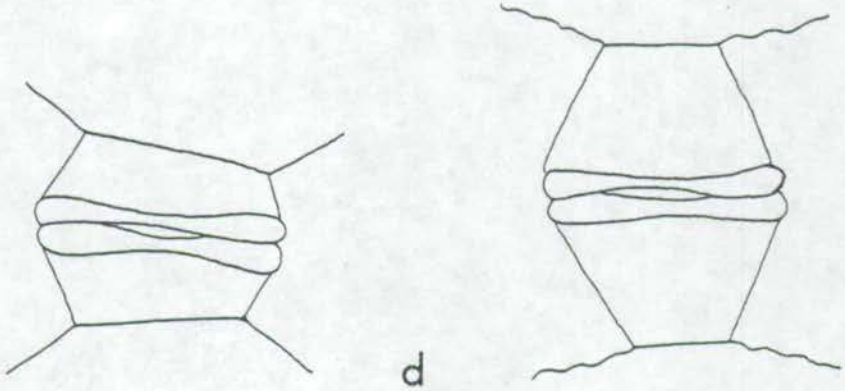


d

Fig.10

(i.e. Alopecurus gerardii, A. aucheri, A. glacialis, Helictotrichon filifolium, H. sedenense, H. setaceum, etc.).

2.7.5. Bulliform cells

The bulliform cells are really part of the adaxial epidermal cells, but they are very much enlarged and specialised for leaf folding or rolling. They should therefore be investigated in cross-sections of the leaf blades. Metcalfe (op. cit.) recognised a few different types of bulliform cells on their shape.

The number of bulliform cells is extremely useful for taxonomic reasons and also to investigate the species relationships in grasses. In certain species there are no bulliform cells, such as Helictotrichon desertorum (Fig. 7, e), H. sedense (Fig. 6, d), H. sempervirens (Fig. 7, g), H. setaceum (Fig. 6, g), H. decorum (Fig. 7, h), H. sedenense (Fig. 7, c). Since the bulliform cells are specialised for folding or rolling of leaf blades, whenever there is permanent rolling which is secured by a continuous subepidermal sclerenchymatous layer, they have lost their function and may be reduced to ordinary epidermal cells. It is not always safe to assume that whenever there is ribbing there should be more than two lines of bulliform cells, but this is often so.

The bulliform cells are either in 2 lines along the mid-vein, as in Helictotrichon pubescens (Fig. 5, d), H. versicolor (Fig. 5, c), H. pratense (Fig. 5, a), H. armeniacum (Fig. 4, c), Trisetum flavescens (Fig. 8, c), etc., or more than 2 lines as in Helictotrichon filifolium (Fig. 7, b) H. parlatorei (Fig. 7, f), H. convolutum (Fig. 5, e), Alopecurus, Phleum, Agrostis, Gaudinopsis, Molineriella, Triplachne, etc.

It seems unreasonable to accept a new genus on the basis of bulliform cells alone, as was done in Helictotrichon by Holub in Flora Europaea vol. 5; subgeneric status seems sufficient. In the subgenus

Helictotrichon of the genus Helictotrichon, there are more than 2 lines of bulliform cells along the mid-vein or bulliform cells are not observable in the intercostal zone of leaves, but there are only 2 lines of bulliform cells along the mid-vein in the subgenus Avenula.

2.7.6. Midrib

The midrib of grass leaf blades has not been investigated very much for taxonomic purposes. In the genus Helictotrichon s.l. some of the species can be distinguished by having an apparent midrib, as in H. compressum (Fig. 4, a), H. argaeum (Fig. 4, b), H. armeniacum (Fig. 4, c), H. planiculme (Fig. 4, d), H. pratense (Fig. 5, a), H. blavii (Fig. 5, b), etc. Other species of Helictotrichon do not have any distinct midrib, as in Helictotrichon convolutum (Fig. 5, e), H. filifolium (Fig. 7, b), H. hackelii (Fig. 7, d), H. desertorum (Fig. 7, e), H. parlatorei (Fig. 7, f), H. sempervirena (Fig. 7, g), etc.

2.7.7. Cuticular Papillae

These are rare in the revised genera and only present in a few species, such as Alopecurus creticus, A. bulbosus, A. geniculatus, A. aequalis, Antinoria insularis and Polypogon monspeliensis. The cuticular papillae are formed originally by the extention of epidermal cells. Rather inflated cuticular papillae are illustrated for Alopecurus geniculatus by Metcalfe (op. cit. Fig. 1, p. 666). The real nature of the papillae can be established when investigated in epidermal surface view preparations.

2.7.8. Sclerenchyma

The sclerenchyma provides mechanical support to the leaf blades and can withstand physical stresses. Sclerenchyma appears to be in the

form of fibrous or thick-walled lignified cells which turn red in contact with acid (HCl). The amount of sclerenchyma differs from species to species and increases with aridity where climatic conditions are rather harsh. The sclerenchyma is in the form of subepidermal longitudinal 'strands' or 'girders', which follow the course of vascular bundles.

Some of the species are quite clearly distinguishable by a continuous subepidermal sclerenchymatous layer, which appears as a band surrounding the abaxial surface of the leaf blades internally, as in Helictotrichon convolutum (Fig. 5, e), H. filifolium (Fig. 7, b), H. hackelii (Fig. 7, d), H. desertorum (Fig. 7, e), H. parlatorei (Fig. 7, f), H. setaceum (Fig. 6, g) and H. sempervirens (Fig. 7, g).

Disposition of sclerenchyma around the vascular bundles was first illustrated diagramatically in Gramineae by Vukolov (1929) and was later used by Chrtek & Jirasek (1963) to define new sections in Trisetum. Five of Vukolov's nine sclerenchyma types (see Fig. 2), around the mid-vein in leaf blades, are found in the genera revised. The distribution of sclerenchyma around the mid-vein appears to be quite different from one species to another in Helictotrichon and Alopecurus. In some species there is only one abaxial strand below the mid-vein without any adaxial sclerenchymatous strand or girders, as in Helictotrichon pubescens (Fig. 5, d), H. versicolor (Fig. 5, c), H. pratense (Fig. 5, a), H. planiculme (Fig. 4, d), H. compressum (Fig. 4, a), H. dahuricum (Fig. 6, f), H. cinciniata (Fig. 7, a), H. desertorum (Fig. 7, e), Alopecurus setarioides, Trisetum flavescens (Fig. 8, c), Zingeria trichopoda (Fig. 8, f), etc. In some of the other species adaxial and abaxial strands are present around the mid-veins as in Helictotrichon bromoides (Fig. 6, h), Alopecurus bulbosus, A. rendlei, A. vaginatus (Fig. 9, i), A. laguroides (Fig. 9, f), A. utriculatus, A. davisii (Fig. 9, g) and A. lanatus (Fig. 9, h). In some of the species there

is an adaxial strand and an abaxial girder around the mid-vein (Fig. 2, IIa), as in Alopecurus creticus, A. geniculatus, A. aequalis, A. aucheri (Fig. 9, b), A. textilis, A. myosuroides, etc. Sometimes the mid-vein has only an abaxial girder (Fig. 2, IVa), as in Helictotrichon armeniacum (Fig. 4, c), H. argaeum (Fig. 4, b), H. marginiata (Fig. 6, a), H. albinervis (Fig. 6, b), H. blavii (Fig. 5, b), H. hackelii (Fig. 7, d), etc. Very often the mid-vein has adaxial and abaxial girders (Fig. 2, I), as in Helictotrichon schellianum (Fig. 6, c), H. praeusta (Fig. 6, e), H. filifolium (Fig. 7, b), H. sedenense (Fig. 7, c), H. decorum (Fig. 7, h), H. setaceum (Fig. 6, g), H. sempervirens (Fig. 7, g), H. convolutum (Fig. 5, e), Alopecurus gerardii, A. arundinaceus, A. glacialis, A. pratensis, etc.

The distribution pattern of sclerenchyma around the next three veins beyond the mid-vein on both sides of the leaf blade is also a useful taxonomic character. Particularly after the first 2 or 3 vascular bundles the same arrangement continues, this pattern being usually consistent in the same species (cf. Table II).

The shape of 'girders' or 'strands' provides useful taxonomic information in grass leaf blades. Various types have been illustrated by Metcalfe (op. cit. Fig. 9). The shapes of strands are usually ovate to rounded but incurved below the mid-vein, as in Helictotrichon planiculme (Fig. 4, d), H. versicolor (Fig. 5, c), H. pratense (Fig. 5, a), etc. In some species, since the adaxial surfaces of leaves are strongly ribbed and the ribs are obtuse above, the adaxial strands appear to be 'crescentiform' as in Alopecurus davisii (Fig. 9, g), A. lanatus (Fig. 9, h), Koeleria cristata (Fig. 9. e), Gaudinopsis macra (Fig. 8, b), etc. The shape of 'girders' appears to be very often I-shaped (after Metcalfe op. cit.), as in Helictotrichon decorum (Fig. 7, h), Anthoxanthum odoratum (Fig. 8, e) Parvotrisetum myrianthemum (Fig. 8, a),

Hierochloë odorata (Fig. 9, d), Alopecurus aucheri (Fig. 9, b), etc. T-shaped sclerenchymatous 'girders' are also very common in grasses, as in Helictotrichon convolutum (Fig. 5, e), H. filifolium (Fig. 7, b), H. sedenense (Fig. 7, c), H. parlatorei (Fig. 7, f), H. setaceum (Fig. 6, g), H. sempervirens (Fig. 7, g), etc.

2.7.9. Vascular Bundles

Number: The number of vascular bundles does not provide very much taxonomic information since it varies greatly with age and environmental conditions. To a certain extent some of the species can be distinguished from one another on the basis of the number of vascular bundles. Some species have up to 11 vascular bundles, such as Helictotrichon filifolium (Fig. 7, b), H. hackelii(Fig. 7,d), H. blavii (Fig. 5, b), H. setaceum (Fig. 6, g), etc. Others have more than 11 vascular bundles, such as Helictotrichon pratense (Fig. 5,a), H. pubescens (Fig. 5, d), H. convolutum (Fig. 5, e), H. compressum (Fig. 4, a), etc.

Arrangement: The arrangement of vascular bundles in the revised genera is usually in one series, with all vascular bundles situated in one plane ± parallel to the adaxial and abaxial surface. The arrangement of vascular bundles has not been studied very much in grasses and never used as a taxonomic character. However, in the genus Helictotrichon I have observed two types of vascular bundle arrangement. In the first type all the bundles are in one series as described above and common in flat and conduplicate leaf blades, as in Helictotrichon compressum (Fig. 4,a), H. argaeum (Fig. 4, b), H. armeniacum (Fig. 4, c), H. pratense (Fig. 5, a), etc. In the second type the vascular bundles are in two series and confined to only some of the convolute leaf blades,

as in H. convolutum (Fig. 5, e), H. sempervirens (Fig. 7, g) and H. parlatorei (Fig. 7, f).

Vascular bundle sheaths: In 'festucoid' grasses, which also include the revised genera, there are two circles of parenchymatous cells around the vascular bundles (see Fig. 3, b). The inner sheath is composed of smaller and thicker cell walls than those of the outer sheath. This case is clearly illustrated in Poa pratensis by Booth (1964 p. 71). The inner sheath remains more or less uniform in the revised group and therefore is not useful from a taxonomic point of view. The outer sheath varies greatly in its interrupted appearance and presents three major types. In the first type the outer vascular bundle sheath completely surrounds the entire vascular bundle, as in Helictotrichon pubescens. The second type is the commonest one, in which the outer vascular bundle is interrupted below. This interruption is often associated with a sclerenchymatous girder or not, and is seen in some species of Helictotrichon, such as H. versicolor, H. pratense, H. armeniacum, H. planiculme, H. argaeum, etc. In the third and final type, the outer vascular bundle sheath is interrupted at both poles by sclerenchymatous girders, as in H. filifolium, H. convolutum, H. parlatorei, etc. (cf. Table II).

Metaxylem elements: As far as the mid-vein is concerned there are always metaxylem elements in the revised genera. Various types of vascular bundles either with or without metaxylem elements are illustrated by Metcalfe (op. cit. Fig. 8). Here, I have investigated the presence or absence of the metaxylem elements in the next three vascular bundles on both sides of the mid-vein and found out their possible taxonomic significance of it (see Table II).

2.7.10. Evolutionary trends

Since an attempt is made here to reveal taxonomically useful internal morphological characters of the leaf blade, it may be rewarding to establish an evolutionary trend on the basis of investigated anatomical characters. For this reason the genus Helictotrichon (incl. Avenula) and a few of its closest neighbouring genera have been investigated and a plausible evolutionary pathway from the most primitive living form to the most specialised one is outlined below.

The shape of the leaves are flat to more or less conduplicate with an apparent midrib in the earliest ones, such as H. pubescens (Fig. 5, d), H. versicolor (Fig. 5, c), H. pratense (Fig. 5, a), H. planiculme (Fig. 4, d), etc. To survive under harsher conditions the leaves became convolute and preserved their midrib, as in H. blavii (Fig. 5, b). Later they lost their midrib, as in H. hackelii (Fig. 7, d), and protected their convolute leaf blades either by having a continuous subepidermal sclerenchymatous layer or by increasing the number of bulliform cell lines, as in H. filifolium (Fig. 7, b), H. sedense (Fig. 6, d), H. decorum (Fig. 7, h), etc.

In the more primitive species, I think the vascular bundle sheath was complete, as in H. pubescens. Later, in accordance with the spread of species into drier environments, the density of the sclerenchyma increased and the complete outer bundle sheath was interrupted at the lower pole by a sclerenchymatous girder. In more favourable conditions the sclerenchymatous girder disappeared and the outer vascular bundle remained interrupred at its lower pole, as in H. compressum, H. planiculme, H. pratense, etc. Finally, when the species penetrated into unfavourable environments, the density of the sclerenchyma increased greatly again and this already semi-interrupted outer vascular bundle sheath was interrupted at both poles by 'girders' and a new type of

vascular outer bundle sheath arose, as in H. convolutum, H. decorum, etc.

The number of bulliform cells is two in most of the less specialised Helictotrichon and also in Trisetum flavescens (Fig. 8, c). Later, in the more specialised species, this number increased greatly and many lines of bulliform cells evolved, but in some of the present Helicto-trichon species bulliform cells have lost their original function as a result of growing under little-changed harsh environmental conditions, and kept their multi-ribbed forms with dense sclerenchyma. In the genera Avena, Arrhenatherum, Ventenata, etc., there are many bulliform cell-lines along the mid-vein. To my mind these are the most recent derivative forms and they are all annuals. Probably the drier and warmer Mediterranean Basin is an ideal place for the formation of these annual genera.

In the genus Helictotrichon all the apparently more primitive species have only one vascular bundle plane, as H. pubescens (Fig. 5, d), H. versicolor (Fig. 5, c), H. armeniacum (Fig. 4, c), etc., but the number of vascular bundle planes increased to two in the more specialised species, such as H. sempervirens (Fig. 7, g), H. parlatorei (Fig. 7, f), H. convolutum (Fig. 5, e).

Characters Observed in Surface View

According to Booth (op. cit.), among the seed plants the epidermis reaches its highest degree of specialisation in Gramineae with the possible exception of Cyperaceae. Grass leaf blades are most important in taxonomic studies than any other part of the plant because they reach maturity long before any other organ. All examples are taken from the middle part of the lowest leaves which reach maturity first. In surface view long cells, short cells and stomata are the main cell types. The short cells are paired and contain one cork cell and one silica cell which often bears a hair.

Fig. 11a. Cell types in epidermal cell strips

Helictotrichon sedenense (x 400) (1882, Reuter)

List of Contractions

H. Hair

I.C. Interstomatal long cell

L.C. Long cell

S. Stomata

S.C. Short cell

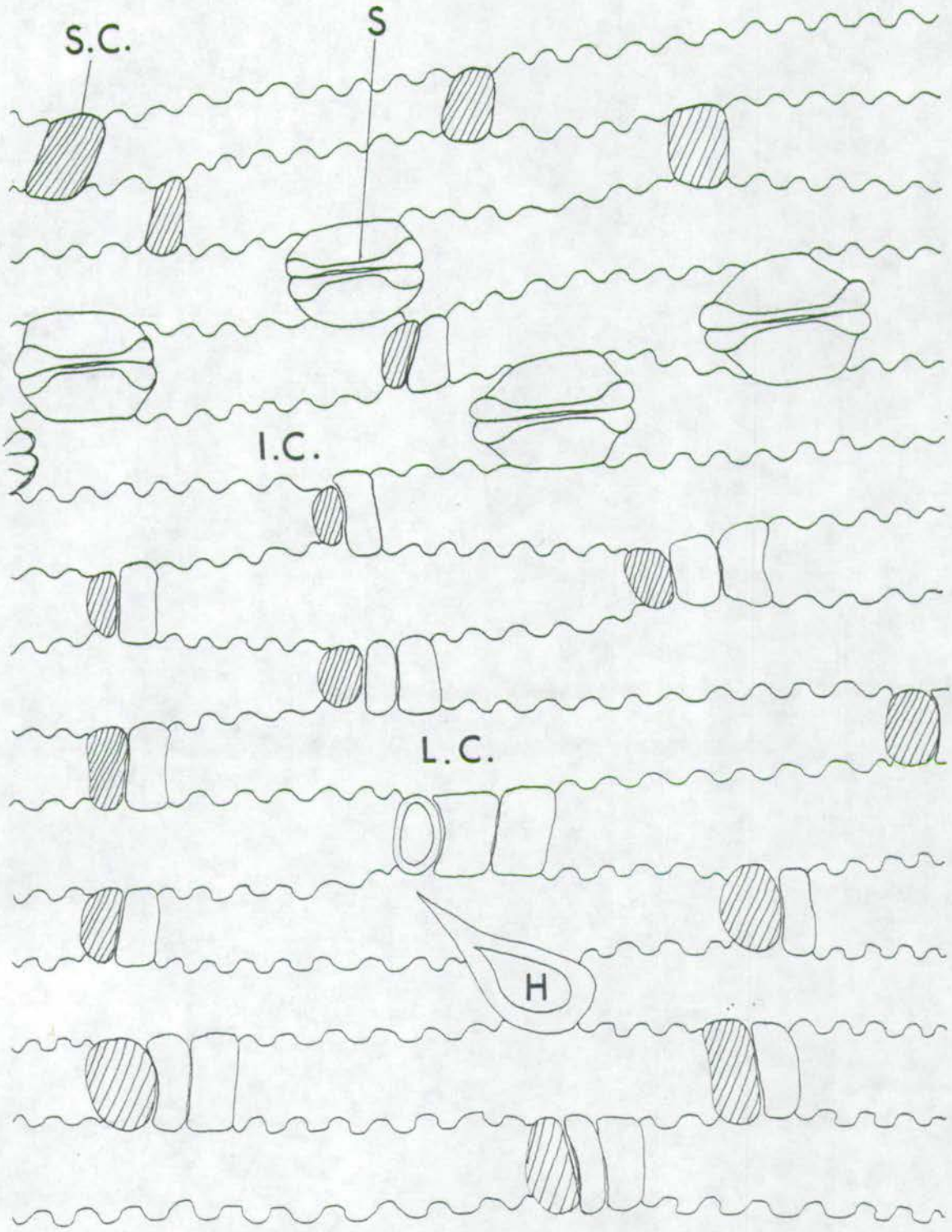
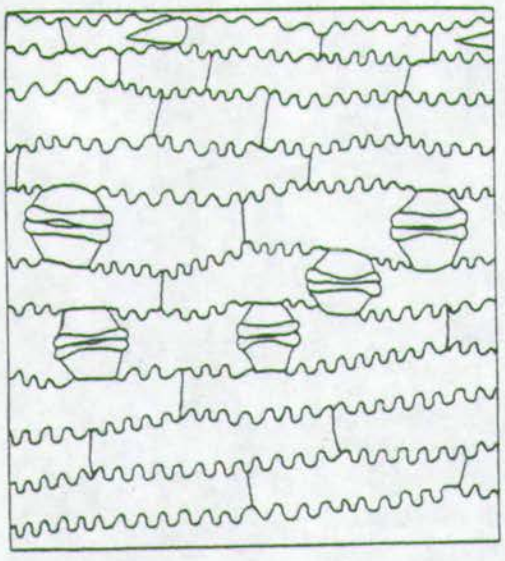


Fig.11a



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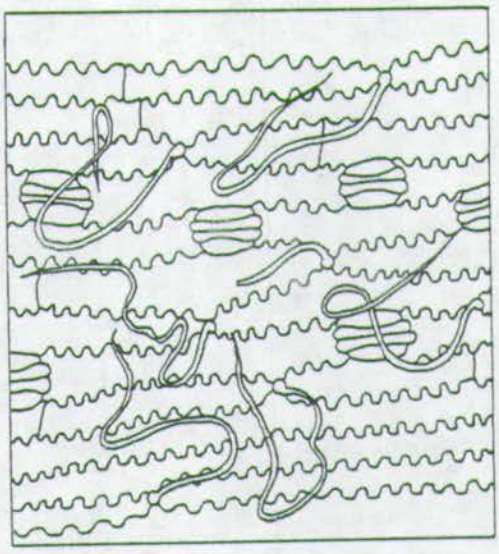

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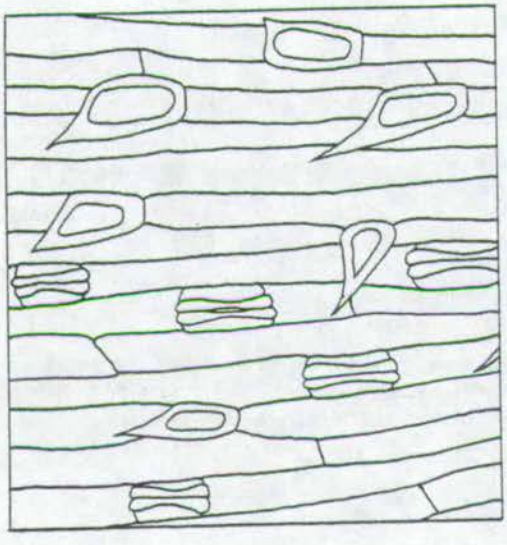

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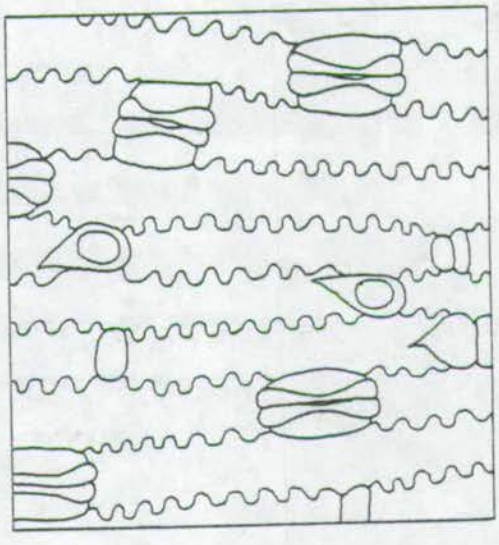

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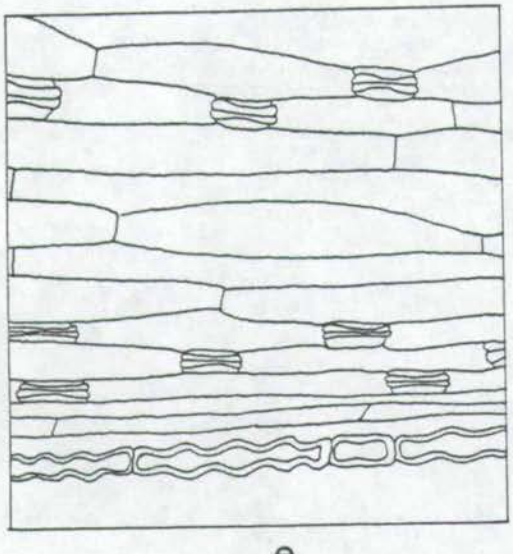

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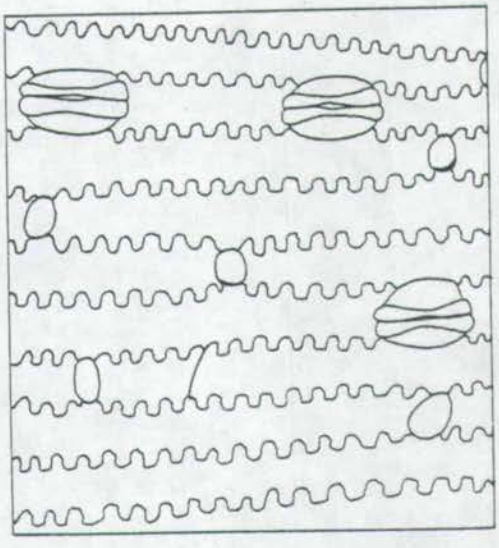


f

Fig. 11b

Fig. 11b. Epidermal cell strips

a) Alopecurus davisii (x 150) (Seçmen & Peşmen EGE 16357)

b) Alopecurus lanatus (x 150) (Coode & Jones 1352)

c) Alopecurus textilis (x 150) (D.20619)

d) Helictotrichon pratense (x 150) (A. Tatli ISTE 31299)

e) Helictotrichon argaeum (x 150) (D.20546)

f) Helictotrichon planiculme (x 150) (F. Holtz 1129)

Fig. 12. Epidermal cell strips

a) Helictotrichon blavii (x 150) (K.F.J. Maly 234)

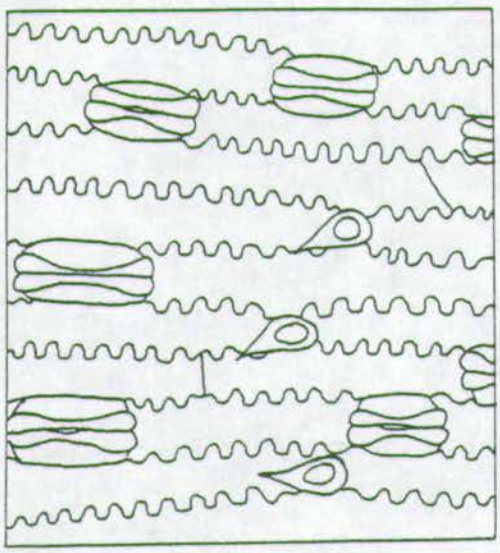
b) H. pubescens (x 150) (D.37401)

c) H. convolutum (x 150) (Y. Akman ISTE 12238)

d) H. praeusta (x 150) (Vierhapper 3496)

e) H. versicolor (x 150) (A. Düzenli 414)

f) H. filifolium (x 150) (13 vii 1879, E. Levier)



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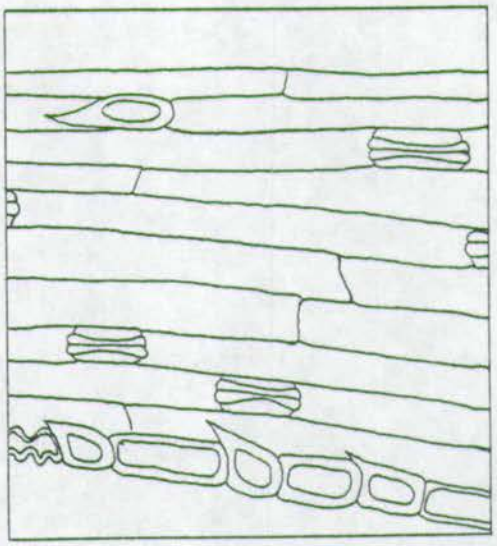

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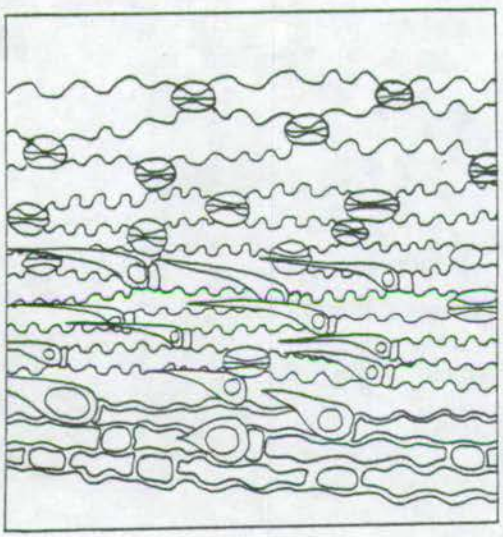

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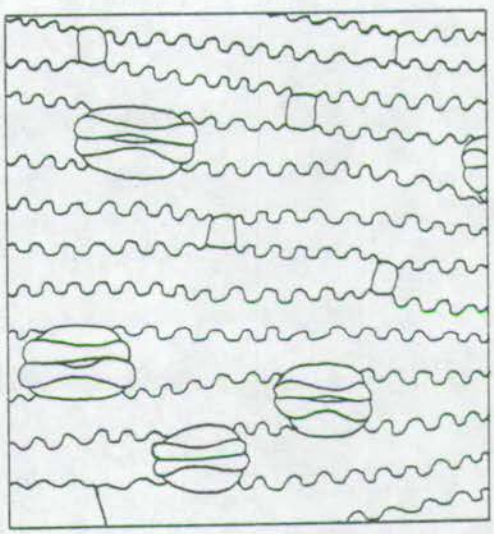

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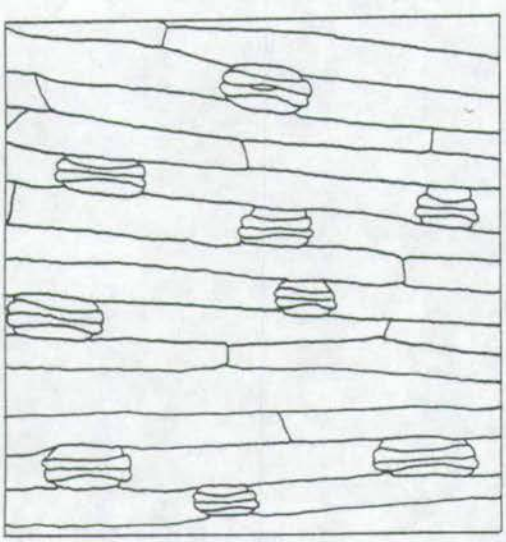

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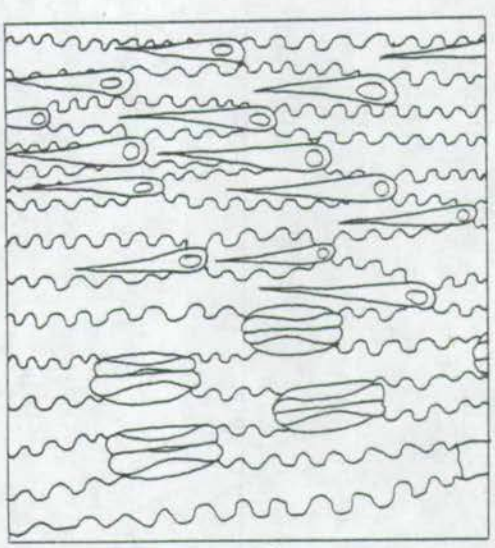

f

Fig. 12

In the epidermal surface preparations, the longitudinal epidermal 'files' overlying the vascular bundles are called the 'costal zone' and the ones between the costal zones are called the 'intercostal zone'.

2.7.11. Crystals

The presence or absence of crystals on the adaxial surface of the leaf blades is investigated on peeled epidermal strips, according to the technique described at the beginning of this chapter. Presence of the crystals was observed in Alopecurus (A. pratensis), Cornucopia (C. cucullatum) and Phleum (P. alpinum, P. montanum, P. pratense). The crystals required further investigation in the revised genera because the technique used for the preparation of slides is not very reliable since it employs HCl for differentiating lignified tissues which may dissolve the crystals.

2.7.12. Hair types

Macro-hairs: The macro-hairs consist of only one cell and are common in the Festucoid grasses. They can be visible to the naked eye and are observable with the help of a hand lens. As the macro-hairs vary in length and thickness, it is sometimes difficult to draw a line between 'prickle' and macro-hair, as was indicated by Metcalfe (op. cit. p. 12). Macro-hairs usually have a sunken base, particularly in the intercostal zone.

Prickle-hairs: The prickle-hairs, as their name implies, are sharp, lignified but short-pointed structures with an enlarged base. They point towards the leaf apex. In previous works, Metcalfe (op. cit.) tried to classify them according to their length/breadth ratio and recognised 'large' and 'small' types, but he admits that intermediate forms are also present. Ellis (op. cit.) compares the width of prickle-hairs with the length of stomata and distinguishes various types.

According to the curving of prickle-hairs a few different types can be distinguished, but it requires further investigation since intermediate types occur between them.

2.7.13. Long cells

Length: The length of intercostal long cells varies greatly from 100 μ to 500 μ or more, and presents some variation since these cells are very sensitive to growth hormones (Stace, 1965). As done by Ellis (op. cit), it seems more practical to compare the length of side walls with end-walls and their ratio, the length/breadth ratio of the cell being up to 3:1 or longer. In the revised genera the intercostal long cells are usually at least 3 x as long as their width, but are very occasionally shorter, as in Triplachne nitens, Calamagrostis arundinacea.

Side walls: Three different types of side walls are recognised here. In the first type, side walls of intercostal long cells are parallel to one another, as in most of the species of Alopecurus and Helictotrichon. In the second type, the side walls of the long intercostal cells form an angle outwards, as in Phleum phleoides, P. echinatum, P. alpinum, etc. In the third type, side walls of intercostal long cells bowed outwards, as in Triplachne nitens, Molineriella minuta, Calamagrostis arundinacea, Polypogon monspeliensis, P. viridis.

End walls: The end walls of long cells are usually at right angles to the horizontal wall, as in Helictotrichon planiculme (Fig. 11, f), H. pratense (Fig. 11, d), H. convolutum (Fig. 12, c), Alopecurus lanatus (Fig. 11, b), A. gerardii, etc. Occasionally the end walls are either oblique or sloping in relation to side walls, as in Phalaris arundinacea, Cornucopia cucullatum, Rhizocephalus orientalis, or rounded as in

Molineriella minuta, Triplachne nitens, Polypogon viridis, Polypogon monspeliensis, etc.

Undulations of side walls: The side walls of intercostal long cells are basically of two types in the revised genera, and further sub-grouping can be recognised here. In the first type cell walls are smooth (straight, bowed or angled), as in Helictotrichon pubescens (Fig. 12, b), H. versicolor (Fig. 12, e), H. armeniacum, etc. In the second type, cell walls are sinuous in various degrees, as in H. planiculme (Fig. 11, f), H. convolutum (Fig. 12, c), H. blavii (Fig. 12, a), etc. (cf. Table II).

2.7.14. Stomata

The stomata are confined to the intercostal region of the leaf blades and arranged in one or more well-defined longitudinal rows. As their fine structure has been fully described by numerous authors, such as Metcalfe (1960), Booth (1964), etc., there is no need to illustrate them here once again. On the basis of subsidiary cell shape, a number of different types of stomata have been recognised in the works of Metcalfe (op. cit.) and Ellis (op. cit.). I have scored four of these types.

The first type, stomata are with parallel-sided subsidiary cells, rectangular in outline, and stomatal complexes are long and narrow (Fig. 10, a). This type is present in a number of species belonging to different genera, such as Helictotrichon pubescens (Fig. 12, b), H. versicolor (Fig. 12, e), Alopecurus vaginatus, A. setarioides, etc.

In the second type, (Fig. 10, b), the horizontal walls of the subsidiary cells are rounded and flattened at the top, as in Helictotrichon pratense (Fig. 11, d), H. planiculme (Fig. 11, f), Alopecurus pratensis, A. geniculatus, etc.

In the third type (Fig. 10, c), stomata are low and dome-shaped, and the vertical width of the subsidiary cells is smaller in relation to the horizontal length, as in Helictotrichon albinervis, H. praeusta, Alopecurus bulbosus, A. textilis (Fig. 11, c), A. utriculatus, etc.

In the fourth type (Fig. 10, d), stomata are flat-topped, side walls and outer horizontal walls are straight, as in Alopecurus davisii (Fig. 11, a), A. lanatus (Fig. 11, b), etc.

2.7.15. Length of Inter-stomatal long cells

The length of the long cells between two stomata also provides quite valuable taxonomic information; these cells are either more than 3 x as long as their width or shorter. Alopecurus davisii and A. lanatus are two closely related species but can even be distinguished on the length of their inter-stomatal cells. As illustrated in Fig. 11, a-b, the inter-stomatal long cells are shorter (120-150 μ) in Alopecurus davisii than in Alopecurus lanatus (170-260 μ).

2.7.16. Short cells

The short cells are also in longitudinal rows like the long cells and are confined either to one of the two zones or occur in both zones. In most cases short cells occur as silica-suberose pairs, but are sometimes solitary. Since they are not sensitive to growth hormones, at a later stage they can remain more or less the same under different environmental conditions and provide valuable taxonomic information.

Types: In the intercostal zone of Alopecurus and Helictotrichon leaves, three major types of short cells are scored. In the first type no short cells are observed, as in Alopecurus pratensis, A. creticus, A. rendlei, A. laguroides, Helictotrichon pubescens (Fig. 12, b), H. versicolor (Fig. 12, e), H. argaeum (Fig. 11, e), etc. In the second

type there is only one short cell between two long cells. This short cell may be in the form of a hook in the intercostal zone, as in H. planiculme (Fig. 11, f), H. bromoides, H. hackelii, Alopecurus geniculatus, A. bulbosus, A. glacialis, A. arundinaceus, etc. In the third type, the short cells consist of two cells between two successive long cells in the intercostal zone, as in Helictotrichon sedenense, H. decorum, H. setaceum, H. sempervirens, H. convolutum (Fig. 12, c), etc.

2.7.17. Silica bodies

In the intercostal zone of Alopecurus leaves, no silica bodies have been observed, but in the other genus, Helictotrichon, silica bodies are present in some species. Since the discovery of the importance of leaf anatomy in taxonomic research, very careful investigations have been carried out by many botanists (Metcalfe (op. cit.), Ellis (op. cit.), etc.).

I have recognised three major types of silica bodies according to their length/breadth ratio. In the first type, the silica bodies are vertically elongated, as in Helictotrichon planiculmis (Fig. 11, f). In the second type, the silica bodies are ± equidimentional and present a number of different forms, such as square, rounded, dumb-bell, etc. Examples of this second type are H. pratense (Fig. 11, d), H. sedenense, H. decorum, H. setaceum, H. convolutum (Fig. 12, c), etc. In the third type the silica bodies are horizontally elongated, as in H. bromoides.

Whenever the distribution of silica bodies in the costal zone is investigated, it is found that their basic type is the same as in the intercostal zone, but they get longer and increase in density. Very often they appear as silica-suberose couples.

2.7.18. Distribution of Intercostal cells

When intercostal cells form horizontal files, they present a

special arrangement pattern. Basically four major types are recognised here. In the first type, there is no short cell at both ends of the long cells so that the long cells join one another, as in Helictotrichon pubescens (Fig. 12, b), H. versicolor (Fig. 12, e), H. armeniacum, H. pratense (Fig. 11, d), Alopecurus davisii (Fig. 11, a), A. gerardii, etc. In the second type, there is only one short cell present between two successive long cells, as in H. planiculmis (Fig. 11, f). In the third type there is a silica-suberose (cork) cell couple present between two successive long cells, as in H. sedenense, H. decorum, H. setaceum, H. sempervirens, H. parlatorei, etc. In the fourth type, there is either a hook, prickle or only a suberose (cork) cell between two successive long cells, as in H. filifolium (Fig. 12, f), H. hackelii, Alopecurus textilis (Fig. 11, c), A. arundinaceus, A. lanatus (Fig. 11, b), etc.

Summary of Characters used in Table II

1. Shape of leaf blades in cross-section

   a) Flat

   b) Conduplicate to conduplicate-flat

   c) Curved

   d) Convolute

2. Number of vascular bundles

   a) Up to 11

   b) More than 11

3. Adaxial surface of leaf blades and its rib shape

   a)  -shaped

   b) -shaped

   c)  to  -shaped

   d)  -shaped

   e) Not ribbed

4. Bulliform cells

   a) Bulliform cells present, in 2-lines along mid-vein

   b) Bulliform cells present, in more than 2 lines along mid-vein

   c) No bulliform cells observed

5. Arrangement of vascular bundles

   a) One-series

   b) Two-series

6. Cuticular Papilla

   a) Present

   b) Absent

7. Unicellular hairs on adaxial and abaxial surfaces

   a) Absent

   b) Small (1-2 x as long as epidermal cell height)

   c) Longer (longer than 2 x as long as epidermal cell height)

8. Sclerenchyma layer

   a) With a continuous ring of sclerenchyma layer surrounding leaf

   b) Without a continuous ring of sclerenchyma layer surrounding leaf

9. Midrib

   a) Visible

   b) Not visible

10. Sclerenchyma types at the mid-vein (after Vukolov, 1929)

   a) VI type

   b) Va type

   c) III type

   d) IIa type

   e) IVa type

   f) I type

   g) IVb type

11. Sclerenchyma types at the first vein (after Vukolov 1929)

   (see 10)

12. Sclerenchyma types at the second vein (after Vukolov 1929)

   (see 10)

13. Sclerenchyma types at the third vein (after Vukolov 1929)

   (see 10)

14. Outer bundle sheath of the mid-vein

a) Complete

b) Interrupted below

c) Interrupted at both poles

15. Presence or absence of Metaxylem elements in mid-vein

a) Metaxylem elements present

b) Metaxylem elements absent

16. Presence or absence of metaxylem elements in first vein

a) Metaxylem elements present

b) Metaxylem elements absent

17. Presence or absence of metaxylem elements in second vein

a) Metaxylem elements present

b) Metaxylem elements absent

18. Presence or absence of metaxylem elements in third vein

a) Metaxylem elements present

b) Metaxylem elements absent

19. Length of intercostal long cells

a) Length 3 x as long as width or longer

b) Length less than 3 x as long as width

20. Side walls of intercostal long cells

a) Parallel to one another

b) Angled outwards

c) Bowed outwards

21. End walls of intercostal long cells

a) Vertical at right angles to the horizontal walls

b) Angled or sloping in relation to the horizontal walls

c) Rounded, cells of the inflated type

22. Undulations of side walls of intercostal long cells

a) Cell walls smooth (straight, bowed or angled)

b) Sinuous

23. Distribution of intercostal cells

a) Long cells without any short cells at both ends, joining one another

b) Single short cell present between successive long cells

c) Silica-suberose cell pairs between successive long cells

d) Hooks and/or prickles present between successive long cells

24. Crystals

a) Present

b) Absent

25. Types of stomata (see Fig. 10)

a) Fig. 10 a type

b) Fig. 10 b type

c) Fig. 10 c type

d) Fig. 10 d type

26. Interstomatal cells

a) 3 x as long as wide, or longer

b) Length less than 3 x as long as wide

27. Intercostal short cells

a) Absent

b) Solitary short cell, includes cells from which hooks arise

c) Paired short cells

28. Papillae

a) present

b) Absent

29. Silica bodies in intercostal zone

a) Vertically elongated

b) Equidimensional

c) Horizontally elongated

d) Absent

TABLE II

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
H. pubescens	b	b	e	a	a	b	c	b	a	b	a	f	g	a	a	b	a	b	a	a	a(b)	a	a	b	a	a	a	b	d
H. versicolor	a	b	e	a	a	b	a	b	a	b	f	a	f	b	a	a	b	a	a	a	a(b)	a	a	b	a	a	a	b	d
H. pratense	b	b	e	a	a	b	a(b)	b	a	b	f	f	f	b	a	b	b	a	a	a	a	b	c-d	b	b	a	b(c)	b	b
H. armeniniacum	c	b	e	a	a	b	a(b)	b	a	e	f	f(e)	f	b	a	b	b	a	a	a	a(b)	a	a	b	a	a	a	b	d
H. planiculme	b	b	e	a	a	b	a	b	a	b	f	f	f	b	a	a	b	a	a	a	a	b	b	b	b	a	b	b	a
H. argaeum	a	b	e	a	a	b	a	b	a	e	f	c(a)	f	b	a	b	b	a	a	a(b)	a(b)	a	a	b	a	a	a	b	d
H. compressum	a	b	e	a	a	b	a	b	a	b	c	c	c	b	a	a	b	a	a	a(b)	a(b)	a	a	b	a	a	a	b	d
H. marginiata	b	b	b	a	a	b	a	b	a	e	f	f	f	b	a	a	b	a	a	a	a(b)	a	a	b	a	a	a	b	d
H. albinervis	b	b	e	a	a	b	a	b	a	e	f	f	f	b	a	a	b	a	a	a	a(b)	a	a	b	c	a	a	b	d
H. schellianum	b	b	e	a	a	b	a	b	a	f	d	a	d	b	a	a	a	a	a	a	a(b)	a	a	b	a	a	a	b	d
H. praeusta	b	b	e	a	a	b	a	b	a	f	f	f	f	c	a	a	b	a	a	a	a	b	c(b)	b	c	a	b(c)	b	a
H. dahuricum	b	b	e	a	a	b	a	b	a	b	f	f	f	b	a	a	b	a	a	a	a(b)	a	a	b	a	a	a	b	d
H. bromoides	b	b	e	a	a	b	a	b	a	c	f	c	f	b	a	a	b	a	a	a	a	a	a-b-d	b	a	a	b	b	c
H. cinciniata	b	b	e(b)	a	a	b	a	b	a	b	f	c	f	b	a	b	a	b	a	a	a	a	a	b	a	a	a	b	d
H. blavii	d	a	e	a	a	b	a	b	a	e	d	f	a(b)	b	a	b	a	b	a	a	a	b	a	b	b	a	a	b	d
H. hackelii	d	a	e	a	a	b	b	a	b	e	f	f	a	b	a	b	a	a	a	a	a(b)	a	d	b	a	a(b)	b	b	d
H. filifolium	d	a	f	b	a	b	a	a	b	f	d	f	f	c	a	b	a	a	a	a	a	b	d	b	b	a	b	b	d
H. sedenense	d	a	f	c(b)	a	b	c	b	b	f	f	f	f	c	a	a	a	a	a	a	a(b)	b	c	b	c	a	c	b	b
H. decorum	d	b	b	c	a	b	c	b	b	f	f	f	f	c	a	b	a	b	a	a	a	b	c	b	b	a	c	b	b
H. setaceum	d	a	f	c	a	b	b(c)	a	b	f	e	f	c	c	a	b	a	b	a	a	a	b	c	b	b	a	c	b	b
H. sempervirens	d(c)	b	f	c	b	b	b	a	b	f	e	f	e	c	a	b	a	b	a	a	a	b	c	b	b	a	c	b	b
H. parlatori	d	b	f	b	b	b	b	a	b	f	e	f	e	c	a	b	a	b	a	a	a	b	c	b	b	a	c	b	b
H. convolutum	d	b	f	b	b	b	a	a	b	f	e	f	e	c	a	b	a	b	a	a	a	b	c	b	c	a	c	b	b
H. desertorum	d	a	f	c	a	b	c	a	b	b	e	f	b	b	a	b	a	a	a	a	a	b	c	b	b	a	c	b	b
H. sedense	d	a(b)	f	c	a	b	a(c)	b	b(a)	f	f	f	f	c	a	b	a	b	a	a	a	b	c	b	b	a	c	b	b

Chapter III

3. Comparative Reproductive Morphology

3.1. Material and Methods

Investigating Reproductive Morphology:

Reproductive organs were studied by the use of x 10 to x 20 dissecting microscope. For further investigation of spikelet structure, spikelets were boiled in a beaker filled with water for 2-5 minutes on an electric hot plate. It was often necessary to add a few drops of Teepol to the boiling water for clearing the specimens. They were then placed on a smooth tile and dissected from below upwards under the dissecting microscope, using two fine needles. All spikelet parts were arranged on a card according to their position in the spikelet, e.g. lower glume, upper glume, lowest lemma, lowest palea, caryopsis, etc. For comparative reasons a number of spikelets from the same inflorescence from below upwards or from different inflorescences were also dissected and mounted on cards. The adhesive was commercial Gloy. All these specimens on cards were numbered carefully.

For analysing microscopal structure, spikelet parts were boiled, then mounted in lactophenol on a slide, covered by a coverslip, sealed with Canada Balsam, labelled and stored for further light microscopal investigations.

Scanning Electron Microscopy:

To study structure of the spikelet parts in high magnification a scanning Electron Microscope (S.E.M.) was used. In the preparation of a spikelet for the study, all spikelet parts were carefully dissected and mounted on the standard S.E.M. stubs by the use of double-sided sellotape. Specimens were coated with a thin gold layer c. 100°A (10 nμ). The specimens and upper surface of double-sided sellotape were

connected in the aluminium stub by the use of conductive silver paint (Electrodag 9/5, Acneson Colloids). All stubs were numbered and kept in a plastic box. Photographs were taken on Ilford PH5.

Awn Structure:

To study the internal structure of awns, carefully dissected awns were placed in 2% "Glutaraldehyde" (made up in 0.1 M phosphate buffer, ph. 7.2) for 24 hours. Awns were first washed in phosphate buffer for another 24 hours and then transferred to 1% Osmium tetroxide for an hour. Specimens were dehydrated in the following alcohol series: 20%, 40%, 60%, 80%, 100%, alcohol. Each stage lasted half an hour. When embedding specimens in "Araldite", the following regime was followed:

*E.P.P. alcohol	1:1	1 hour
E.P.P.	Pure	1 hour
E.P.P./ Araldite	2:1	overnight (12 hours)
E.P.P./ Araldite	1:1	next morning (12 hours)
E.P.P./ Araldite	1:2	next afternoon (12 hours)
Fresh Araldite		overnight (12 hours)

Finally specimens were blocked out in fresh Araldite and were placed in an oven for 48 hours at 60°C. Specimens were cut out by the use of a metal saw and 2 μ thick sections were made with an LKB Ultrotome using a glass knife. Sections were transferred to a slide with the help of a small brush and left on a dishwarmer until the preparation was completely dry. All sections were stained with Toluidine Blue and finally dehydrated. Slides were numbered and kept for further investigation.

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* E.P.P. (Propylene oxide)

3.2. General Inflorescence Types

Generally speaking, the inflorescence consists of the flowering part of the stem. Several different types have long been recognised on the basis of degree of branching on the main axis. Croizat (1943) explained briefly the concept of the inflorescence and later Ricket (1944) revised previous classifications of inflorescence and defined various types. In the group revised in this thesis three major types of inflorescence are recognised: Spike, Raceme, Panicle.

Whenever spikelets are sessile on the main axis, this is called a "Spike". A typical example of this type of inflorescence is illustrated by Gaudinia fragilis. In this group some genera, such as Haynaldia, Henrardia, Triticum, Secale, Hordeum, etc., have a very dense inflorescence and more than one spikelet at each node; but in some others, such as Lolium, Elymus, Aegilops, etc., there is only one spikelet at each node and the inflorescence is more or less interrupted in most cases. Here, the position of the spikelet is very important from a taxonomic viewpoint. In certain genera, spikelets are "edge on" to the main axis (Fig. 13), as in Agropyron, Eremopyrum, Elymus, Gaudinia, and contain 2 perfect glumes, but in some others spikelets are "back on" to the main axis (Fig. 13) and contain only 1 glume, as in Lolium.

In some genera spikelets are borne on short or relatively long pedicels and secondary branching is not present, as in Gaudinopsis, Danthonia, Trachynia, Vulpia, Micropyrum, Brachypodium, etc. The presence of only primary branching defines what is here called a "Raceme". Some genera have very short pedicels and can be mistakenly treated as spike since they are not obvious to the naked eye. There is also another controversy over the presence of racemes in some genera, viz. Avena, Bromus, etc. Some taxonomists have treated their inflorescences as racemes, while others as panicles, because a few of the pedicels

arise from the same node. It is probably best to treat them as panicles because when the pedicels get longer they also tend to have some secondary branching, as in Avena for example.

If spikelets are inserted on secondary or higher order branches of an inflorescence it is called a "Panicle". This is the commonest inflorescence type of all and occurs in many grass genera. Very often, it is easy to divide this large group into 2 subgroups on the basis of the plumose appearance of their inflorescence, such as in the genera Calamagrostis (C. epigejos, C. pseudophragmites, C. canescens), Agrostis (A. olympica), Arundo (A. donax), Imperata, etc., and the remaining non-plumose ones. This non-plumose group is also divided into 2 further groups according to the density of inflorescence branches. The inflorescence may be a dense spike-like panicle and at least twice as long as broad (e.g. Koeleria, Gastridium, Pseudophleum, Polypogon, Rostraria, Alopecurus, Phleum, etc.) or it may be a dense head-like panicle, 1-2 times as long as broad (e.g. Rhizocephalus, Lagurus, Cornucopia, Phleum crypsoides, Alopecurus (A. utriculatus, A. rendlei, A. textilis, A. setarioides, etc.).

3.3. Pedicels

Pedicels do not have much taxonomic value at the supra-specific level, but they can be used in certain cases to distinguish some closely related species. In most cases the shape of the pedicel is unique and usually swollen at its distal end, having a clavate appearance. The length of the pedicels is used quite often for comparative reasons, being either given as absolute length, such as in Milium (M. vernale, M. pedicellare), Zingeria (Z. trichopoda, Z. pisidica), or as pedicel/spikelet ratio, as in Aira (A. caryophylla, A. elegantissima).

The scabridity of pedicels can also be used for taxonomic purposes.

Plate 1. Pedicels in Agrostis

a) A. olympica (A. Baytop ISTE 20936)

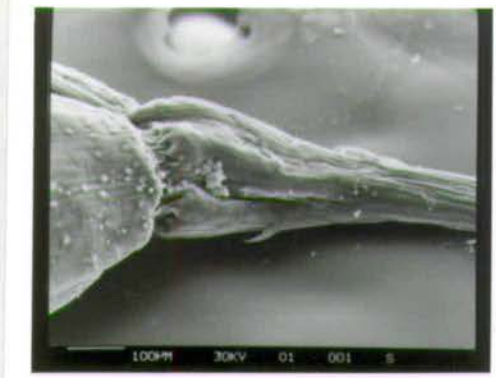
b) A. canina (A. Baytop ISTE 33691)

c) A. gigantea (McNeil 697)

d) A. capillaris (A. Baytop ISTE 33728)

e) A. lazica (Bal. 624)

f) A. stolonifera (D.47278A)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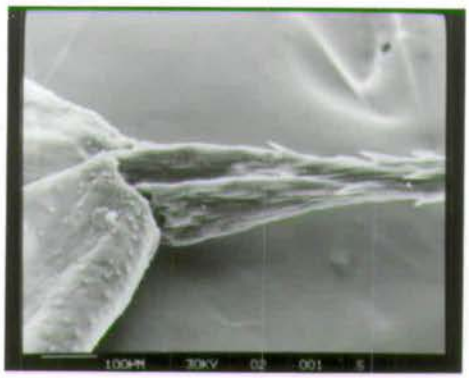
a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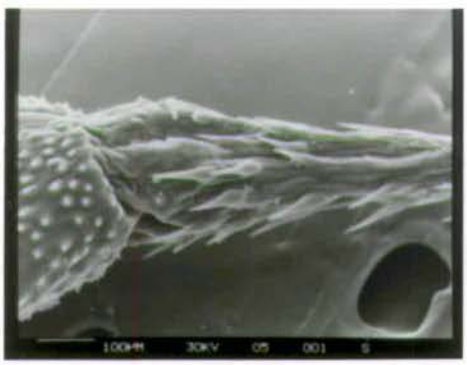
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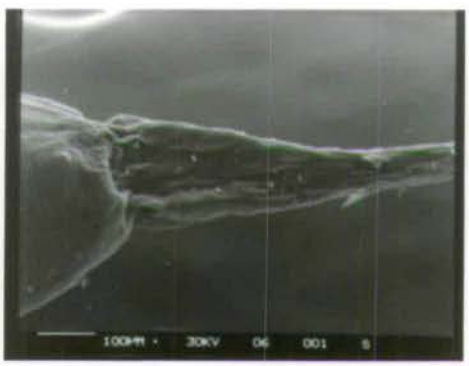
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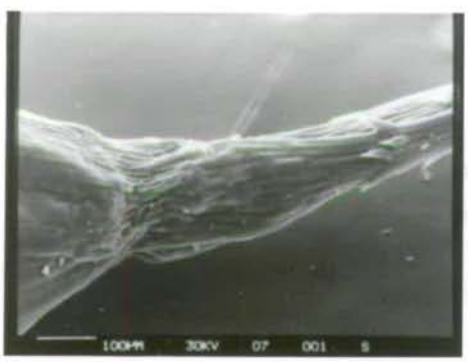
d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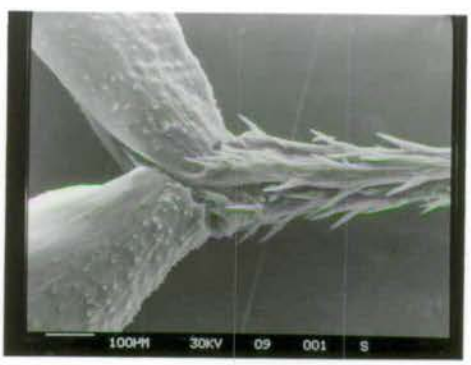
e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f

Pl.1

In the genus Agrostis, as illustrated in Pl. 1, A. gigantea and A. stolonifera are the only species in which pedicels are rather scabrid; the remaining Turkish species have more or less glabrous pedicels.

3.4. Involucre

Only in the genus Cornucopia is there an involucre - a cup-shaped structure which envelops almost half of the dense head-like panicle. Its occurence is very rare in grasses as a whole, but whenever it is present, provides much taxonomically valuable information, here for instance in helping to distinguish Cornucopia from its closest relative Alopecurus. One can assume that the involucre protects the spikelets, but in some other genera protection of spikelets is taken over by the uppermost leaf sheaths, as in Crypsis (C. aculeata, C. schoenoides), Rhizocephalus, etc. Since the involucre persists, holding the spikelets very tightly in Cornucopia, it plays a major role in seed dispersal and the entire inflorescence is transported to new locations.

3.5. Spikelets

There is a considerable literature dealing with spikelet morphology. The most important papers are by Arber (1934), Hackel (1887), Bews (1929), Philipson (1934), Saunders (1937, 1939) and Hubbard (1948).

Glumes are usually 2 in number (i.e. Agrostis, Ammophila, Aira, Avena, etc.), sometimes one (i.e. Lolium) or absent (i.e. Leersia). Each floret consists of a lemma ("bractlet" according to Hackel, op. cit.) and palea ("superior lemma" according to Boissier, 1884). The lemma and palea protect ovary, stamens and lodicules. Whenever spikelets have more than one floret, each of these florets is connected to the others by the floret axis which is called a "rhachilla". The attachment of the floret to the rhachilla is a scarred organ called the callus.

3.5.1. Spikelet diagrams:

As illustrated in Fig. 14, there appear to be four very distinct types of floral diagram in the four tribes revised here; Aveneae (incl. Agrostideae), Milieae, Phalarideae and Phleeae. In this revised group only the floral diagrams of Avena and Anthoxanthum have so far been illustrated previously by Hackel (op. cit. p. 12), but in his Anthoxanthum illustration he placed the stamens opposite to each other by mistake. Later Arber (op. cit. p. 158) corrected this situation.

Type I includes genera in which the spikelets have 1 to few florets, laterally compressed, glumes and lemmas keeled, palea 2-keeled, stamens 3, lodicules 2(-3), and caryopsis dorso-ventrally compressed. Among the genera with this type of floral diagram are Avena (Fig. 14, Ic), Helictotrichon, Arrhenatherum, Gaudinia, Ventenata, Gaudinopsis, Trisetum, Trisetaria, Parvotrisetum, Koeleria, Rostraria, Avellinia, Deschampsia, Antinoria, Molineriella, Aira, Corynephorus, Holcus, Calamagrostis, Ammophila, Apera, Lagurus, Agrostis (Fig. 14, Ia-Ib), x Agropogon, Polypogon, Gastridium and Triplachne.

Type II includes genera in which spikelets have 1 floret, ± dorso-ventrally compressed, glumes and lemma rounded on the back, palea 2-keeled, stamens 3, lodicules 2, caryopsis ± dorso-ventrally compressed or almost terete. This type of floral diagram is seen in Milium and Zingeria (Fig. 14, II).

Type III includes those genera with 1(-2) florets, laterally compressed, glumes keeled but lemmas rounded on the dorsal side, palea 2-keeled, stamens 3(-2), lodicules 2, caryopsis ± dorso-ventrally compressed. This type of floral diagram is seen in Beckmannia (Fig. 14, IIIb), Phleum (Fig. 14, IIIa), Rhizocephalus and Pseudophleum.

Type IV includes those genera in which the spikelets have 1-3 florets, laterally compressed, glumes and lemmas keeled, palea 1-keeled,

Fig. 13. Spikelet morphology

a) "Back on Spikelet" (Lolium perenne) (x 15) (T. Ekim 2284)

b) "Edge on Spikelet" (Elymus repens) (x 15) (F. Holtz 980)

List of Contractions

A. Axis

L. Lemma

L.G. Lower glume

LO. Lodicule

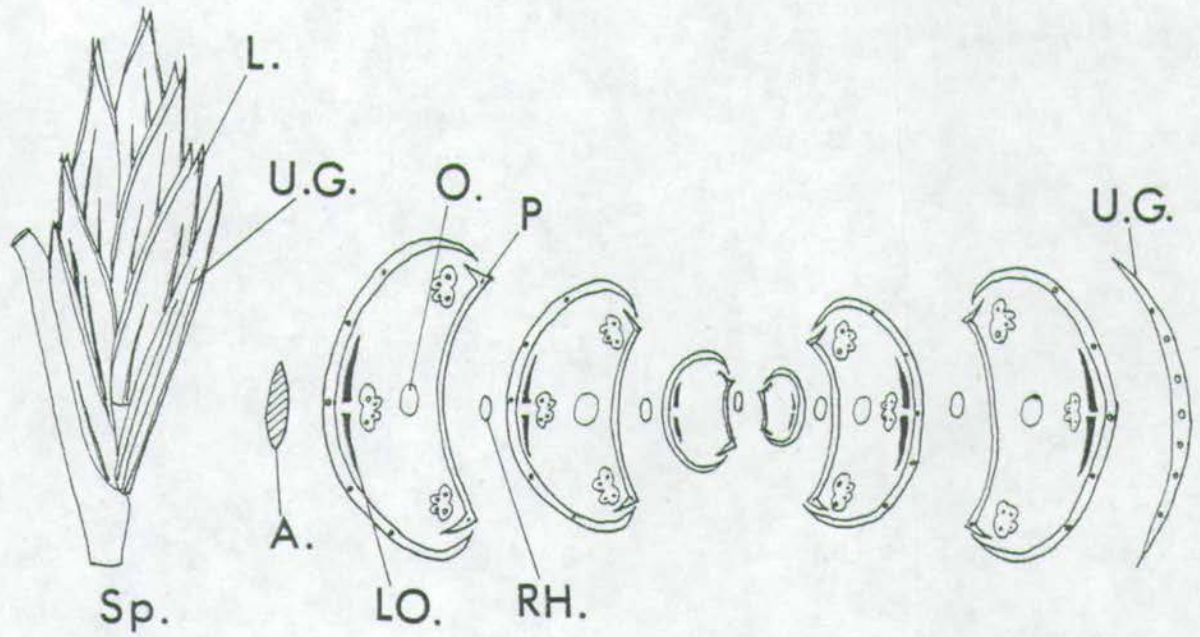
O. Ovary

P. Palea

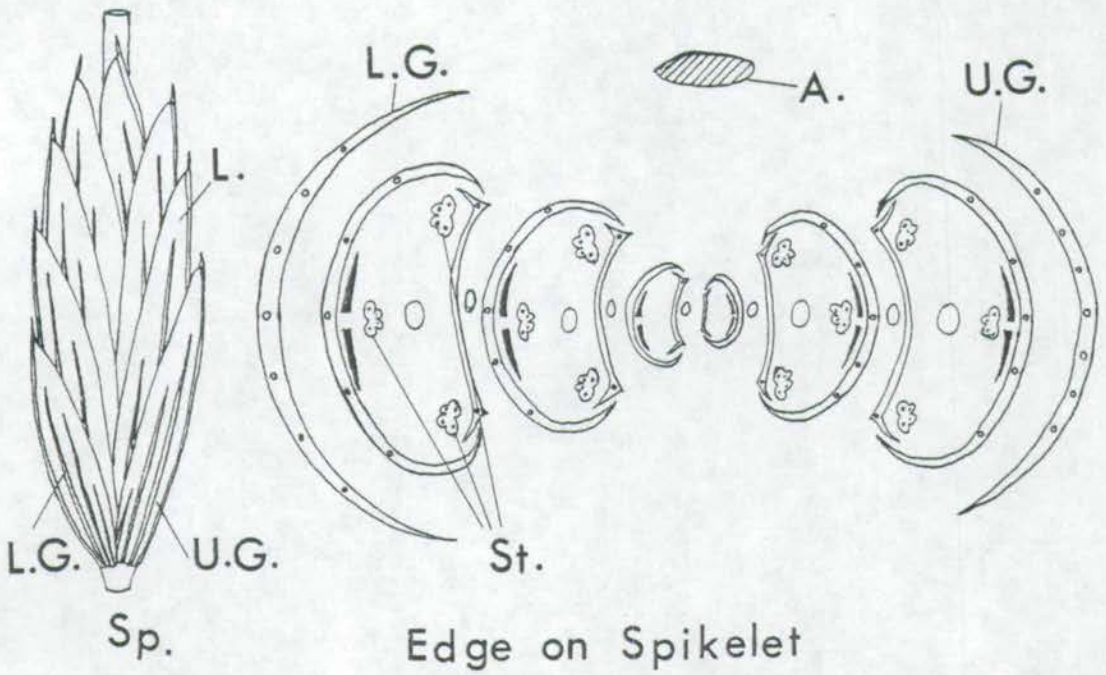
Sp. Spikelet

St. Stamens

U.G. Upper glume



Back on Spikelet



Edge on Spikelet

Fig.13

Fig. 14. Spikelet diagrams

Ia Agrostis planifolia

Ib Agrostis castellana

Ic Avena sativa

II Zingeria pisidica

IIIa Phleum boissieri

IIIb Beckmannia eruciformis

IVa Phalaris minor

IVb Alopecurus aequalis

IVc Alopecurus vaginatus

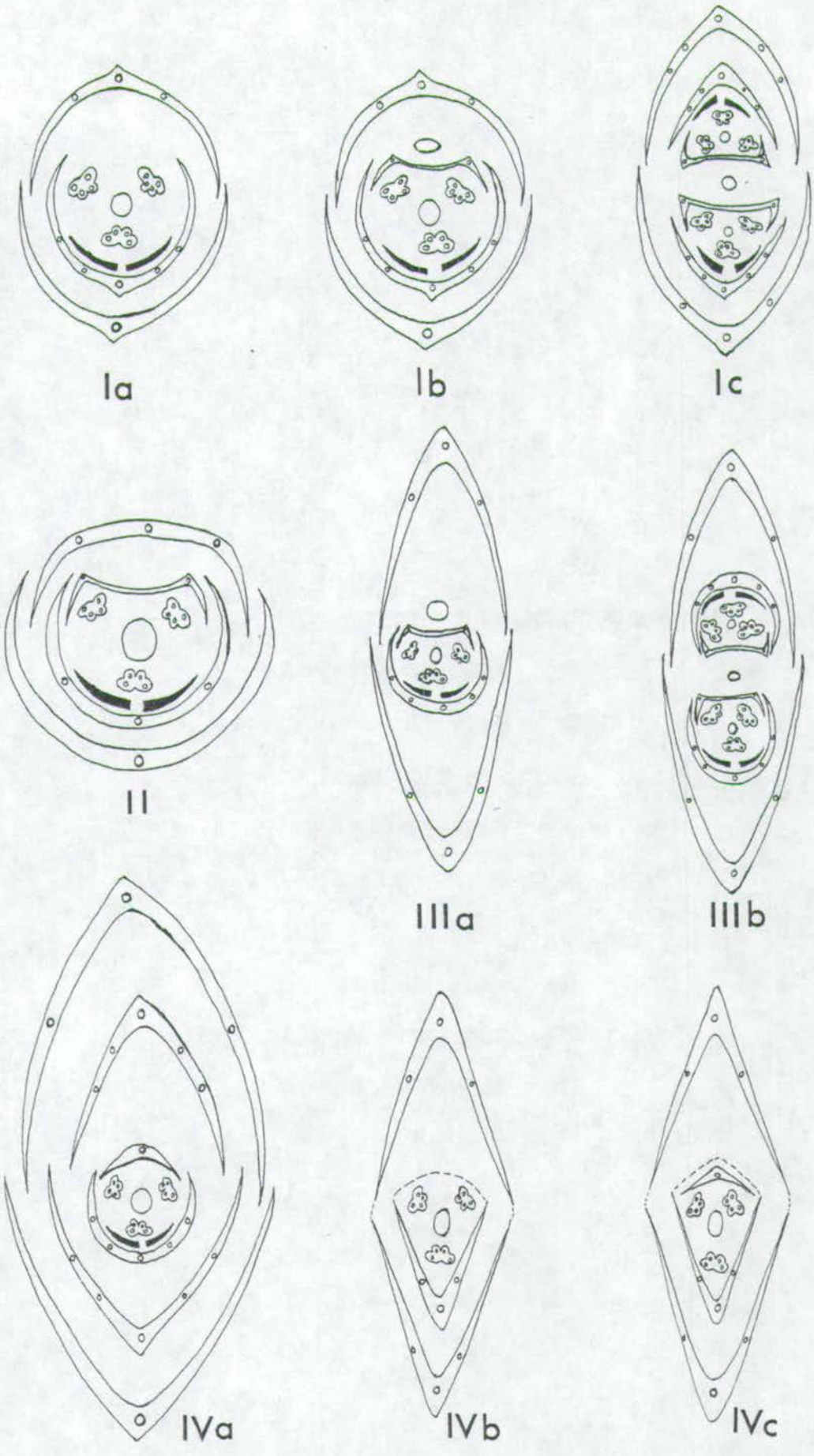


Fig. 14

stamens 2-3, lodicules 0(-2), and caryopsis ± laterally compressed. Some examples of this type of floral diagram are Phalaris (Fig. 14, IVa), Anthoxanthum, Hierochloë, Alopecurus (Fig. 14, IVb-IVc) and Cornucopia.

3.5.2. Spikelet shape (see Fig. 15-23)

Spikelet shape is not very useful at generic level, but within the genus, particularly at the species level, it is found to be very valuable. Spikelet shapes are defined according to Stearn (1973, p. 318-319). Phleum and Alopecurus species differ from each other on the basis of their spikelet shapes; they can be oblong (i.e. P. alpinum, P. bertolonii, P. pratense, P. phleoides, P. montanum, A. bulbosus, A. gerardii, A. glacialis, A. aucheri, A. creticus, etc.), elliptic (i.e. A. utriculatus, A. myosuroides, A. arundinaceus, A. geniculatus, P. exeratum, P. arenarium, P. crypsoides, etc.), ovate (i.e. P. boissieri, P. subulatum, A. textilis, A. rendlei, etc.) or cuneate (i.e. P. paniculatum).

3.5.3. Glumes (Fig. 15-23)

Length: The relative length of the glumes is ofgreat help for distinguishing species. Glumes can be equal, as in Antinoria, Aira, x Agropogon, Alopecurus, Cornucopia, Milium, Agrostis, Beckmannia, Phleum and Rhizocephalus. When the lower glume is shorter than three-fourths of the upper one, the glumes are treated as unequal, as in Avena clauda, Avena eriantha, Gaudinia fragilis, Ventenata, Trisetum, Avellinia michelii, Rostraria, Anthoxanthum, Pseudophleum, etc. The lower is sometimes longer than three-fourths of the upper one, as in Helictotrichon, Gaudinopsis, Parvotrisetum, Deschampsia, Molineriella, Corynephorus, Holcus, Ammophila, Lagurus, Polypogon, Gastridium, Triplachne, Hierochloe, Zingeria, etc. Whenever the lower glumes are longer than three-fourths of the upper ones, they are termed "subequal".

Plate 2. Glume surface view in Agrostis

a) A. olympica (A. Baytop ISTE 20936)

b) A. canina (A. Baytop ISTE 33691)

c) A. castellana subsp. byzantina (A. Baytop ISTE 33691)

d) A. capillaris (A. Baytop ISTE 33728)

e) A. lazica (Bal. 624)

f) A. balansae (Bal. 620)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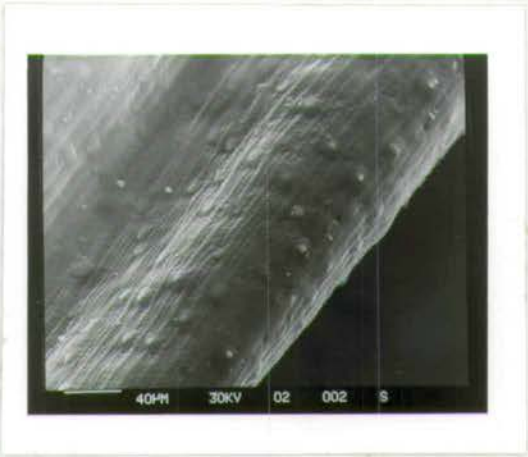
a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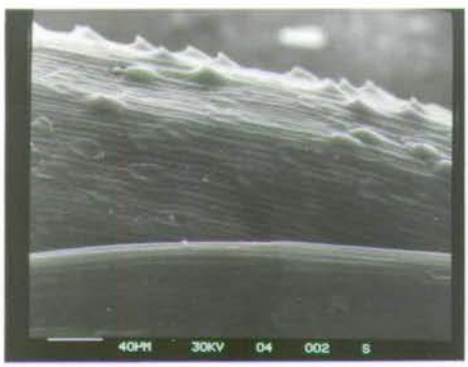
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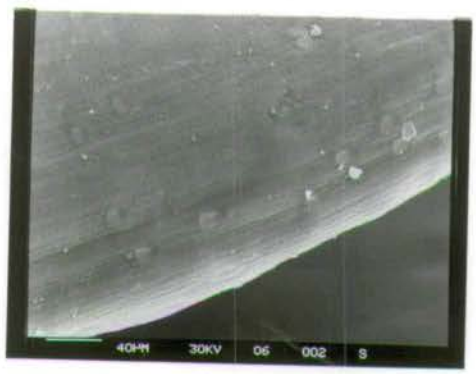
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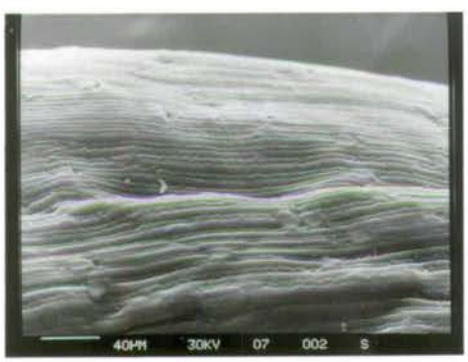
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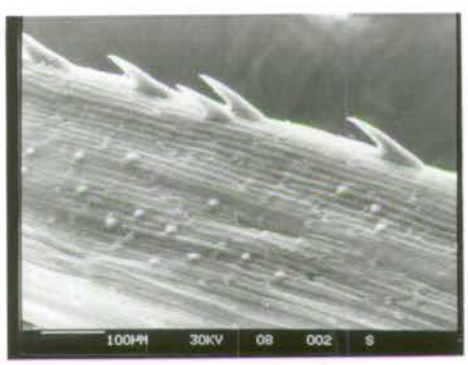
e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f

Pl. 2

The upper glume is always the longest one when the glumes are not equal. It is often useful to compare the length of upper glume with the lowest lemma. In most of the genera lowest lemma/upper glume ratio is < 1, but in some of the genera, such as Rhizocephalus, Pseudophleum, Molineriella and Beckmannia, the lowest lemma/upper glume ratio is > 1.

Shape: Glumes are various in their shape. The commonest shape, as far as my revised genera are concerned, appears to be lanceolate, as in Avena, Helictotrichon, Ventenata, Gaudinopsis, Triplachne, Trisetum, Trisetaria, Parvotrisetum, Koeleria, Calamagrostis and Agrostis. The lower glume is occasionally very small, and linear in outline, as in Avellinia and Lagurus. Other, less common, glume shapes are oblong (i.e. Phleum, Cornucopia, Alopecurus, etc.), ovate (i.e. Hierochloë, Antinoria), ovate to elliptic (i.e. Zingeria, Milium, Anthoxanthum, Aira, Deschampsia), elliptic (i.e. x Agropogon), obovate (i.e. Beckmannia), navicular (i.e. Pseudophleum), urceolate (i.e. Rhizocephalus) and subulate (i.e. Polypogon).

Callus: In Polypogon maritimus a callus is present below the glumes and its length is taxonomically quite valuable in this species for distinguishing two subspecies. The callus is 0.1-0.2 mm in P. maritimus subsp. maritimus, but rather longer (0.8-1.5 mm) in subsp. subspathaceus.

The breakage point is just below the glumes in Polypogon viridis and P. monspeliensis, but in P. maritimus the spikelets break up below the callus. Occurrence of a callus below the glumes is rather rare in grasses, but it must play some role in dispersing P. maritimus either by attaching diaspores to animal fur or by burying them in the ground.

Fig. 15. Spikelets of Phleum (x 10)

a) P. alpinum (Duncan & Tait 34)

b) P. echinatum (Noë 1486)

c) P. bertolonii (A. Baytop ISTE 5986)

d) P. pratense (D.46602)

e) P. subulatum (R. Alava 5047)

f) P. phleoides (F. Holtz 979)

g) P. montanum (Balls 396)

h) P. paniculatum subsp. ciliatum (R. Anşin 2368)

i) P. exeratum (Peşmen & Güner 1311)

j) P. boissieri (D.28737)

k) P. arenarium (13 v 1905, F.C. Crawford)

l) P. crypsoides (12 vi 1870, Bourgeau)

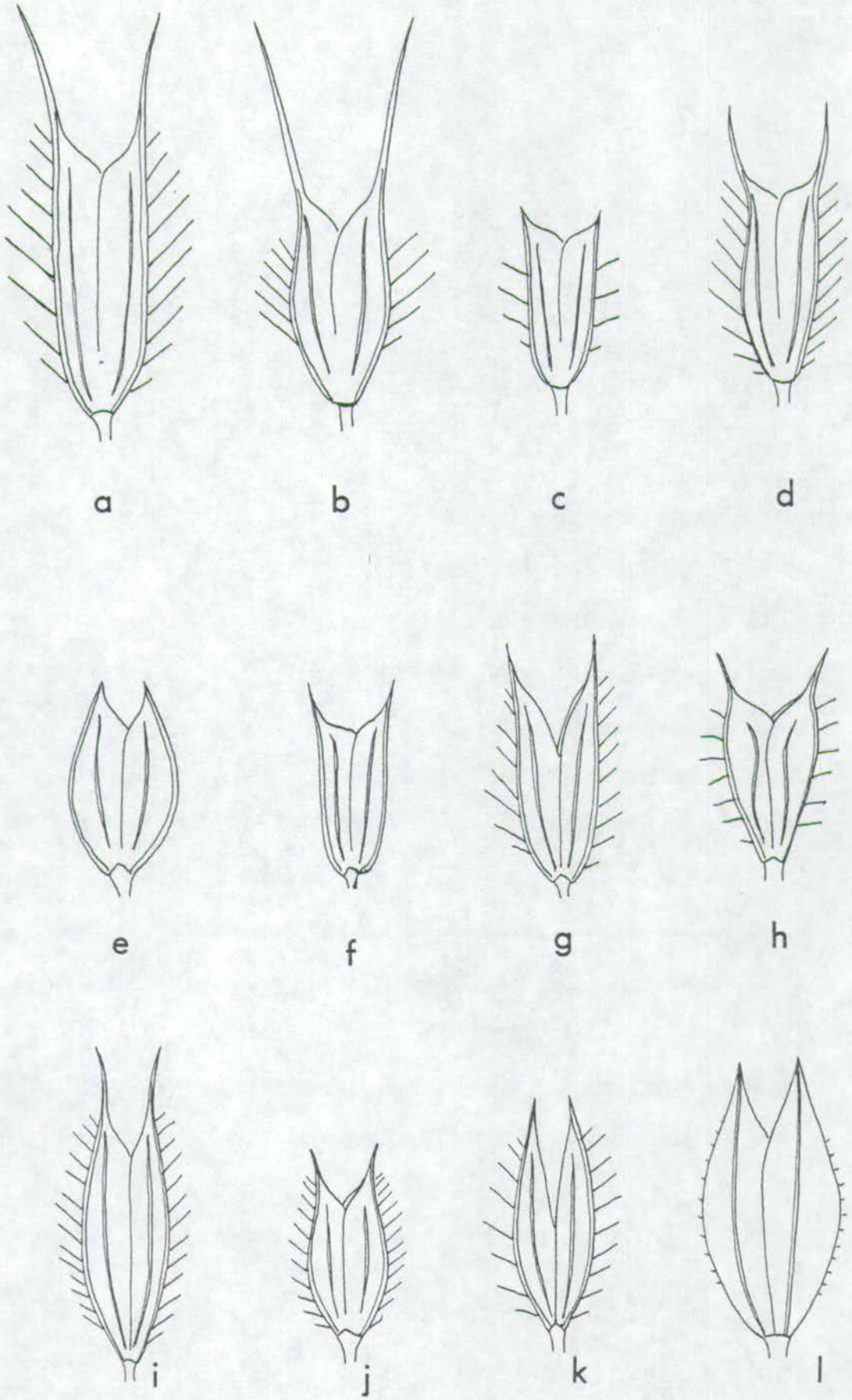


Fig.15

Fig. 16. Spikelets of Alopecurus (x 10)

a) A. pratensis (12 vi 1961, A. Nordström)

b) A. creticus (H. Demiriz ISTE 7185)

c) A. aequalis (Khan et al. 734)

d) A. geniculatus (21 vi 1971, R. Alava & K. Alho)

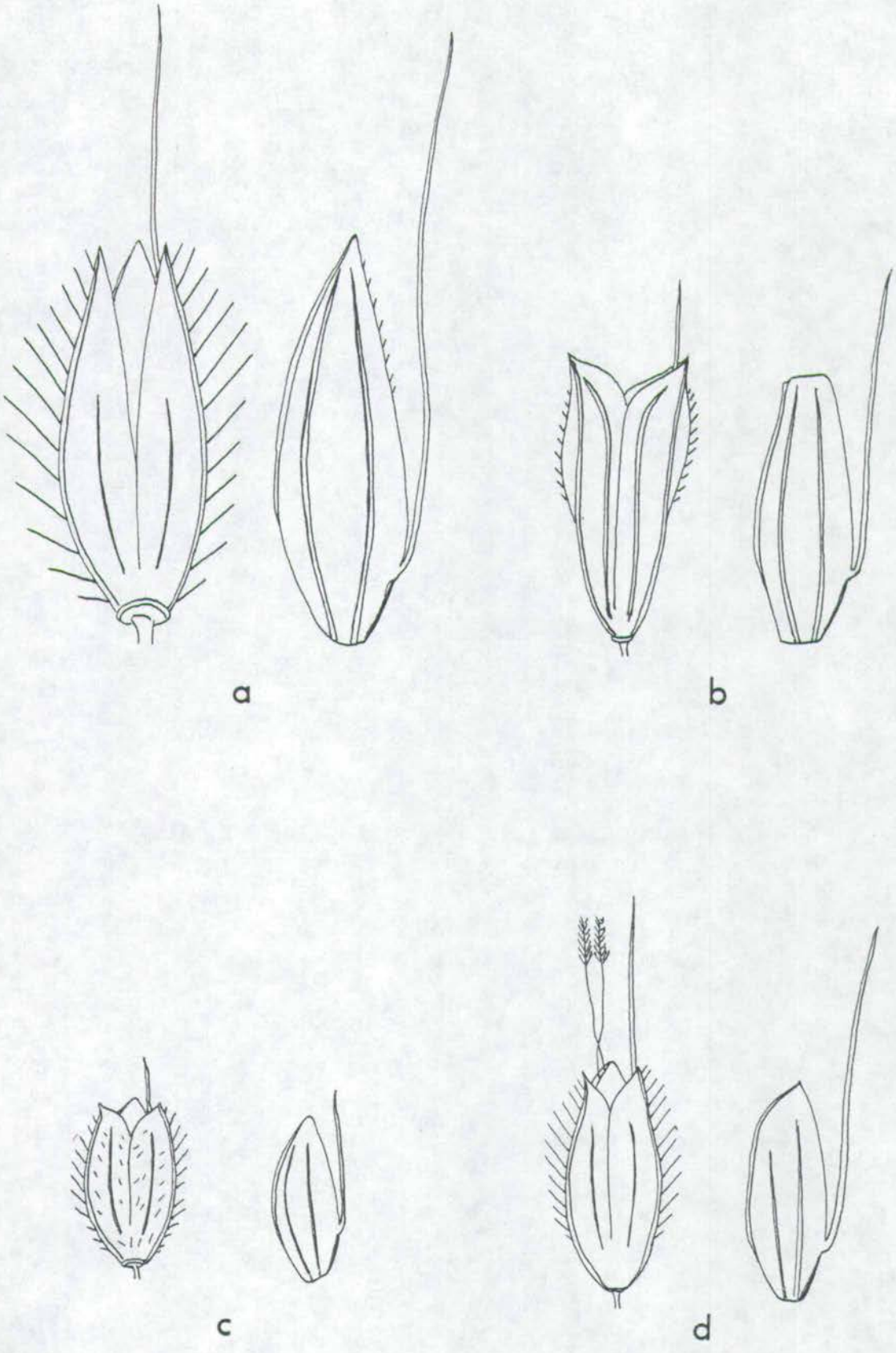


Fig.16

Fig. 17. Spikelets of Alopecurus (x 10)

a) A. bulbosus (A. Baytop ISTE 10210)

b) A. laguroides (D.24664)

c) A. rendlei (D.26250)

d) A. aucheri (Stn. & Hend. 5285)

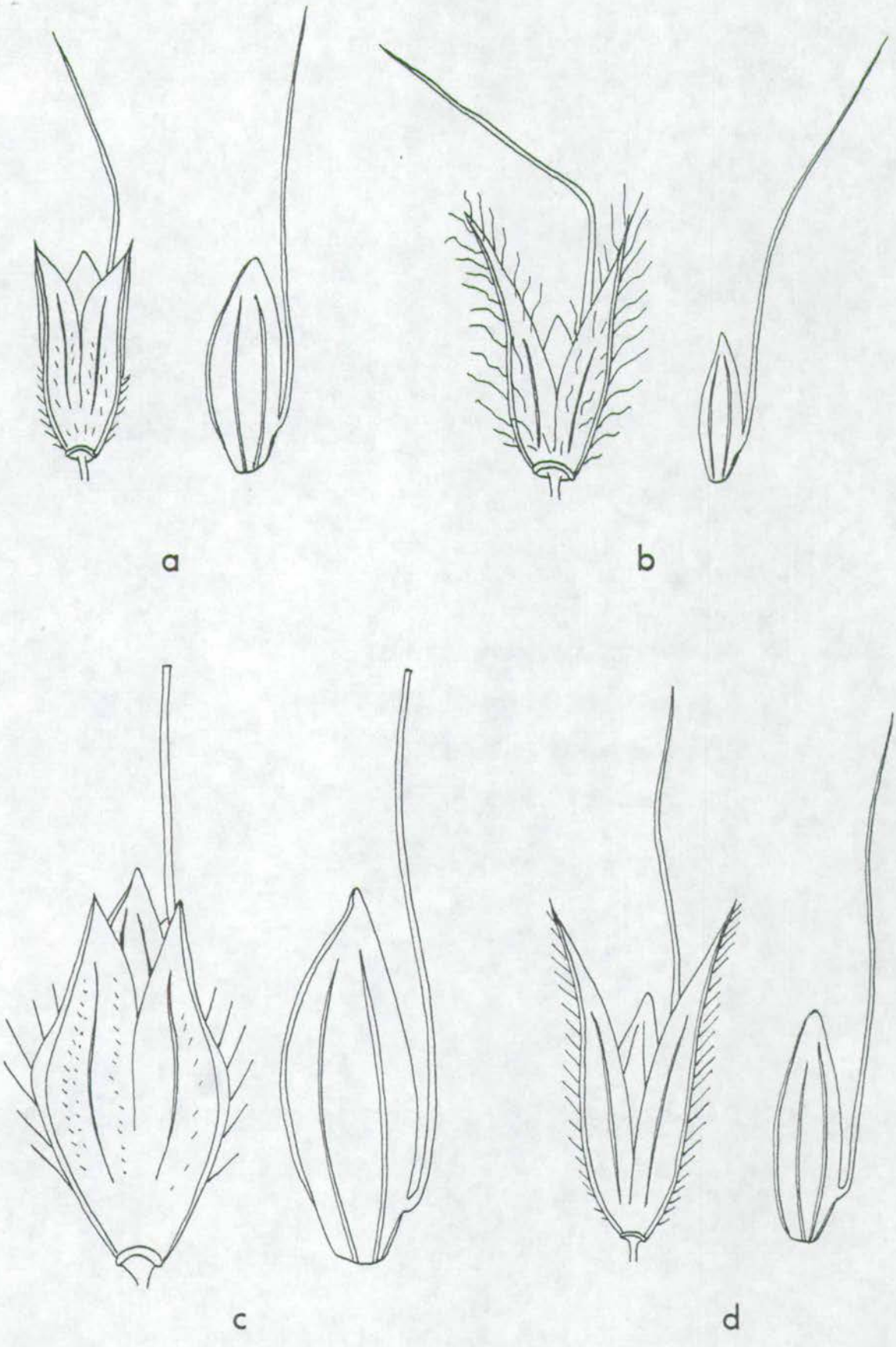


Fig.17

Fig. 18. Spikelets of Alopecurus (x 10)

a) A. textilis (D.20619)

b) A. myosuroides (D.28207)

c) A. arundinaceus (D.27520)

d) A. setarioides (H. Peşmen EGE 5044)

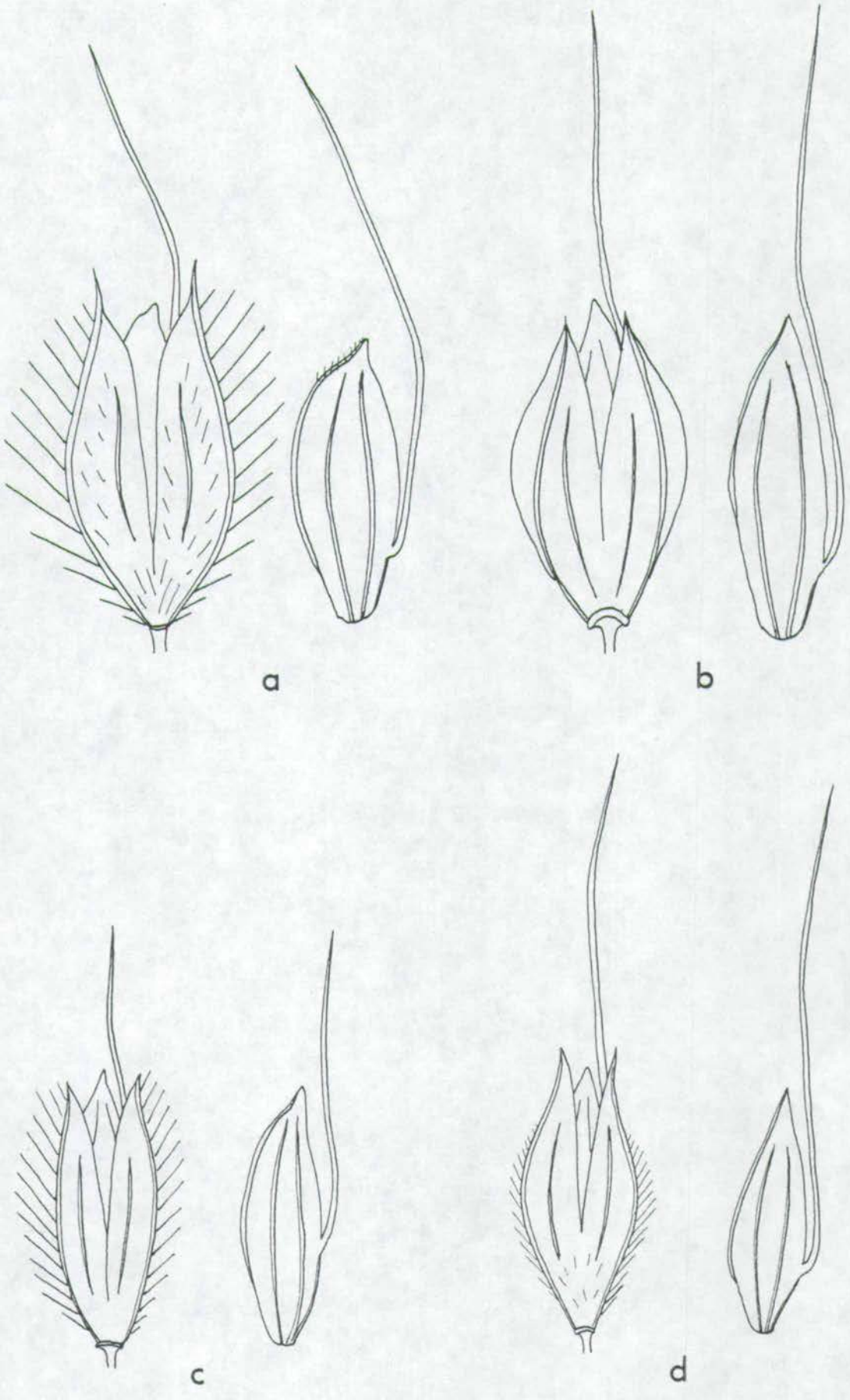


Fig.18

Fig. 19. Spikelets of Alopecurus (x 10)

a) A. utriculatus subsp. anthoxanthoides (D.27298)

b) A. utriculatus subsp. utriculatus (D.25452)

c) A. davisii (Seçmen & Peşmen EGE 16357)

d) A. lanatus (Coode & Jones 1352)

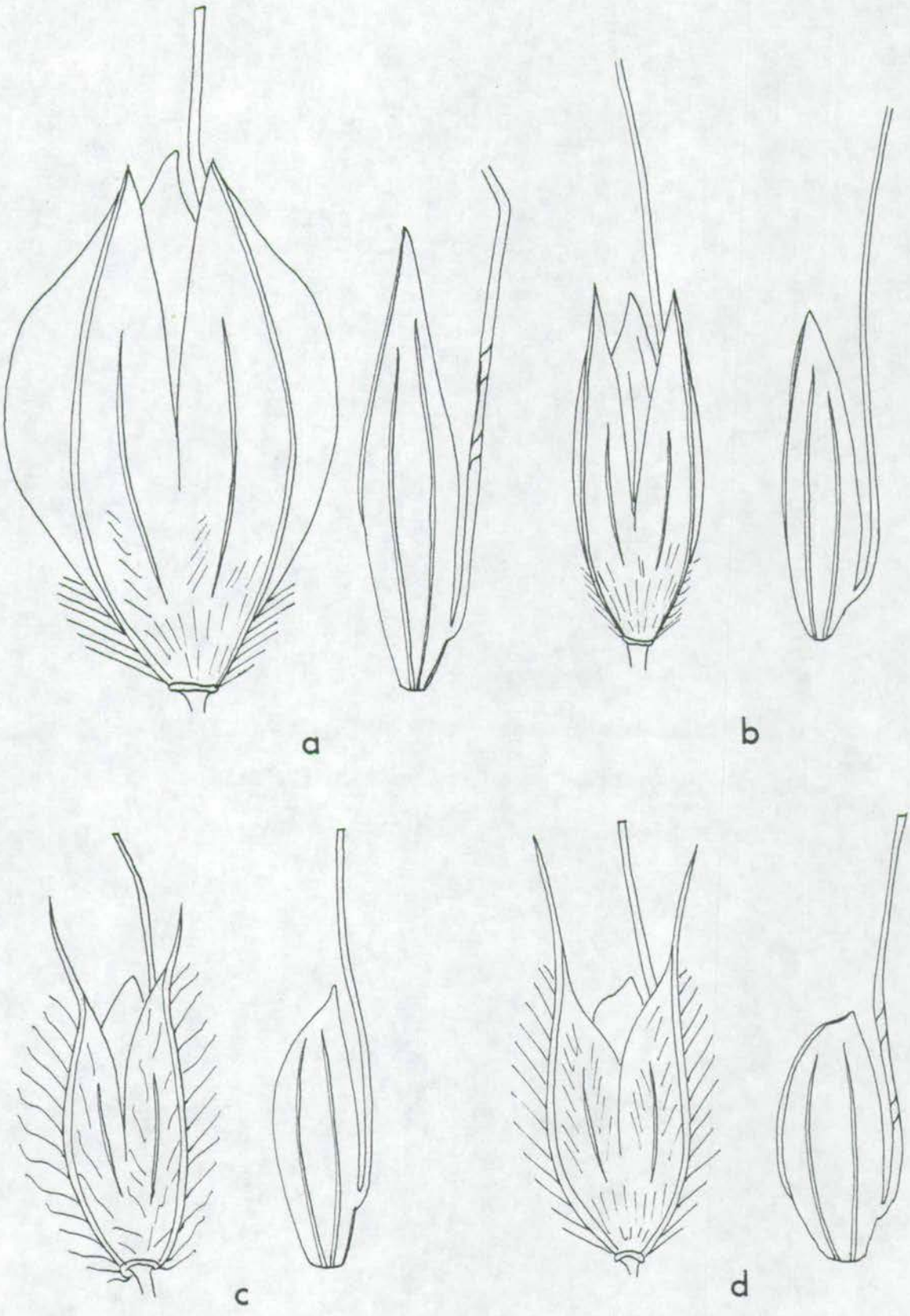


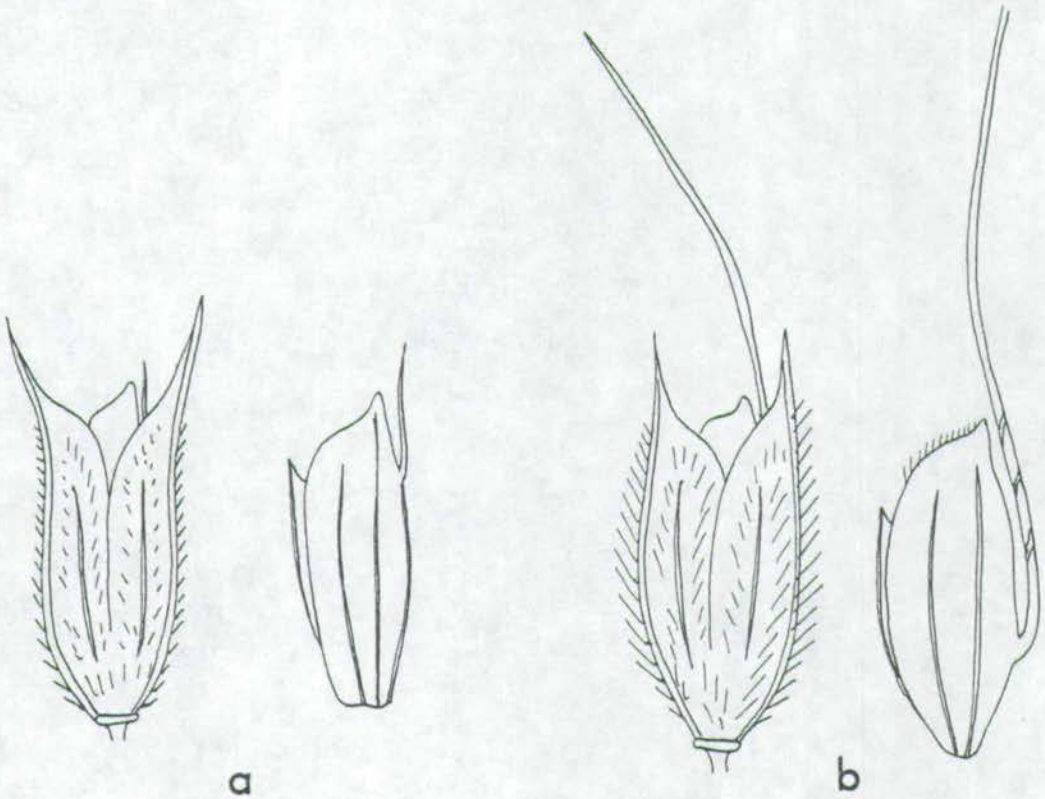
Fig.19

Fig. 20. Spikelets of Alopecurus

a) A. gerardii (Coode & Jones 2714)

b) A. vaginatus (D.33372A)

c) A. glacialis (A. Güner 1029)



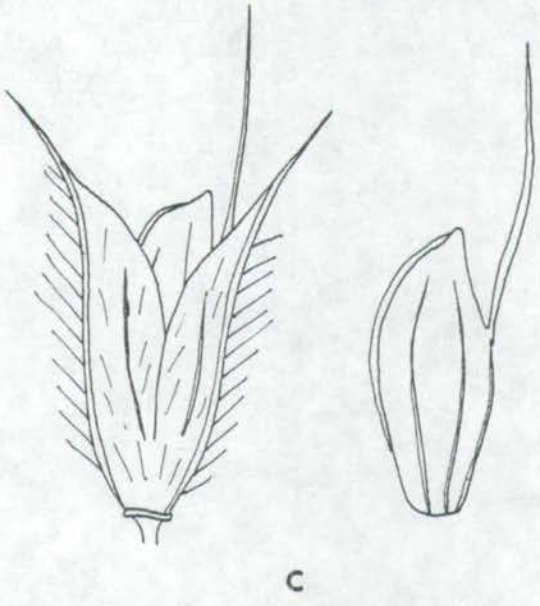


Fig. 20

Fig. 21. Spikelets of the revised genera

a) Polypogon maritimus (x 10) (H. Birand ANK 1168)

b) Parvotrisetum myrianthemum (x 10) (20 vi 1885, Heldreich)

c) Ventenata dubia (x 5) (A. Baytop ISTE 6548)

d) Trisetaria loeflingiana (x 10) (Sint. 1584)

e) Trisetum flavescens (x 10) (D.46282)

f) Arrhenatherum elatius (x 5) (Ehrend. et al. 487-42-7)

g) Anthoxanthum odoratum subsp. alpinum (x 5) (T. Ekim 918)

h) Antinoria insularis (x 20) (Bal. 705)

i) Apera interrupta (x 10) (Stn. & Hend. 5582)

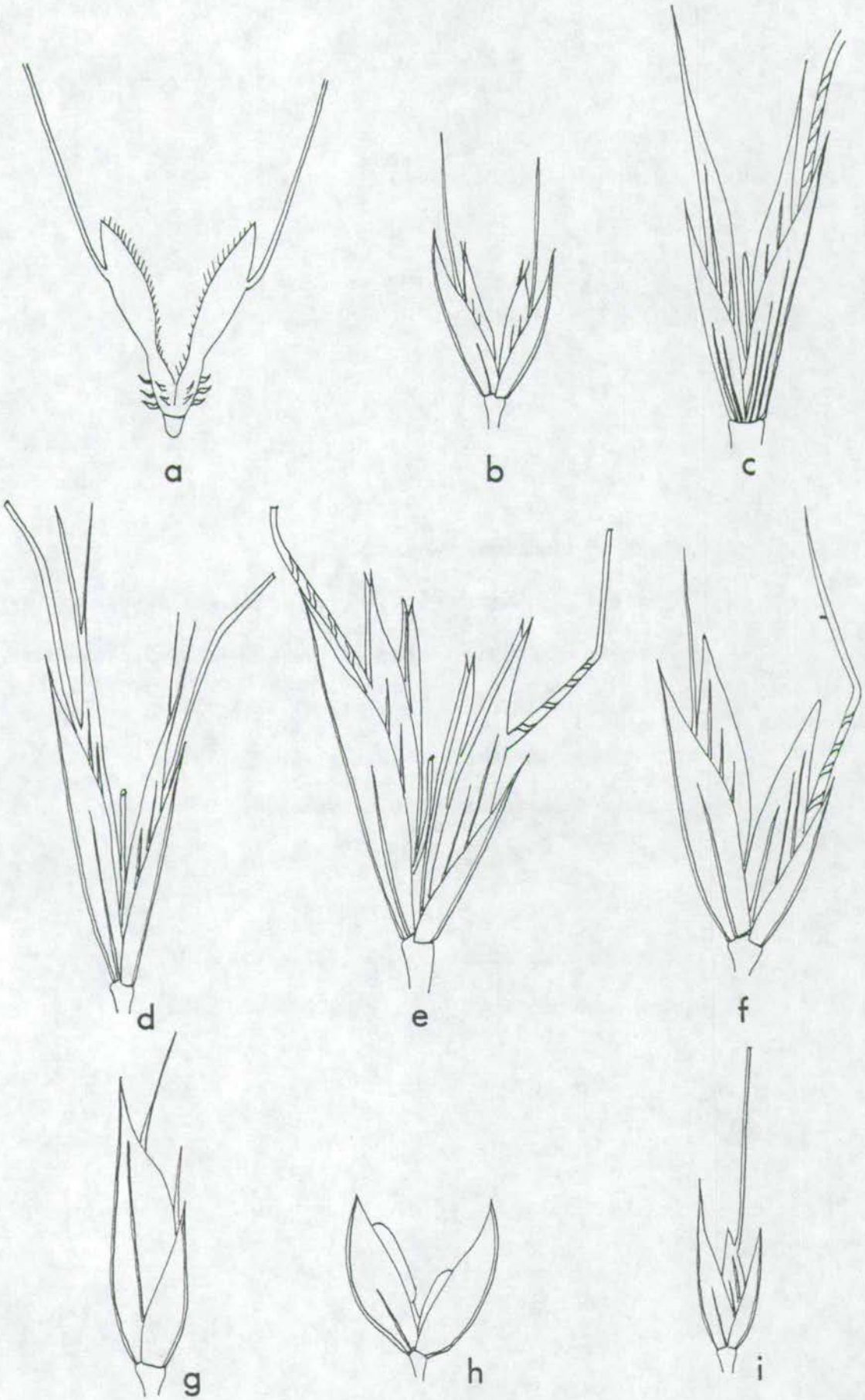


Fig. 21

Fig. 22. Spikelets of the revised genera

a) Avellinia michelii (x 10) (23 v 1897, Azn.)

b) Beckmannia ereuciformes (x 10) (R. Alava 7024)

c) Deschampsia caespitosa (x 10) (F. Holtz 945)

d) Cornucopia cucullatum (x 10) (Sint. 697)

e) Corynephorus divaricatus (x 10) (T. Uslu 3542)

f) Holcus lanatus (x 10) (Hub.-Mor. 16431)

g) Aira caryophylea (x 10) (4 vi 1870, Bourgeau)

h) Lagurus ovatus (x 5) (Tobey 255)

i) Agrostis stolonifera (x 20) (D.36255)

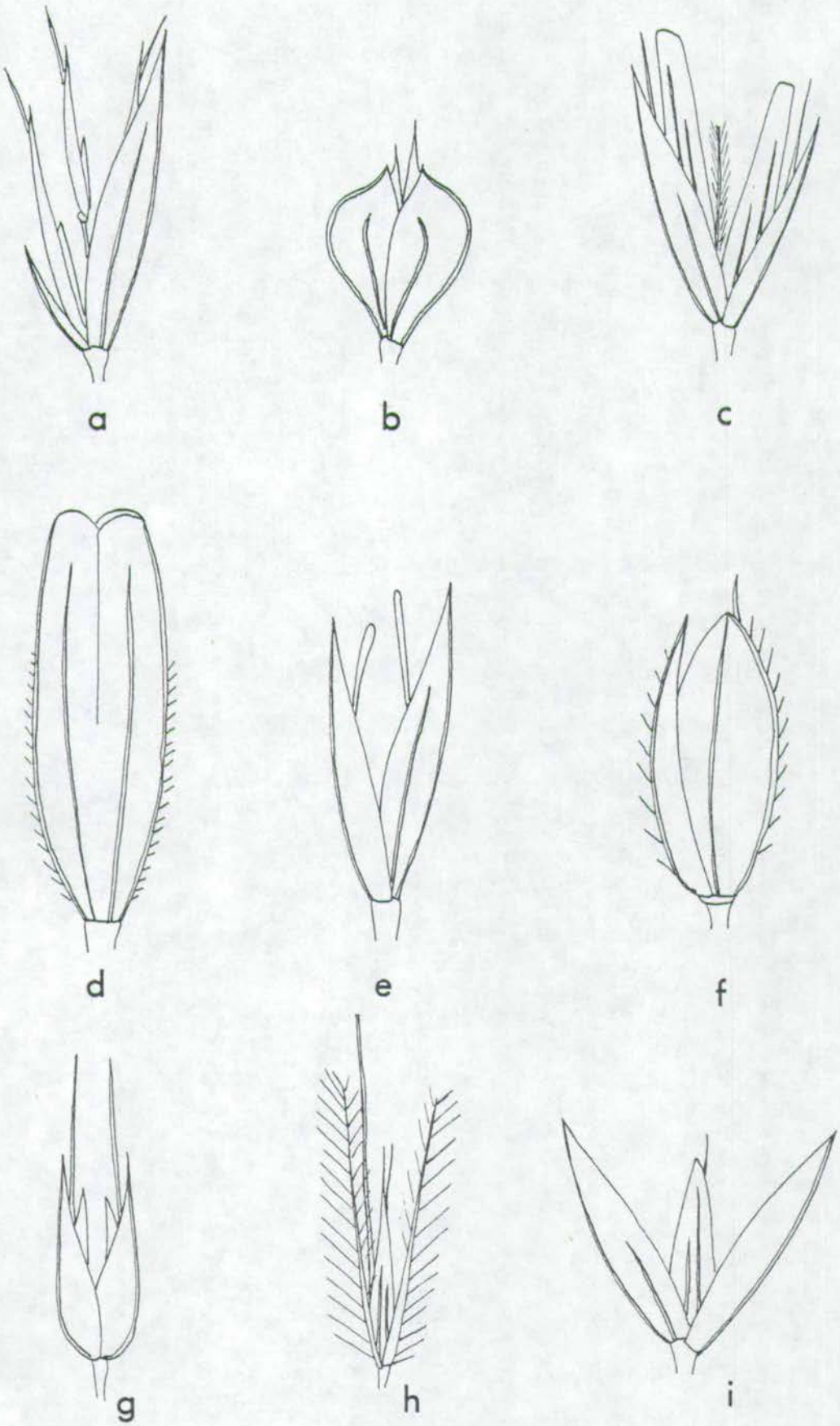


Fig. 22

Fig. 23. Spikelets of the revised genera

a) Gaudinopsis fragilis (x 5) (22 v 1904, Azn.)

b) Ammophila arenaria (x 5) Seçmen & Leblebici 452e)

c) Rhizocephalus orientalis (x 10) (Coode & Jones 183)

d) Calamagrostis epigejos (x 10) (Duncan & Tait 215)

e) Milium effusum (x 10) (Prihler 252)

f) Zingeria trichopoda (x 10) (Samuelsson 4532)

g) Koeleria cristata (x 10) (G. Halliday 140)

h) Rostraria cristata (x 10) (D.43100)

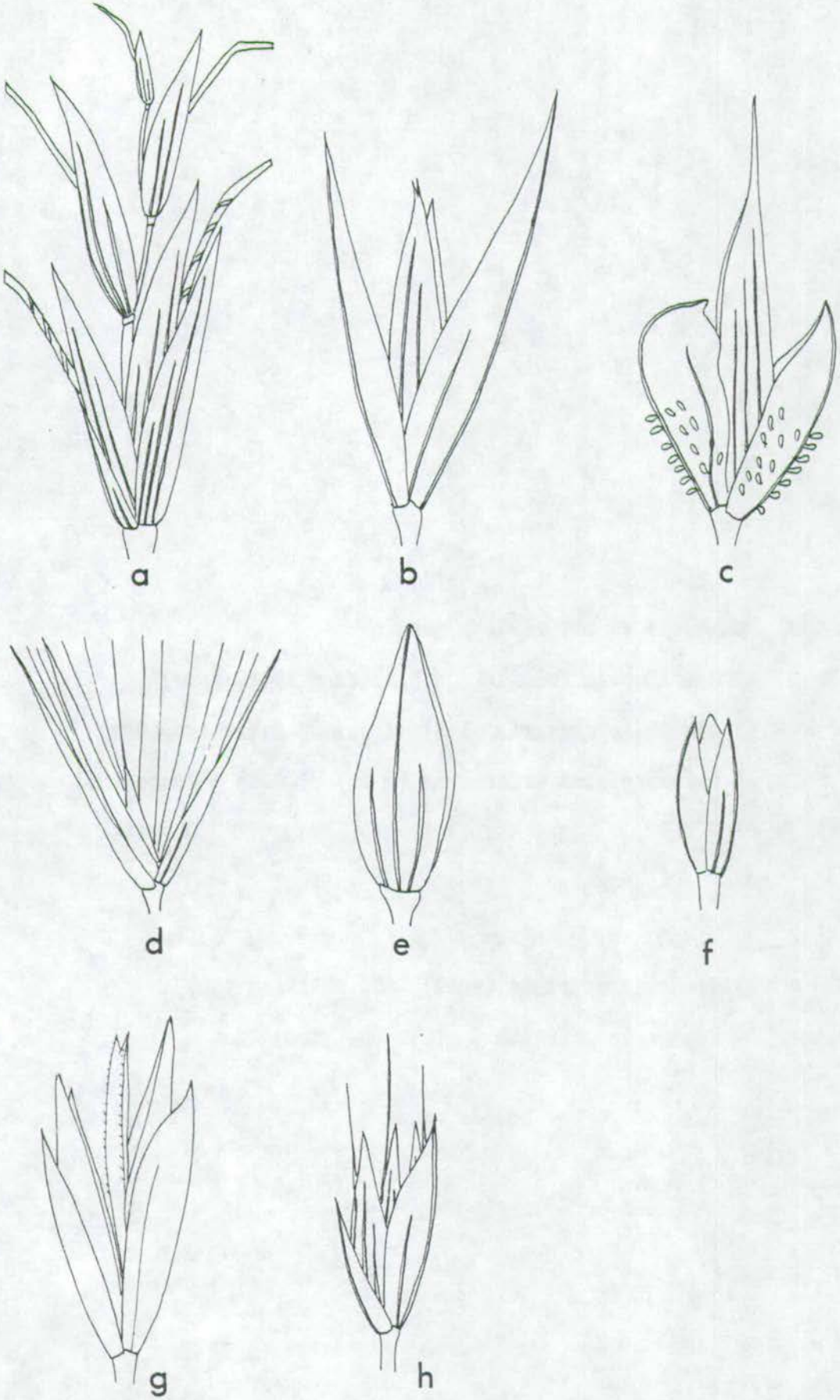


Fig. 23

Apex: Among the genera revised four major glume apex types have been found: truncate (i.e. Alopecurus, Phleum, etc.), obtuse (i.e. Antinoria, Alopecurus, Rostraria obtusiflora, etc.), acute (i.e. Arrhenatherum elatius, Gaudinopsis, Apera, Deschampsia, Corynephorus, Zingeria, Milium, Triplachne, Agrostis, etc.) and acuminate (i.e. Avena, Arrhenatherum kotschyi, Ventenata, Calamagrostis, etc.). Sometimes glumes terminate in an aristate point, as in Alopecurus, Phleum, Apera and very occasionally only one of the glumes appears to have a smaller mucro, as in Zingeria verticillata. Only in Polypogon (P. monspeliensis, P. maritimus) and x Agropogon, are glumes bifid at apex and with a long or short seta from the sinus. The glume apex of Cornucopia cucullatum is always termed truncate, seen in side view, but when glumes are flattened they seem to be emarginate at the apex.

Colour: Whenever glumes are studied under the microscope, most appear to have a wide range of colour variation from whitish green to brownish or purple. The density of pigmentation differs according to the age of plant. Almost all glumes are ± whitish green at the early stage but later they change colour. However, the colour of glumes does not have very much taxonomic value, but in spite of this some species can be distinguished on glume colour (i.e. Milium effusum from Milium schmidianum).

Margins: The margins of glumes are usually free, but sometimes connate, particularly at the base, as in Alopecurus, Cornucopia, Pseudophleum and Rhizocephalus. Whenever the rhachilla disarticulates below the glumes, the entire spikelet falls off as a unit and the glumes are the organs which hold florets as a result of their connate base.

The degree of connation is a quite valuable taxonomic character in Alopecurus. Some species of Alopecurus have glumes connate for $\frac{1}{4}$ or

less of their length (i.e. A. bulbosus, A. geniculatus, A. equalis, A. pratensis, A. arundinaceus), but some other species have them connate for 1/3 to 4/5 (i.e. A. utriculatus, A. myosuroides, A. creticus, A. setarioides, A. rendlei).

Margins are often glabrous but occasionally ± ciliate (i.e. Polypogon maritimus, Anthoxanthum odoratum subsp. odoratum).

Compression: As illustrated diagramatically in Fig. 14, glumes are usually keeled (i.e. Avena, Helictotrichon, Phleum, Alopecurus, Triplachne, etc), but in two genera, Milium, Zingeria, they are rounded on the back. In Polypogon (P. maritimus, P. monspeliensis) and Gastridium, glumes are keeled in the upper half but swollen and rounded in the lower half.

Wing: Occasionally there is a narrow or relatively broad wing on the keels of glumes. Among the genera which have winged glumes are Alopecurus (A. utriculatus, A. myosuroides, A. creticus), Phleum (P. crypsoides) and Phalaris. It is often useful to investigate the length and width of wings of glumes since they can provide valuable information for distinguishing particularly the infraspecific taxa. In Alopecurus utriculatus subsp. utriculatus wings are only in the upper half of glumes and relatively narrow, but in the subsp. anthoxanthoides they are broader and longer. In Alopecurus myosuroides, a newly discovered broadwinged specimen is here given varietal status (var. latialatus).

A wing on glumes might be an effective wind dispersal organ in grasses; in almost all winged spikelets lemmas tend to have short awns or none at all.

Veins: The number of veins in glumes varies from 1 to 11. If the number of veins is scored in the genera revised, it can be seen that there are four major groups. In the first group, both glumes are 1-veined, as in Lagurus, x Agropogon, Polypogon, Gastridium and Triplachne. In the second group, glumes are 1- to 3-veined, as in Arrhenatherum, Trisetum, Trisetaria, Parvotrisetum, Avellinia, Rostraria, Koeleria, Deschampsia, Molineriella, Antinoria, Aira, Holcus, Corynephorus, Calamagrostis, Ammophila, Zingeria, Milium and Anthoxanthum. In the third group, both glumes are 3-veined, as in Hierochloë, Alopecurus, Cornucopia, Beckmannia, Phleum, Pseudophleum and Rhizocephalus. In the fourth group, a number of other genera are placed in which glumes are usually at least 3-veined, as in Avena, Helictotrichon, Gaudinia, Ventenata and Gaudinopsis.

Surface view: Prat (1932) studied glumes and lemmas in a number of genera and illustrated some of the cell types of the epidermal system. Baum (1971, 1980) studied surface view of glumes, lemma and caryopsis in Avena and some other Triticoid genera by means of Scanning Electron Microscopy (S.E.M.). Kaufman et al. (1972) investigated silicification patterns of inflorescence bracts (glumes, lemmas) of Avena sativa with S.E.M. For defining the type of hairs, the terminology of Lawrence (1951) has been used.

Glumes are often glabrous but sometimes covered by various types of hairs. In Alopecurus and Phleum, thereis usually a line of cilia on the keel. Presence and absence of this cilia is often used to distinguish infraspecific taxa in certain species (i.e. Phleum subulatum, P. paniculatum).

In surface view, epidermal cells provide very useful taxonomic characters. Basically two types of cells can be recognised. The first type consists of cells which are rather elongated and with straight cell walls (i.e. x Agropogon, Anthoxanthum, Gaudinia, Hierochloë, etc).

In the second type, cells are short or long but cell walls are more or less sinuous (i.e. Aira, Ammophila, Avellinia, Calamagrostis, Gastridium, Helictotrichon, Rostraria, etc.). It is also possible to recognize further subgrouping in this type. For example in Alopecurus, A. rendlei, A. creticus and A. bulbosus, epidermal cells are equidimentional with very strongly sinuous cell walls, but in other species of this genus the cells are rectangular in shape and cell wall undulations are very regular. The degree of cell wall undulations are presumably due to the amount of metabolic activities taking place in cells in the short growth period. Under these conditions the cells enlarge their surface through the cell wall undulations to allow necessary inorganic material transfer from neighbouring cells. Another explanation for the causes of cell wall undulations was put forward by Watson (1942), who is of the opinion that the hardening of the cuticle extends gradually over the surface from the central area of the outer, free tangential wall.

Hairiness of glumes was investigated in Agrostis and turned out to resemble pedicel hairiness (see Pl. 2). Glume surface is sometimes more or less smooth, as in A. olympica, A. canina, A. capillaris and A. lazica, but in the other Turkish species (A. planifolia, A. balansa and A. stolonifera) glumes covered with scabridulous projections.

3.5.4. Rhachilla

The rhachilla is the axis of the spikelet upon which the glumes and florets are distichously arranged.

Disarticulation: As far as the revised genera are concerned, the rhachilla often consists of a few segments which, after reaching maturity, break up at each joint, thus enabling the florets to fall to the ground. Among the genera in which spikelets disarticulate below the glumes are Holcus, Alopecurus, Beckmannia and Polypogon. In other genera

disarticulation is above the glumes, but even here there is a sub-grouping. In Avena, sometimes all florets in each spikelet form a unit and disarticulation occurs only below the lowest floret (i.e. A. eriantha, A. sterilis), or disarticulation occurs between each floret, so that they fall independently (i.e. A. clauda, A. fatua, A. barbata, A. wiestii). The breakage point of rhachilla segments is also quite a valuable taxonomic character. In Avena sativa, rhachilla segments break up at their apex and eventually fall attached to the lower floret, but in Avena byzantina, rhachilla segments break up at their base and fall attached to the upper florets.

Length: The length of second rhachilla segments (between lower and second upper florets) has been used for distinguishing some closely related species. In Arrhenatherum, A. palaestinum and A. elatius can be distinguished by their rhachillas. In A. elatius, the length of the second rhachilla segment is 0.5-1 mm, but it is 1-2.5 mm in A. palaestinum. The length of rhachilla is also used in other genera for distinguishing closely related species. For example, Helictotrichon armeniacum differs from Helictotrichon pratense in having longer rhachilla segments [4-5 mm].

Hairiness: The hairiness of rhachilla segments has great taxonomic value. Rhachilla segments are usually more or less hairy in the genera revised here, but in certain genera this hairiness is unique to particular species, like Helictotrichon pubescens and Trisetum rigidum in which the long rhachilla hairs more or less equal the spikelets. Among the species of Helictotrichon in Turkey, only H. compressum does not have any hairs on the rhachilla segments.

Presence or absence of the second rhachilla segment: Particularly in genera belonging to the formerly accetped tribe Agrostideae, the presence or absence of the second rhachilla segmant has been carefully investigated, and much used in infra-generic grouping. In the genus Calamagrostis, C. arundinacea and C. parsana, belonging to Sect. Deyeuxia, have the second rhachilla segment is prolonged beyond the floret, but in Sect. Calamagrostis the rhachilla is not prolonged beyond it. Nor is the second rhachilla segment prolonged beyond the floret in Polypogon and x Agropogon, but is often present in a number of other genera, such as Gastridium, Ammophila, Lagurus, Apera, Agrostis, Alopecurus, Phleum, etc.

The presence or absence of a second rhachilla segment is certainly an important taxonomic feature and also indicates an evolutionary trend. Whenever there is a second (sterile) rhachilla segment, indicating that this species (or genus) once had more than one floret, the florets have been reduced to one. During the investigation of floret number, 2 floret spikelets in Agrostis castellana and Apera baytopiana have been discovered. In the genera Milium and Zingeria there is no second rhachilla segment, therefore one might assume that they did not have 2 floret forms in their past. Their resemblance to other one floret genera such as Agrostis could be due to parallel evolution.

3.5.5. Floret Number and Sex Distribution

The number of florets in each spikelet varies greatly in the four tribes revised. In the genera of the formerly accepted tribe Agrostideae, spikelets consist of one floret, as in Phleum, Cornucopia, Alopecurus, Triplachne, Rhizocephalus, Agrostis, Calamagrostis, Apera, Lagurus, Ammophila, Polypogon, Gastridium, Milium, Zingeria, etc. In some other genera the spikelets have 2 florets, like Beckmannia, Holcus, Coryne-phorus, Aira, Molineriella, Antinoria, etc. In some of the other genera,

such as Anthoxanthum, Hierochloë and Phalaris, there are 3 florets in each spikelet. The other remaining genera have an indefinite number from one to eleven.

Conner (1979) gave a brief review of literature which deals with the floral systems of grasses. According to differentiation of florets in spikelets, it is possible to recognise two major groups in the genera revised. In the first group spikelets contain 3 florets, the lower two being male but the uppermost one hermaphrodite, as in Anthoxanthum, Hierochloë and Phalaris. In general terms this first group includes genera in which spikelets are "andromonoecious". When the floret number is not considered, two more genera, Holcus and Arrhenatherum, can also be included here. In Holcus, the male floret is the upper one, and the hermaphrodite one the lower floret, but this situation is reversed in Arrhenatherum.

3.5.6. Lemma (Fig. 16-23)

Length: As mentioned in 3.5.3., lemmas are longer than glumes in Rhizocephalus, Pseudophleum, Molineriella and Beckmannia. Sometimes the length of the lemma is one of the most useful characters for distinguishing infraspecific taxa. In Avena sterilis subsp. sterilis, lemmas are 25-35 mm, but in subsp. ludoviciana, lemmas are only 20-25 mm. Koeleria nitidula differs from Koeleria cristata in having longer lemmas which almost equal the upper glume. In Calamagrostis the lemma is usually half to two-thirds as long as glumes, but in Sect. Deyeuxia the lemma is at least three-fourths as long as the glumes.

Shape: There is considerable variation in lemma shape. The commonest shape is lanceolate, as in Avena, Helictotrichon, Arrhenatherum, Ventenata, Gaudinia, Gaudinopsis, Trisetum, Parvotrisetum, Rostraria,

Beckmannia, etc. Lemmas are sometimes elliptical, as in Polypogon, Gastridium, Alopecurus, Hierochloë, Milium, Zingeria, etc., or ovate as in Triplachne, Cornucopia and Phleum. Lemmas are oblong in some genera, such as Pseudophleum, Rhizocephalus, Anthoxanthum, Alopecurus, etc.

Apex: The lemma apex presents a great range of variation from truncate to acuminate or aristate. It is found to be one of the most valuable taxonomic characters. In certain genera, such as Deschampsia, Holcus, Agrostis, x Agropogon, Polypogon, Gastridium, Triplachne, Alopecurus, Cornucopia and Phleum, lemmas are truncate at the apex. There is also variation within the truncate-lemma category; sometimes the lemmas are denticulate or quite deeply lobed, as in Anthoxanthum in which the two sterile lemmas have two obtuse lobes at the apex; also in Antinoria the lemma is 2-lobed. Some genera have an obtuse lemma, such as Milium, Molineriella, Zingeria, Alopecurus, Phleum, etc. In Anthoxanthum and Hierochloë, the uppermost lemma is also obtuse at the apex. In Rhizocephalus and Pseudophleum the lemmas have a terminal mucro. Glumes commonly have acute apices, but this is not the case with lemmas; only two of the genera, Koeleria and Apera, have species with an acute lemma. In the tribe Aveneae, at least some of the lemmas are usually bifid at the apex, viz. Avena, Helictotrichon, Arrhenatherum, Gaudinopsis, Trisetum, Avellinia, Rostraria, Aira, Corynephorus, Calamagrostis, Ammophila, etc. An acuminate lemma apex is uncommon in the revised genera, but is found in a few species, for instance in Ventenata (lowest lemmas only). In some of the genera the lemmas terminate in two fine setae, as in Avena, Ventenata, Trisetaria, Parvotrisetum and Lagurus.

Margin: Lemma margins are usually free, as are those of the glumes, but connate in two of the genera, Alopecurus and Cornucopia. Whenever

margins are connate the role of lodicules is greatly reduced or lost because lodicules cannot open the lemma and palea to release the stamens. In Alopecurus and Cornucopia, lodicules are completely lost. Since lemma margins are united this reduces the role of the palea which may be completely absent in some species of Alopecurus.

Veins: The number of lemma veins varies from 1 to 9 as far as the revised genera are concerned. In Corynephorus, lemmas have only one vein but the number increases to three in some of the genera, viz. Avellinia, Antinoria, Milium and Zingeria. Most of the remaining genera have 3-5 to 5-7 lemma veins, but in Gaudinia, the number reaches 7-9.

Awns: presence and position: In taxonomic treatments awn characters - presence or absence, position when present, geniculation, etc. - are used very often. Some genera can be recognised straight away by their awnless lemmas, such as Phleum, Milium, Zingeria, Phalaris, Koeleria and Antinoria, but in the remaining genera there is always a short or long awn on their lemmas. Whenever a lemma awn is present it is necessary to define its position. It may be either subterminal, as in Avellinia, Rostraria, Ammophila, Apera, x Agropogon, or dorsal to sub-basal, as in Avena, Helictotrichon, Gaudinia, Gaudinopsis, Trisetum, Trisetaria, Parvotrisetum, Deschampsia, Molineriella, Aira, Corynephorus, Triplachne, Alopecurus, Cornucopia, etc.

In a few genera like Rhizocephalus, Pseudophleum, Polypogon, Beckmannia, lemmas terminate in a small mucro or an apical awn. Sometimes the position of awns can vary on the lemma within the same spikelet. For example in Ventenata and Gaudinopsis the lowest lemma can sometimes be awnless but the upper ones are always dorsally awned. In Anthoxanthum only the lower two male florets are dorsally awned but the uppermost hermaphrodite one is awnless.

Plate 3. Twisting and compression of awn in Helictotrichon

a) H. compressum (A. Baytop ISTE 4001)

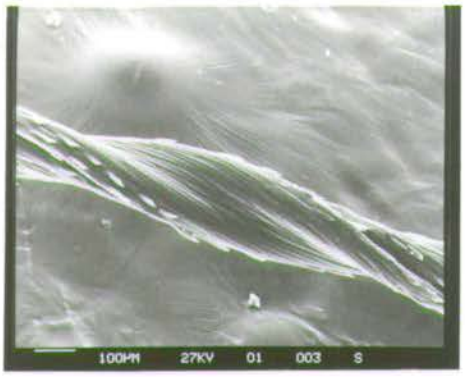
b) H. argaeum (Stn. & Hend. 6274)

c) H. armeniacum (2 vii 1908, D. Litvinov)

d) H. planiculme (9 vii 1968, O. Dubovik)

e) H. blavii (K.F.J. Maly 234)

f) H. pubescens (D.37401)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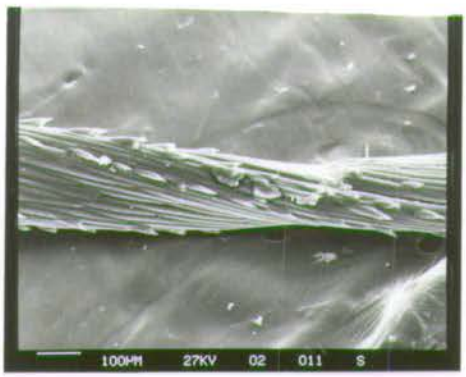
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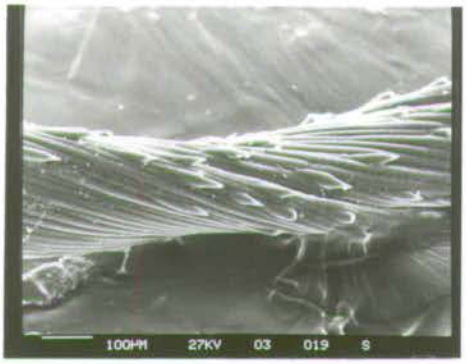
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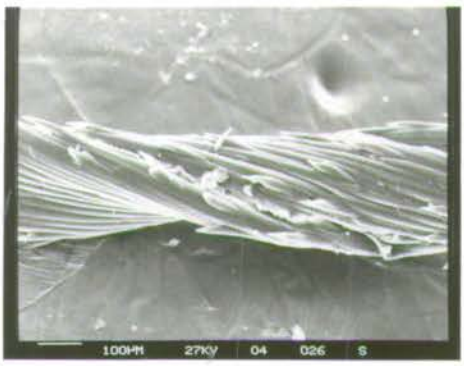
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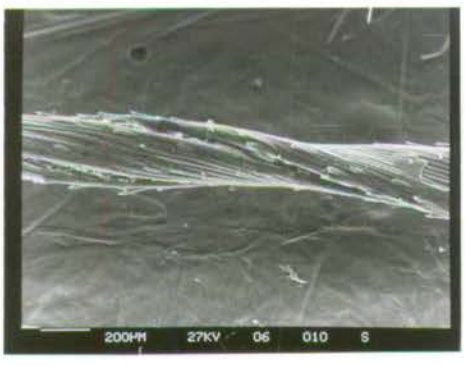
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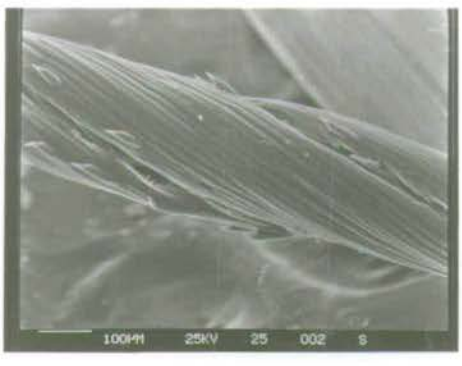
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f

Pl.3

Awn shape: In most of the genera awns taper to a fine point. Only in the genus Corynephorus is the upper half of the awn swollen and clavate in outline and there is a hairy joint between the upper and lower halves. These features are illustrated by Albers (1976, p. 419, 420).

Awn geniculation and twisting: Awns are usually geniculate in the middle part and more or less twisted below. Trisetum sibiricum has a curved awn and this is taxonomically important. Albers (op. cit.) investigated the taxonomic importance of awn twisting in a number of genera belonging to the tribe Aveneae. The twisting mechanism of awns in Helictotrichon etc. is illustrated in Pl. 3.

Internal structure of awn: The internal structure of awns was studied and illustrated by Albers (1976) for three species belonging to three different genera: Aira cupaniana, Corynephorus canescens, Deschampsia caespitosa.

To investigate the possible use of awn internal structure in the present work, awns from Helictotrichon (H. compressum, H. pubescens, H. convulatum), Triplachne (T. nitens), Anthoxanthum (A. odoratum) and Trisetum (T. flavescens) were sectioned according to the technique described earlier. The awns of H. pubescens are subterete at the base (Fig. 24), but in the other two species, H. compressum and H. convolutum, are more or less compressed at the base (see also Pl. 3).

The awn tissue is composed of sclerenchyma with the cells very tightly attached to each other, without any intercellular spaces between them. The shape of the cells is pentagonal, hexagonal, etc. as in Trisetum and Helictotrichon, but in Anthoxanthum odoratum and Triplachne nitens the outermost cells are more or less rounded. In Triplachne nitens the cells have only a small lumen but in other remaining species

Plate 4. Lemma surface view

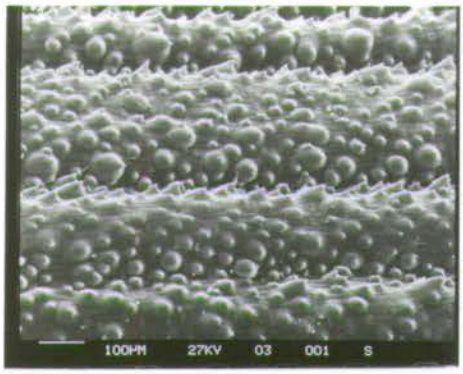
a) Helictotrichon compressum (A. Baytop ISTE 4001)

b) Agrostis balansae (Bal. 620)

c) Rhizocephalus orientalis (Coode & Jones 136)

d) Phleum subulatum subsp. subulatum (F. Sorger 77-1-18)

e) Pseudophleum gibbum (22 vii 1854, Bal.)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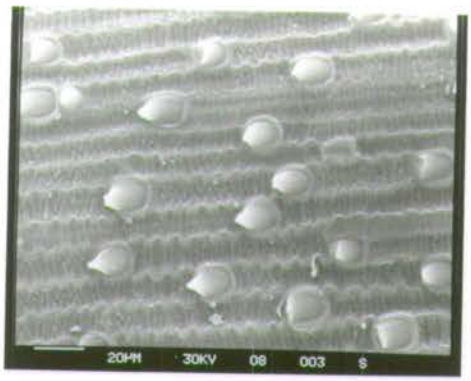
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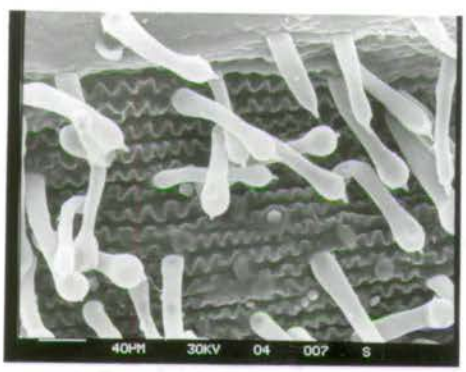
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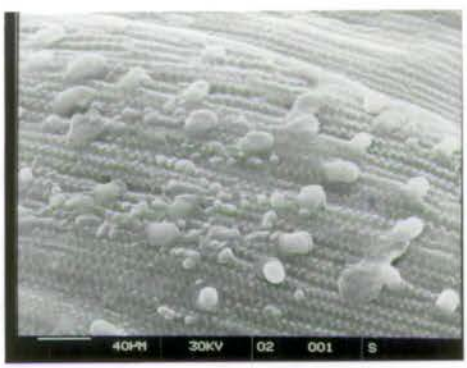
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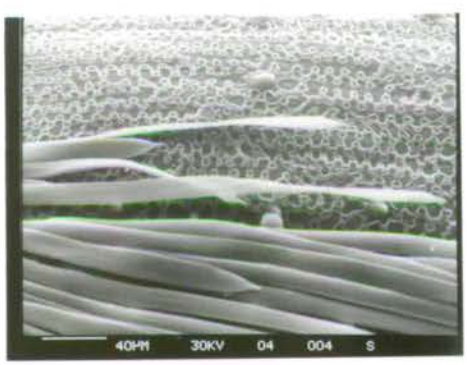
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e

Pl. 4

lumina are always large. As a general rule in the species of Helicotrichon and Trisetum the inner cells are always bigger than the outermost cells. Only in Anthoxanthum (A. odoratum) are the outermost cells larger than the inner ones.

Lemma surface micromorphology

Epidermal cell types: There are two types of cell walls, as in glumes. In the first type cell walls are completely smooth, as in Anthoxanthum, Calamagrostis, Hierochloë, Helictotrichon (Pl. 4, a), etc. but in the second type cell walls are sinuate, as in Agrostis (Pl. 4, b), Rhizocephalus (Pl. 4, c), Phleum (Pl. 4, d), Avellinia, Gaudinia, Rostraria, etc. In addition to this second type a third type has been discovered in the genus Pseudophleum (Pl. 4, e) in which cell walls are sinuate but there are small globose projections at the corner of each fold. This gives a completely different pattern to lemma epidermal cells from its surface view. The lemma surface of Pseudophleum (P. gibbum) is illustrated in Pl. 4.

Hair types: On the dorsal surface of the lemma there are sometimes a number of different types of hairs, varying in their length and shape. This has been fully investigated here only for the genus Phleum (Pl. 5-6). In this genus the type of hair provides one of the most useful additional characters for the recognition of infrageneric groups and even for distinguishing closely related species. In P. crypsoides lemma surface is completely glabrous, but in other species there are various types of hair. In the highland species, P. alpinum (hair length 36-60 μ), P. pratense (80-114 μ), P. bertolonii (20-66 μ) and P. montanum (c. 170 μ), hairs are more or less filiform but they vary greatly in their length from one species to another. P. echinatum and P.paniculatum

Plate 5. Lemma surface view in Phleum

a) P. alpinum (Duncan & Tait 34)

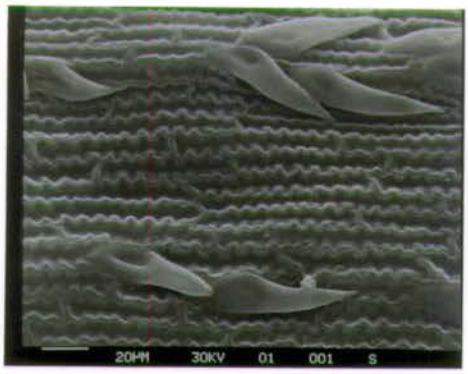
b) P. pratense (D.47587)

c) P. bertolonii (Aytug & Yalt. 3309)

d) P. echinatum (Noë 1486)

e) P. subulatum subsp. ciliatum (W. Greuter 10849)

f) P. crypsoides (12 vii 1870, Bourgeau)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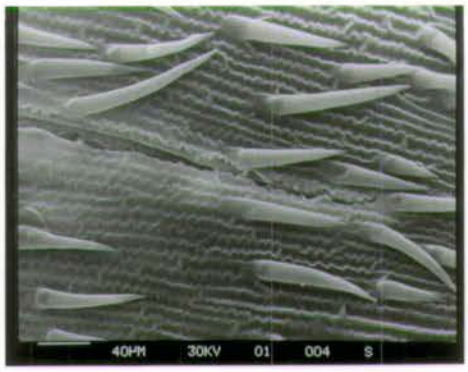
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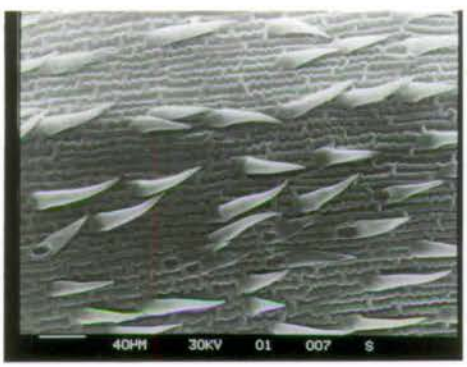
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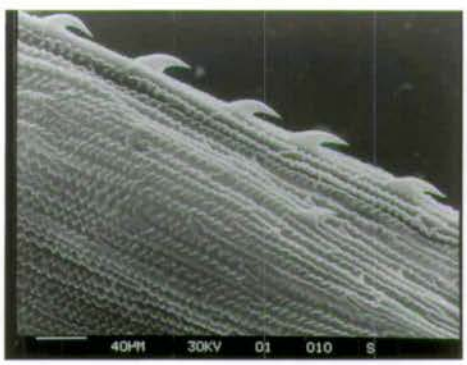
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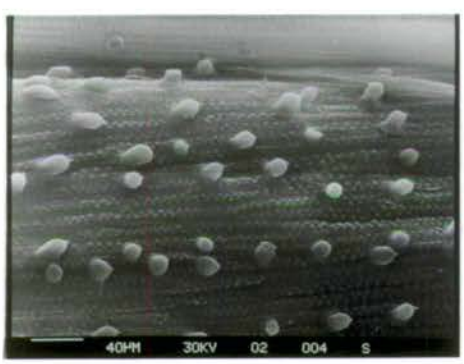
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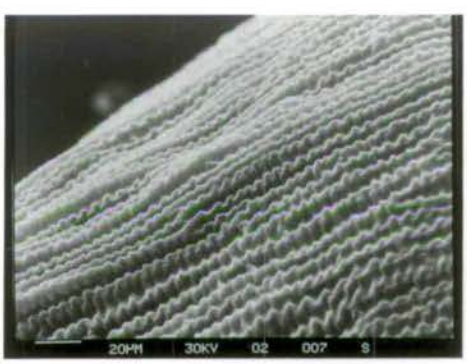
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Pl.5

Plate 6. Lemma surface view in Phleum

a) P. paniculatum subsp. paniculatum (D.33902)

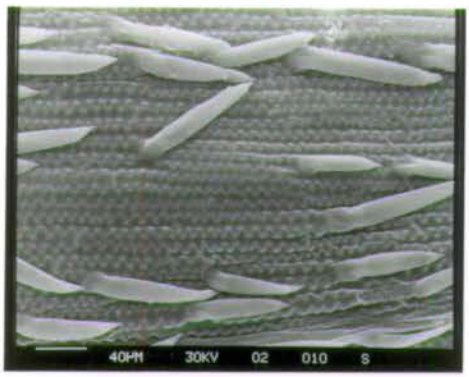
b) P. paniculatum subsp. ciliatum (J. Trelawny 1103)

c) P. montanum (Dent 75)

d) P. arenarium (13 v 1905, F.C. Crawford)

e) P. exeratum (Y. Akman 6622)

f) P. boissieri (D.28744)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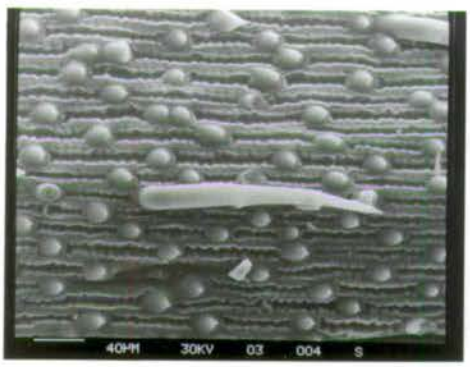
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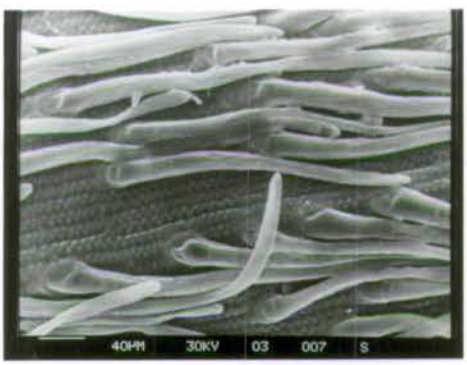
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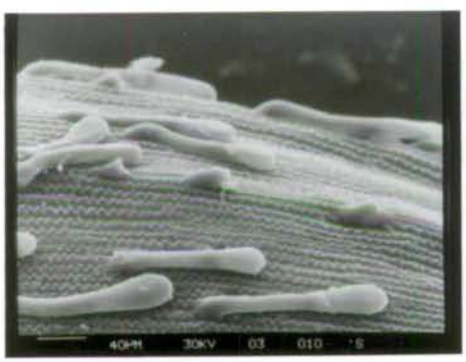
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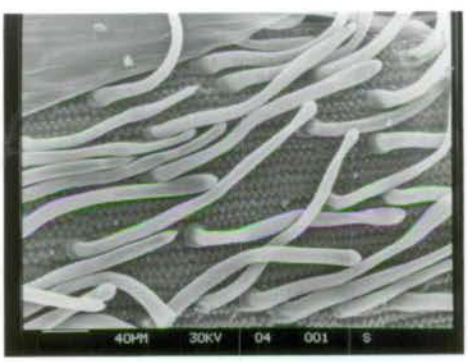
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Pl.6

have only slightly different hairs, which are oblong-acute in P. paniculatum (53-114 μ) and retrorsely scabridulous in P. echinatum (23-34 μ). The presence of these more or less similar hair types in these annual species might suggest that they once had an ancestor from high mountains. P. arenarium grows in lowland places around the Mediterranean and has very dense hairs on its lemma surfaces. Its hair type is like that found in P. pratense, but its hairs are rather long (280-533 μ). P. arenarium also has an ancestor from high mountains like the previous two species. The remaining three Turkish species are all annuals and their distribution is confined mainly to lowlands around the Mediterranean. These three species have rather different types of hair. Hairs are roughly orbicular in P. subulatum (13-16 μ), clavate in P. exeratum (126-150 μ) and long-cylindrical but obtuse in P. boissieri (213-266 μ).

In the closely similar genus, Pseudophleum, (P. gibbum), the hairs resemble those of Phleum boissieri but they are extremely long and rather pointed at apex (Pl. 4, e). In another similar genus, Rhizocephalus (R. orientalis), the hairs are clavate, c. 106-120 μ long (Pl. 4, c). Lemma hairs are extremely useful in distinguishing Zingeria (clavate) from Milium (glabrous).

The significance of hairs on the outer surface of lemmas has not been investigated fully below the species level; only Phleum paniculatum has been studied in its two subspecies. The type of hairs remain the same, but hair length greatly differs between the subspecies. In subspecies paniculatum the hairs are 68-114 μ long but only 53-80 μ long in the subspecies ciliatum.

Lemma colour: The colour of the lemma is quite uniform and does not often have very much taxonomic value. Whenever lemmas are coriaceous,

Fig. 24. Awns in Cross Section

a) Helictotrichon pubescens (x 130) D.37401)

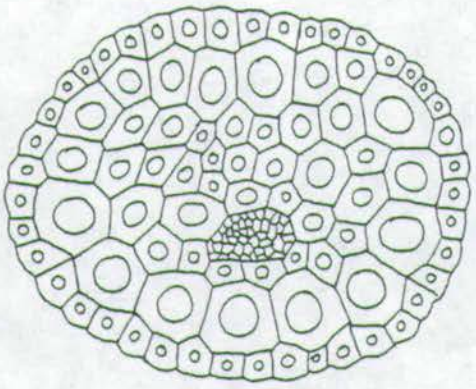
b) Helictotrichon compressum (x 130) (T. Ekim 932)

c) Helictotrichon convolutum (x 130) (Y. Akman ISTE 12238)

d) Trisetum flavescens (x 220) (D.20638)

e) Anthoxanthum odoratum (x 220) (Peşmen & Güner 1312)

f) Triplachne nitens (x 400) (iv 1883, G. Ruhmer)



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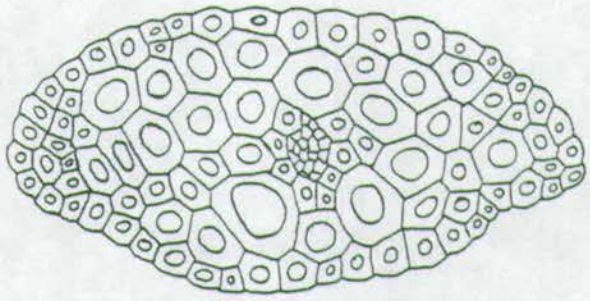

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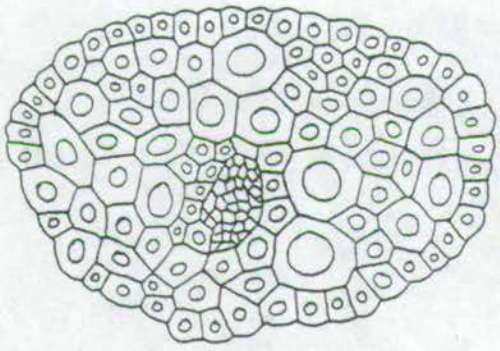

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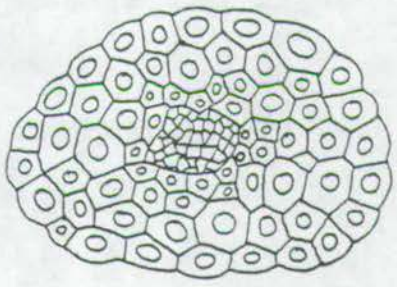

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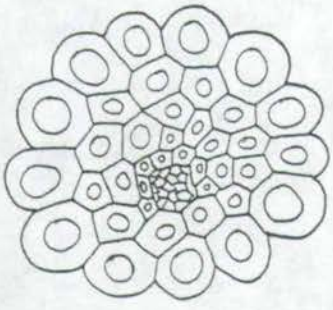

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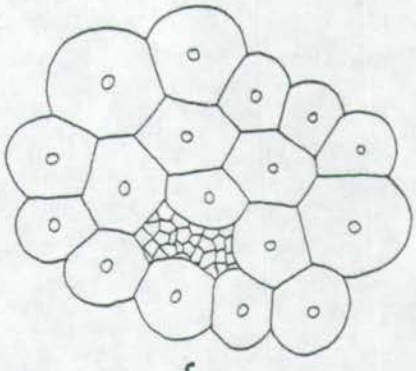


f

Fig. 24

they are shiny as in Milium. In Helictotrichon lemmas are variegated with brown and violet which distinguishes this taxon from the four other Turkish species: H. armeniacum, H. pratense, H. versicolor and H. argaeum. In these four species the lemmas are brownish to green. Even here, it is possible to distinguish species from each other on their lemma colour: H. versicolor and H. argaeum differ from H. pratense by their reddish-brown lemmas.

Lemma compression: The compression of the lemma is one of the most valuable taxonomic characters, but in most cases the spikelet compression has received more attention than that of the lemma. This must be the main reason for the placing of Alopecurus and Phleum next to each other in many taxonomic treatments. In fact, the lemmas are rounded in Phleum on the dorsal side, but are keeled in Alopecurus. This feature of the lemmas is also useful for the recognition of tribes Milieae and Phleeae in which the lemmas are dorsally rounded (i.e. Milium, Zingeria, Phleum, Beckmannia, Pseudophleum, Rhizocephalus, etc.), while in the remaining tribes (Aveneae and Phalarideae), the lemmas are more or less keeled.

Callus: The callus of grasses varies in form and plays a major role in the dispersal of diaspores. Most of the genera in the revised tribes have a more or less hairy callus, but only in the tribes Phleeae, Milieae and Phalarideae is the callus either glabrous or missing completely (because of the disarticulation of the rhachilla below the glumes). The tribe Aveneae can be recognised by its hairy callus. Here the callus hairs are sometimes extremely long in some species, as in Helictotrichon pubescens, Agrostis olympica, Calamagrostis (Sect. Calamagrostis), etc.

In Agrostis, (Pl. 7) the callus hairs are absent or up to 100 μ in the Turkish species; A. capillaris, A. lazica, A. stolonifera, A. canina and A. gigantea. In four other species callus hairs are at

Plate 7. Callus in Agrostis

a) A. olympica (A. Baytop ISTE 20936)

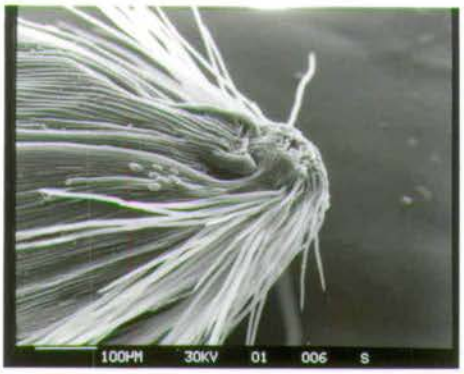
b) A. planifolia (viii 1866, Bal.)

c) A. castellana subsp. byzantina (A. Baytop ISTE 33691)

d) A. gigantea (McNeil 697)

e) A. capillaris (A. Baytop ISTE 33728)

f) A. lazica (Bal. 624)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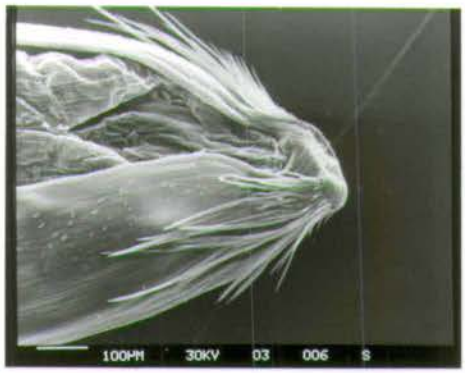
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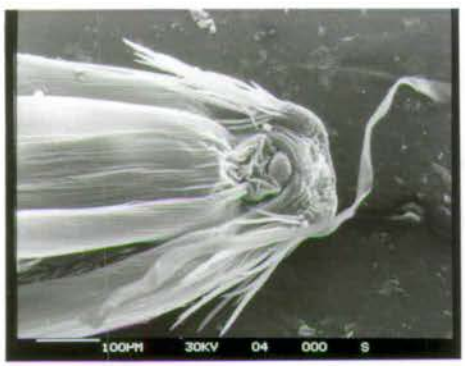
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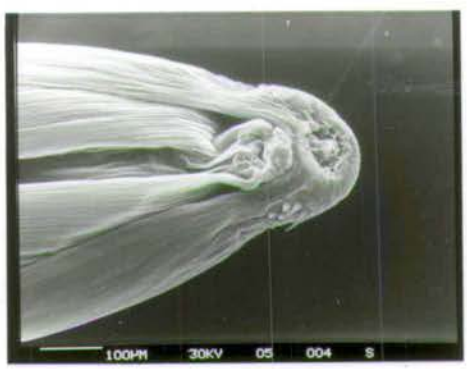
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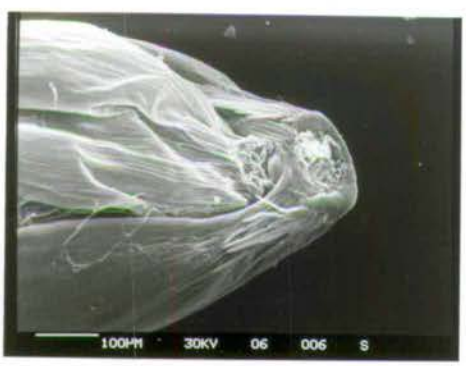
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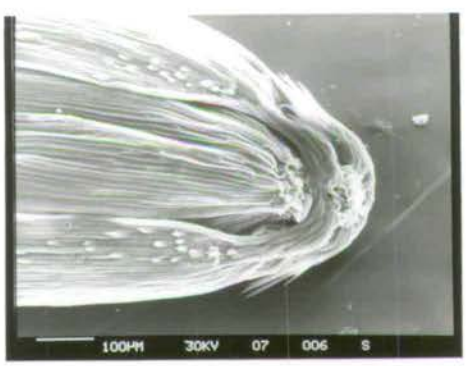
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Pl.7

Plate 8. Length of Palea in Agrostis

a) A. gigantea (McNeil 697)

b) A. canina (A. Baytop ISTE 33691)

c) A. planifolia (viii 1866, Bal.)

d) A. castellana subsp. byzantina (A. Baytop ISTE 33691)

e) A. olympica (A. Baytop ISTE 20936)

f) A. lazica (Bal. 624)


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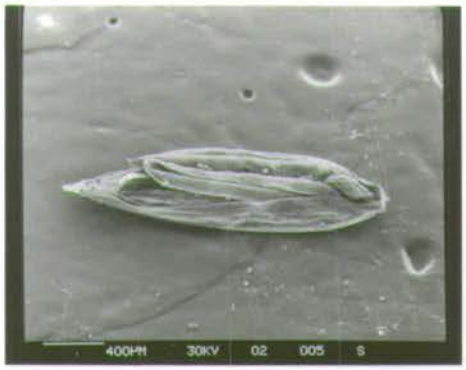
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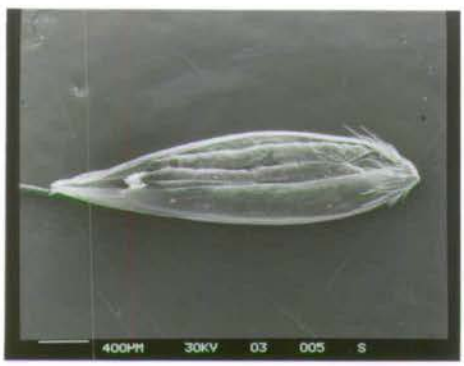
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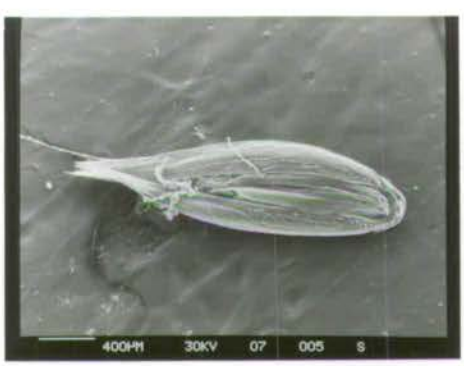
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Pl. 8

least 150 μ long [A. olympica (hairs equaling spikelet), A. planifolia (280-500 μ), A. castellana subsp. byzantina (150-270 μ) and A. balansae (900-1000 μ)].

3.5.7. Palea

Length: Paleas may be present or absent, even within the same species (Alopecurus). In most of the revised genera the palea protects the ovary and stamens and often invests the caryopsis tightly within the lemma. As it is shown in Pl. 8 the length of palea varies greatly in Agrostis. Some species lack a palea or have a small one (up to 2/5 of lemma, as in A. planifolia and A. canina), but in the other remaining Turkish species the palea is at least 1/3 of the lemma. In the previous classifications of Alopecurus, the presence or absence of a palea has been used in sectional delimitation, but produced dubious sections. Three previously described species of Alopecurus,(A. seriecceus, A. glacialis, A. ponticus), turned out to be the same polymorphic species [that varies slightly on palea characters which might be due either to the breeding mechanism or inhibiting action of palea genes]. The discovery of a specimen of A. arundinaceus from Turkey (B6 Sivas, Tobey 1679) also supports this idea, because though typical A. arundinaceus lacks a palea, Tobey's specimen has a palea.

Veins: The number of veins in the palea plays a very important role for the recognition of tribes. In most of the genera the number is 2, but in Alopecurus, Anthoxanthum, Phalaris and Hierochloë the paleas have only one vein. This is one of the main reasons for transferring Alopecurus and Cornucopia from the tribe Phleeae (Tzvelev 1976) to Phalarideae.

Plate 9. Scabridity of Palea in Helictotrichon

a) H. compressum (A. Baytop ISTE 4001)

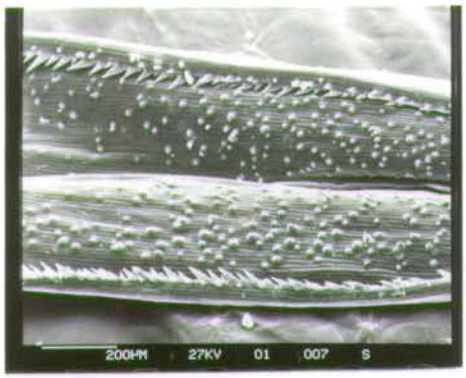
b) H. argaeum (Stn. & Hend. 6274)

c) H. planiculme (9 vii 1968, O. Dubovik)

d) H. pratense (D.37401)

e) H. blavii K.F.J. Maly 234)

f) H. convolutum (Y. Akman ISTE 12238)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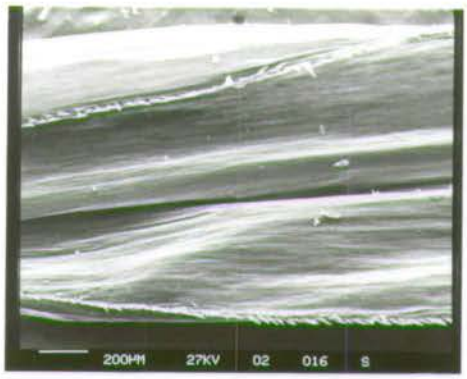
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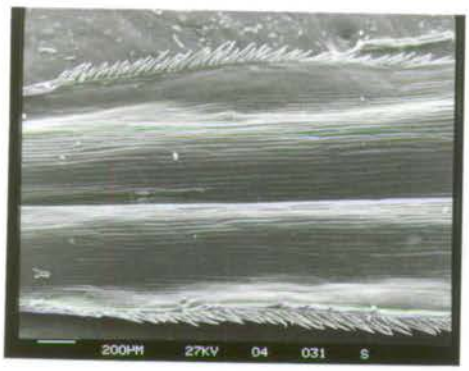
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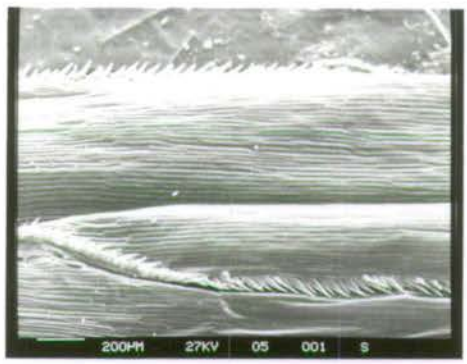
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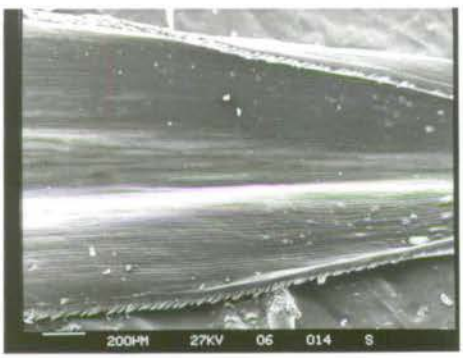
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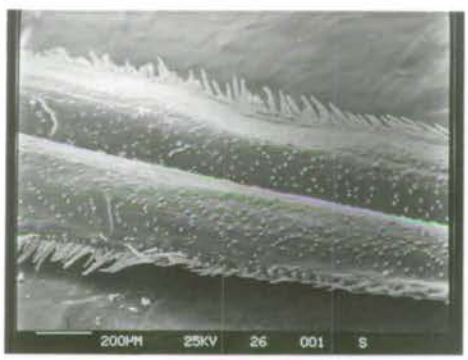
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Pl. 9

Apex: The palea apex is bifid in most of the genera, but in Anthoxanthum, Phalaris, Hierochloë and Alopecurus it is acute. In certain species the bifid apex of the palea provides useful diagnostic features between species. For example, Rostraria berythea can be distinguished from other Turkish species by its two exserted aristae at the apex of the palea.

Indumentum: The hairiness of palea is not very useful in most of the genera, but in Helictotrichon, H. pubescens can be distinguished from other Turkish species by its glabrous palea. In other species there are one or two lines of hairs on each keel (Pl. 9). The keel hairs are scabrid in most species (i.e. H. compressum, H. argaeum, H. pratense, H. blavii, H. versicolor, etc.), but in H. convolutum the hairs are more or less vertical on the keel.

Surface view: Palea surface is usually glabrous and has never been the subject of investigation, but during the study of keel hairs in Helictotrichon, two types of palea surface appearance were discovered. In the first type the palea is completely glabrous (i.e. H. argaeum, H. armeniacum, H. planiculme, H. pratense, H. versicolor), but in the second type the palea surface is covered by very fine hairs (i.e. H. compressum, H. convolutum).

3.5.8. Lodicules

The lodicules of grasses have long been investigated in great detail and used for comparative purposes. The most important contributions are by Hackel (1887), Bergal (1948), Baum (1969 a, b, 1971), Guedes & Dupuy (1976), Albers (1979) and particularly Jirasek & Jozifova (1968). Stebbins (1956) recognised four types of lodicules, viz. festucoid, chloridoid, panicoid and bambusoid.

The number of lodicules is usually 2(-3) in Aveneae, Milieae and Phleeae, but sometimes lodicules are absent, as in Anthoxanthum, Alopecurus and Cornucopia. When lodicules are present their apex type is a useful taxonomic character. The apex is acute in Milium and Zingeria, but bifid in Avena, Helictotrichon, Arrhenatherum, etc.

Lodicules are generally considered to be the two anterior members of a rudimentary perianth (Arber 1934) whose posterior member is developed in Dantoniastrum, Stipa and many Bambuseae.

The function of lodicules has long been understood. Their rapid swelling pushes palea and lemma apart and consequently results in the opening of the floret. Whenever lodicules are entirely lacking, the florets remain entirely closed and the reproductive organs protrude only at the apex, as in Alopecurus, Anthoxanthum and Cornucopia.

3.5.9. Androecium

Stamen numbers: In grasses stamen number varies greatly, but in the revised genera it is usually 3, or very occasionally 2, as in Anthoxanthum, Phleum crypsoides and Rhizocephalus orientalis. Reduction in stamen number follows a fairly simple pathway; from six to three by loss of one whorl; from three to two by the loss of the anterior anther, and from three to one by the loss of lateral anthers. A brief discussion on stamen number is given by Conner (1979).

Anther length: Anther length is used to distinguish some closely related species. For example Rostraria cristata has anthers which are 0.2-0.6 mm long, but in Rostraria hispida anthers are 0.7-1 mm long. In Agrostis, A. olympica has rather small anthers (0.3-0.5 mm), but other species have longer anthers, at least in Turkey. Phleum arenarium is often confused with Phleum exeratum but can be easily distinguished on anther length. Anthers are 0.3-0.5 (-0.8) mm in P. arenarium but 1.2-2 mm in P. exeratum.

Anther colour: The colour of anthers varies even within the same species according to age: anthers are often purplish at a late stage. Only in Alopecurus aequilis can the anther colour be used to distinguish this species from its closest relative Alopecurus geniculatus in which anthers are yellow to purplish; A. aequilis has very characteristic orange-coloured anthers.

3.5.10. Gyneocium

Ovary: There has been a slight controversy about the interpretation of ovary structure in grasses. Some researchers, Arber (1934), Belk (1939), Takhtajan (1948), believe that the gyneocium has arisen from 2 to 3 carpels intergrown at their edges and presents a modified form of asyncarpic ovary. Some other researchers like Rendle (1930) and Deyl (1955) believe that the gynoecium of grasses has originated from one single carpel and might have developed as a result of the reduction of the other two carpels from the tripartite apocarpous gynoecium similar to that of certain modern palms.

Terrel (1971) investigated the occurrence of liquid or soft endosperm in grass genera. Rosengurtt et al. (1972) noted that liquid endosperm is often correlated with another secondary character in the structure of the caryopsis, viz. a small, oval hilum. In the revised tribes there is usually liquid endosperm, as in Aveneae (i.e. Helictotrichon, Gaudinia, Trisetum, Trisetaria, Koeleria, Ventenata, Gaudinopsis, Holcus, Lagurus, Calamagrostis, Agrostis, Apera, etc.) Phalarideae (Alopecurus) and Phleeae (Beckmannia). It seems that liquid endosperm is present in all laterally compressed caryopses so far as the revised genera go, and also occurs widely in the genera in which the caryopsis has a ventral groove, as in most of the Aveneae.

Style: In the revised genera the number of styles is always two. Style characters have not been used very much in taxonomic accounts, but it is noted here that the styles are connate at the base in Alopecurus and Cornucopia. In the remaining genera styles are free to the base.

Stigma: Among the genera investigated, stigmas present a more or less similar appearance and it is therefore difficult to use stigma characters successfully in taxonomic accounts. There are two feathery stigmas. Stigmas are usually exserted apically in grasses without lodicules, a perfect adaptation to the anemophily syndrome.

Hilum: This is the funicular scar on the seed coat (after Radford et al. 1974). It is located in the ventral side of the caryopsis and is often very clearly visible due to slightly darker colour. Among the genera revised, most of them have a dorsally compressed caryopsis with a hilum located in a longitudinal groove. The shape of the hilum is extremely useful in taxonomic study. The shape is various, from linear to shortly oval according to xerophilization in grasses. The linear hilum is usually correlated with a longitudinal groove. In the revised genera the shape of hilum is linear to oblong, reaching to $\frac{2}{3}$ of the caryopsis.

Embryology: Work concerning the structure of the embryo was started in the 19th Century. Since then a number of researchers, including Bruns (1892) and Van Tieghem (1897) used the structural differences of embryo in grasses. The most up-to-date classification of embryos was proposed by Reeder (1957, 1961, 1962). Reeder based his classification on the following four principal characters: a) The arrangement of the

conducting bundles in the embryo; b) The presence or absence of the epiblast; c) The presence or absence of the aperture between the coleorhiza and the lower part of the scutellum; d) The shape of the cotyledon of the embryo in transverse section. However, Reeder finally recognised two main types of embryo in grasses, "Festucoid" and "Panicoid", as well as four additional mixed types; "Centothecoid", "Eragrostoid", "Oryzoid-Bambusoid" and "Arundinoid". All the revised genera have festucoid embryos according to Reeder (op. cit.), and show the following characters: the conducting bundle of the scutellum develops immediately beneath the coleoptile, an epiblast is present, and aperture between the base of the scutellum and the coleorhiza is lacking, and the lateral edges of the cotyledon of the embryo do not overlap. Reeder (1953) also discovered that Beckmannia had a festucoid anatomy and it was therefore necessary to separate it from the Chlorideae and place it with the festucoid grasses. Size of embryo was used successfully by Kinges (1961) and three types of embryo were recognised: Festucoid - with a small embryo; Panicoid - with a large embryo; and a third, intermediate type characteristic of chloridoid cereals. All the revised genera fall within the festucoid type in Kinge's system

Caryopsis

Length: The size of the caryopsis is certainly a useful taxonomic character, often used for comparative reasons, but there is almost no genus in which the caryopsis has uniform length and is alone sufficient to identify this genus. In spite of this difficulty, it is easy to distinguish a few groups of genera on their caryopsis length, such as Avena, Helictotrichon and Arrhenatherum. In these genera the caryopsis is relatively large, being at least 3-4 mm long.

Plate 10. Caryopsis shapes

a) Oblong (Arrhenatherum elatius, Ehrend. et al. 487-42-7)

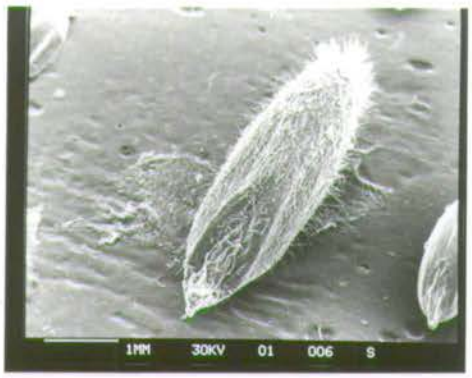
b) Elliptical (Phleum boissieri, D.28744)

c) Ovate (Pseudophleum gibbum, R. Çetik 1419)

d) Ovate (Rhizocephalus orientalis, Coode & Jones 136)

e) Linear-lanceolate (Avellinia michelii, 23 v 1897, Azn.)

f) Trullate (Rostraria cristata, F. Chesler & T. Deaver 144)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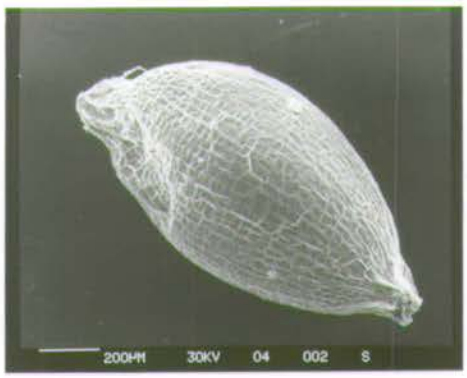
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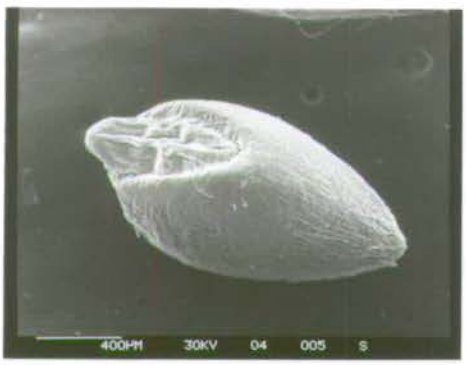
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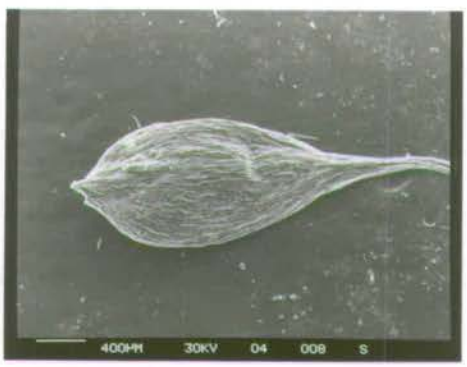
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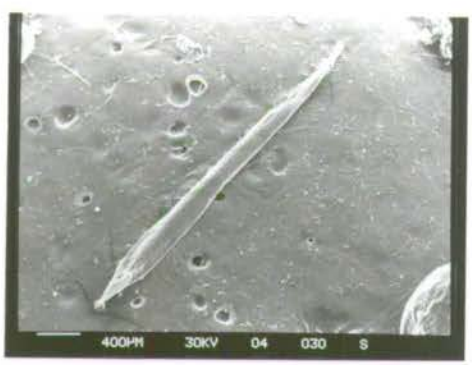
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Pl. 10

Compression and shape in cross-section: Martin (1946) investigated seeds of a number of families on their longitudinal and cross-section and finally illustrated the caryopsis of many species of grasses (i.e. Koeleria cristata, Aira caryophyllea, Anthoxanthum odoratum, Agrostis stolonifera, etc.).

In most of the revised genera the compression of the caryopsis is dorso-ventral, but in a few genera the caryopsis is compressed laterally (i.e. Holcus, Phalaris, Alopecurus and Cornucopia).

In cross-section, the middle part of the caryopsis varies in outline from one genus to another, and presents variation within genera. Two major types are recognised in the genera revised. The first type includes genera in which the caryopsis is laterally compressed and obovate in outline (i.e. Alopecurus, Anthoxanthum, Holcus, Phalaris, Hierochloë and Cornucopia). The second type includes the remaining genera in which caryopsis sections are more or less circular in outline and there is always a minute groove on the lateral side. As far as the investigated genera go, it is certainly true to say that the shape of the caryopsis in cross-section is correlated with the palea and lemma characters, because in the first type the number of palea veins is always one and the lemmas are strongly keeled. In the second type, the palea has 2 veins, and the lemmas are either not keeled or only slightly so.

Shape: For defining the caryopsis shape, the terminology of Lawrence (1951), Radford et al. (1974) and Baytop (1977) have been used. In all generic descriptions it is useful to give caryopsis shape. Even within a genus, closely related species can be distinguished on the basis of caryopsis shape (Olesen (1974) distinguished Phleum pratense and Phleum bertolonii). Whenever the caryopsis is strongly laterally compressed its shape is described from dorsal view. The caryopsis

Plate 11. Caryopsis surface view in Phleum

a) P. alpinum (A. Güner 1158)

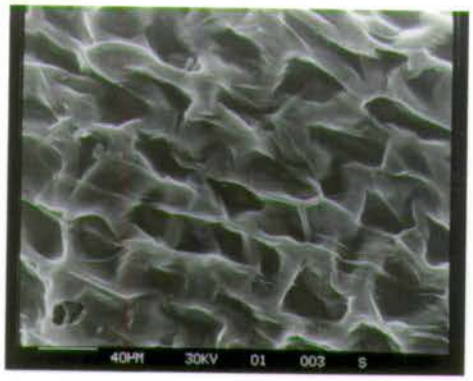
b) P. pratense (D. Spencer 101)

c) P. bertolonii (F. Sorger 68-2-35)

d) P. subulatum subsp. subulatum (F. Sorger 77-1-18)

e) P. crypsoides (22 vi 1870, Bourgeau)

f) P. arenarium (v 1872, J. Ball)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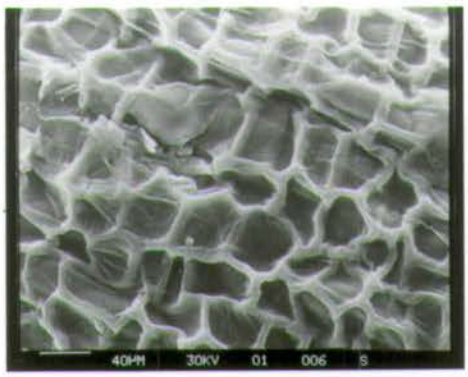
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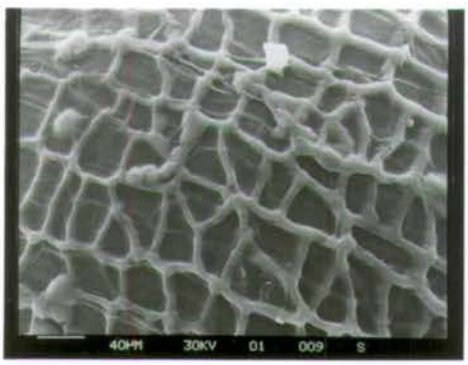
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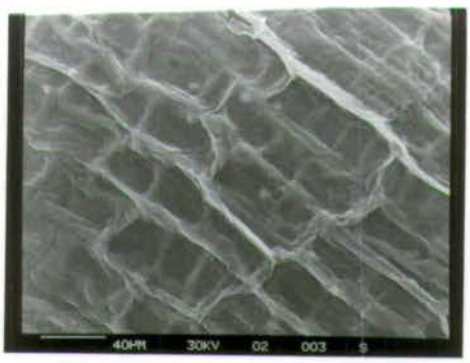
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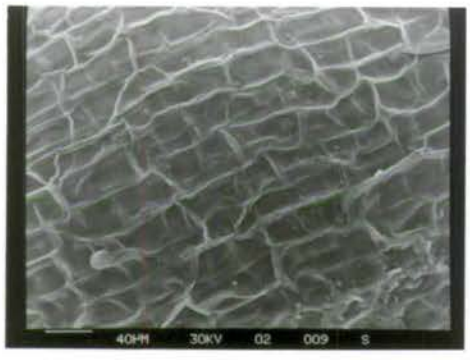
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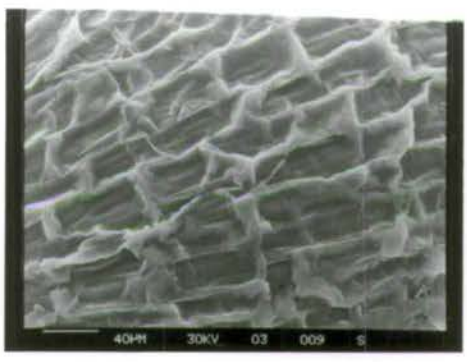
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f

Pl.11

shape is oblong in Avena, Helictotrichon, Arrhenatherum (Pl. 10, a), Gaudinia and Parvotrisetum. In some other genera, such as Ventenata, Corynephorus, Apera, Phleum (Pl. 10, b) x Agropogon, Polypogon, Gastridium, Triplachne, Milium, Anthoxanthum and Hierochloë, caryopsis shape is elliptical. Caryopsis shape is occasionally ovate, as in Pseudophleum (Pl. 10, c) and Rhizocephalus (Pl. 10, d). In Antinoria, Phalaris, Alopecurus and Cornucopia, caryopsis shape is obovate. In Alopecurus and Cornucopia the caryopsis is rather rounded on the ventral side and sometimes defined as obliquely-obovate. Only in Avellinia (Pl. 10, e), the caryopsis turned out to be linear-lanceolate in outline. In Trisetum, Trisetaria, Rostraria (Pl. 10, f) and Koeleria, the caryopsis is swollen near the base and presents a new form of ovate caryopsis, this type of caryopsis is defined as trullate after Radford et al.(op. cit. p. 130).

Apex: The apex of the caryopsis is a very useful taxonomic character (e.g. Bromus), but so far has been little used. In the revised genera it does not provide very much taxonomic information because it varies little, being usually obtuse to rounded. It is acuminate in Avellinia michelii. There is usually no beak at the top of the caryopsis, but in Rhizocephalus orientalis the caryopsis apex is pointed (Pl. 10, d).

The caryopsis is usually glabrous all over, but it is hairy in certain genera, particularly in Avena, Helictotrichon and Arrhenatherum (Pl. 10, a). Hairs are mainly at the apex and provide great help for distinguishing these three genera.

Starch grains: Starch grains of grasses have long been investigated by a number of botanists. The structural differences of starch grains were first recognised by Harz (1880) and later this work was followed

by other researchers, viz. Avdulov (1931), Tateoka (1962). The main reason for the investigation of starch grains was to elucidate the phylogenetic system of grasses, but in the most recent study Tateoka (1962) recognised four major types of starch grains, viz. triticoid ("Triticum type"), panicoid ("Panicum type"), miscanthus ("Miscanthus type"), festucoid ("Festuca-Eragrostis type"). The revised four tribes, Aveneae, Milieae, Phleeae and Phalarideae have caryopses in which starch grains are compound; they are all placed under the festucoid type by Tateoka (op. cit.).

Surface micromorphology: Baum (1971) studied caryopsis surfaces in Avena and some other Triticoid genera by means of S.E.M. Schuyler (1971) used S.E.M. to analyze achene epidermis in Scirpus and related genera.

The ornamentation of the seed coat at maturity presents useful taxonomic characters, but it is often not easy to assess variation which might occur according to the age of seed. In most cases, only random sampling has been done, and caryopsis surface views of various genera are discussed on the basis of a few species in order to demonstrate its usefulness. Caryopsis surface views are studied in three closely related genera, viz. Phleum, Rhizocephalus and Pseudophleum.

There are two major types of caryopsis surface appearance in the genus Phleum (Pl. 11). The first type presents a more or less honeycomb appearance and cells are either tetragonal, pentagonal or hexagonal from surface view, as in P. pratense, P. bertolonii and P. echinatum, but a slightly modified form of this type is present in P. alpinum in which cell walls are very thick and the honeycomb appearance is less conspicuous. In the second type, cells are regularly arranged in

longitudinal files and are usually rectangular in shape, or sometimes at an early stage the seed coat is almost glabrous. The second type is found in P. subulatum, P. crypsoides, P. paniculatum, P. arenarium, P. exeratum and P. boissieri. These two major types of caryopsis surface appearance clearly distinguish perennial species from annual ones.

Chapter IV

4. Some Observations on the Karyotype

4.1. Introduction

There have been a number of publications concerning the cytology of the Gramineae as a whole, particularly the cultivated ones. These previous works have been brought together by various botanists like Darlington & Wylie (1955), Federov (1969) etc. Only very few of these chromosome counts were based on Turkish material and therefore have little value for Turkish grasses in general. In the tribes revised in this thesis, not many counts could be done by me because of the lack of viable and identifiable Turkish grains available during the research period. Certainly this is the first taxonomic revision of these tribes in Turkey, and it is obvious that a great deal of cytological work still needs to be done on the Turkish material. In particular, chromosome counts of the endemic species of Turkish grasses need to be analysed as soon as possible in relation to their allies.

4.2. Chromosome Techniques

Pretreatment was done in Petri dishes using moistened filter paper. A colchicine solution of 0.05 % W/V was used. Fixation was accomplished in 3:1 ethanol/acetic acid for 24 hours or 6:2:2:1 ethanol/acetic acid/chloroform/formalin if quick fixation (5 minutes) was required. For routine work the lactopropionic orcein technique (Dyer 1979, p. 6-11) was used. This technique was found to give a high proportion of broken cells, so a pectinase wall-softening step was introduced so that intact cells were observed. It was found that acid treatment following the enzyme treatment was required to prevent severe cytoplasmic or wall staining.

The modified technique is as follows:

a) Pretreatment: 0.05 % colchicine for 4 hours.

b) Fixation: in Cornvoy's for 5 minutes or 3:1 fixation overnight.

c) Enzyme: Wash, then place in 1% pectinase at pH 4.5 for 1.5 hours at room temperature.

d) Maceration: 6M HCl at room temperature for 5 minutes.

e) Staining: tap out in a drop of 35% of 2% lacto-propionic orcein stock solution. Leave for 5 minutes to 24 hours before squashing.

Permanent preparation can be made if the coverslips are pre-treated with glycerine albumen. After squashing, the slides are flamed and the coverslips floated off in 45% acetic acid. The coverslips, with cells attached, are taken through three step series (75%, 90%, 100%) to absolute alcohol (5-10 minutes in each one) then mounted directly in Euparol. This technique was used for the visual verification of karyotypes or chromosome counts. Feulgen staining is considered to be the best stain for preparation where chromosome measurements are to be made, probably because of the clarity with which it shows the chromosomes. It is also better for callus work because a large piece of callus can be stained then the small meristematic regions can be identified, cut out and squashed. Feulgen stain was prepared as in Darlington & La Cour (1942). After pretreatment and fixation as above, tissues are stained as follows:

a) Hydrolyse in 1M HCl at 60° C for 12-14 minutes.

b) Wash in two rinses of tap water.

c) Place in stain and leave at least one hour before squashing.

4.3. Chromosome Counts

Chromosome counts made from Turkish specimens by me are as follows:

Species	Collector numbers	2n =
Agrostis canina	A. Baytop (ISTE 33691)	14
Aira elegantisima	A. Baytop (ISTE 15437)	14
Apera baytopiana	Leblebici, Seçmen & Bekat 2857	14
Apera spica-venti	A. Baytop (ISTE 13501)	14
Arrhenatherum elatius	A. Baytop (ISTE 20789)	28
Alopecurus aequalis	Tobey 774	14
Alopecurus gerardii	Pamukçuoglu & Quezel (HUB)	14
Beckmannia eruciformis	Seçmen & Güner 2310	14
Corynephorus divaricatus	A. Baytop (ISTE 22155)	14
Gastridium ventricosum	B. Çubukcu (ISTE 10501)	14
Gaudinia fragilis	A. Baytop (ISTE 5984)	14
Holcus annuus	T. Uslu (ISTE 36773)	14
Holcus lanatus	T. Baytop (ISTE 14244)	14
Helictotrichon compressum	N. Tanker (ISTE 10573)	14
Helictotrichon convolutum	Y. Akman (ISTE 15437)	14
Phleum bertolonii	F. Sorger 68-2-35	14
Phleum alpinum	A. Güner 1158	28
Phleum subulatum	F. Sorger 77-1-18	14
Phleum exeratum	F. Sorger 67-21-34	14
Polypogon maritimus	A. Baytop (ISTE 9780)	28
Polypogon viridis	A. Baytop (ISTE 9780)	28
Polypogon monspeliensis	A. Baytop (ISTE 10014)	28
Ventenata dubia	A. Baytop (ISTE 6548)	14

Chapter V

5. Taxonomic Concepts and Categories

5.1. Introduction

Since the Pre-Linnean period taxonomists have been trying to establish the real nature of taxonomic categories. An extensive literature dealing with various taxonomic categories was brought together by Davis & Heywood (1973) and a brief summary is also given by Lawrence (1951). Certainly concepts of the categories have changed over the years, but as far as the revised group is concerned, it seems desirable to give an explanation of my treatment of five taxonomic categories: Genus, Section, Species, Subspecies and Variety.

5.2. Genus

I have recognised 38 genera in the tribes Aveneae (incl. Agrostideae), Miliеae, Phalarideae and Phleeae in Turkey on the basis of their overall similarities and dissimiliarities. My treatment of the genus is very much a morphological one which may appear more or less a tradition in grasses, since their morphology has been much investigated for a long time. Many of the Linnean genera are retained today not only because of their historical background but because of their more or less natural grouping. However, Linnaeus made a number of mistakes and included many distinct genera in other ones (see 1.3.). Each genus (unless monotypic) is made up of closely related species which have more in common with each other than with species outside that genus. I have investigated all the species in my revised genera to see if they form natural groupings. Only in the genus Phleum, one species (P. gibbum Boiss.) was found to differ very much from the other members on floral morphology. However, I have separated this species from Phleum and given it a generic name, Pseudophleum, in order

to make the genera more natural and equivalent (Dogan, M. 1981). Certainly the degree of difference between the species of one genus is not as great as two species belonging to two genera. To some botanists it may seem unnecessary to divide up the traditional genera if their main aim is ease of identification, whether the limits of the genera are natural or not. I find this approach unscientific and believe that respect for tradition is not justified if the genera thereby recognised are manifestly heterogeneous and therefore unnatural. Many of our present genera, such as Triplachne, Pseudophleum, Rhizocephalus, etc., are monotypic ones because it seems impossible to retain them within another genus without destroying the naturalness of that other genus. It is also unnecessary to recognise a new genus on the basis of an anatomical character alone (i.e. Avenula and Helictotrichon s.s.) or an external morphological one (i.e. Maillea).

5.3. Section

To many botanists sections are not accessory taxa and have often been established for the sake of convenience on the basis of one or more arbitrary characters. My concept of the section is slightly different from the above. The three genera Helictotrichon, Alopecurus and Phleum have been investigated throughout their entire geographical range. The sections recognised within these three genera consist of closely related species, and the level of difference between the members of each section is less pronounced than that between the members of the other sections. However, I have employed gross morphological characters as well as anatomical ones in order to make the sections more natural.

5.4. Species

The treatment adopted for the species is much the same as that of Du Rietz (1930) who postulated that the species were "the smallest natural populations permanently separated from each other by a distinct discontinuity in the series of biotypes". As suggested by Hedberg (1958), clear discontinuous variation in two independent characters is the criterion followed for specific distinction, at least in so far as the amount of investigated material allows. Phleum bertolonii was often treated as a subspecies of P. pratense but as it differs from P. pratense in at least three characters it requires species status. The same thing also applies to P. phleoides and P. montanum. As I had almost no information on the cytology and breeding behaviour of the species investigated, information from these sources could not be used. My species concept is therefore basically morphological.

5.5. Subspecies

My treatment of subspecies is basically the same as that proposed by Du Rietz (1930). Major geographical races of the species are treated as subspecies. In spite of being always differentiated by morphological features, subspecies are morphologically not so well separated as the species because the degree of difference between them is less pronounced. For reaching a more consistent subspecies concept, a species should be investigated throughout its entire geographical range. Subspecies have rather distinct geographical distributions, but may be interconnected clinally in the contact zone by populations or individuals exhibiting transitional characters. In many cases, however, subspecies are completely allopatric, and in such situations morphological intermediates may not be found.

5.6. Variety

Varietal rank is often assigned to local populations of a species or subspecies. Varieties differ from other such populations in one or more hereditary characters. The variety may or may not be confined to a definite geographical range in relation to other varieties of the same taxon. As in some cases it is difficult to decide what to do with some specimens. I have sometimes found it useful to give varietal rank to individuals whose nature is not understood at present (i.e. Alopecurus myosuroides var. lataelatus).

A 'Form' is best treated as a minor variant which is generally of sporadic occurence (e.g. hairy versus glabrous forms within a population), and names have not been applied to them in my thesis.

6. Infrageneric Classification in Helictotrichon, Alopecurus and Phleum

To achieve a more consistent level of infrageneric grouping here, external and internal morphological characters are combined together and fully used to make taxa as natural as possible.

6.1. Infrageneric Classification in Helictotrichon

Boissier (1884), in his Flora Orientalis, accepted all perennial species as a section, Avenastrum Koch, of the genus Avena s.l. Later St.-Yves carried out very detailed investigations concerning the internal structure of leaf blades and recognised three subsections, namely Costatae, Ecostatae and Anomalae in the section Avenastrum of the genus Avena s.l. Komarov (1963), in his Flora of U.S.S.R. accepted the existence of another genus, Avenastrum Jessen, in the genus Avena s.l. and transferred all perennial species of Avena s.l. to this newly adopted genus. Komarov (op. cit.) recognised three series, Pratensis, Desertícolae and Tianschanicae in the genus Avenastrum. Recently another Russian botanist, Tzvelev (1976), used the name Helictotrichon instead of the previously adopted name Avenastrum and recognised three sections, Pratavenastrum, Pubavenastrum and Helictotrichon, in this genus. The most recent major investigation in this genus was undertaken by Holub (1980) when he revised its European members for Flora Europaea vol. 5. Holub divided the genus into two, Helictotrichon s.s. and Avenula. According to this account the leaves of Helictotrichon are strongly ribbed on their adaxial leaf surface and have many lines of bulliform cells along the mid-vein, whereas in Avenula there are only two lines of bulliform cells along the mid-vein and the leaf blades are not ribbed on their adaxial surface. Holub did not recognise any infrageneric taxa in Helictotrichon s.s., but in the other genus, Avenula, he distinguished

TABLE III

Boissier (1884)	St.-Yves (1931)	Komarov (1963)	Tzvelev (1976)	Holub (1980)	M. Dogan -	
Avena L.	Avena L.	Avenastrum Jessen	Helictotrichon Besser	Helictotrichon Besser	Helictotrichon Besser	H. cycladum
				H. decorum		H. gervaisii
Sect. Avenastrum	Sect. Avenastrum	Ser. Pratenses	Sect. Pratavenastrum	H. sedenense	Subgen. Helictotrichon	H. pruinosa
A. pubescens		A. Pratense	H. daburicum	H. planifolium		H. crassifolia
A. convoluta	Subsect. Costatae	A. schellianum	H. planiculme	H. parlatorei	Sect. Helictotrichon	
A. scheuchzeri	A. macrostachya	A. adzharicum	H. praeustum	H. setaceum	H. sempervirens	Sect. Blavia
A. argaea	A. aspera	A. armeniacum	H. pratense	H. petzense	H. parlatori	H. blavii
A. pratensis	A. decora	A. asiaticum	H. armeniacum	H. sempervirens	H. convolutum	
A. caryophyllaea	A. junghuhnii	A. daburicum	H. adzharicum	H. convolutum		Sect. Scleravenastrum
A. agropyroides	A. montana	A. pubescens	H. versicolor	H. sarracenorum	Sect. Unistrata	H. hackelii
A. planiculmis	A. deftschenkoi		H. bookeri	H. filifolium	H. filifolium	
A. compacta	A. mongolica	Ser. Deserticolae		H. murcicum	H. sedense	
A. oligostachya	A. sempervirens	A. desertorum	Sect. Pubavenastrum	H. cantabricum	H. decorum	
A. carmeli	A. desertorum	A. krylovii	H. pubescens	H. desertorum	H. setaceum	
	A. partatorii	A. hissaricum			H. sedenense	
	A. filifolia		Sect. Helictotrichon	Avenula (Dumort) Dumort	H. desertorum	
		Ser. Tianschanicae	H. mongolicum		H. planifolium	
	Subsect. Ecostatae	A. tianschanicum	H. tianschanicum	Subgen. Pubavenastrum	H. cantabricum	
	A. jahandiesii	A. fedtschenkoi	H. turcomanicum	A. pubescens	H. pedzense	
	A. pubescens	A. mongolicum	H. fedtschenkoi		H. murcicum	
	A. hackelii	A. compactum	H. hissaricum	Subgen. Avenula	H. sarracenorum	
	A. pratensis		H. desertorum			
	A. versicolor		H. krylovii	Sect. Avenula	Subgen. Avenula	
	A. blavii			A. versicolor		
	A. bromoides			A. schelliana	Sect. Pubavenastrum	
	A. breviaristata			A. marginata	H. pubescens	
				A. albinervis		
	Subsect. Anomalae			A. occidentalis	Sect. Avenula	
	A. neumayeriana			A. delicatula	H. versicolor	
	A. oligostachya			A. levis	H. pratense	
				A. compressa	H. armeniacum	
				A. aetolica	H. argaeum	
				A. blavii	H. compressum	
				A. mirandana	H. marginiata	
				A. ganzaloi	H. albinervis	
				A. requienii	H. schellianum	
				A. pungens	H. praeusta	
				A. pratensis	H. daburicum	
				A. praeusta	H. bromoides	
				A. planiculmis	H. cincinnata	
				A. bromoides	H. planiculme	
				A. murcica	H. aetolica	
				A. cincinnata	H. occidentalis	
				A. peloponnesiaca	H. delicatula	
				A. cycladum	H. mirandana	
				A. gervaisii	H. gonzaloi	
				A. prunosa	H. requienii	
				A. crassifolia	H. pungens	
					H. murcica	
				Sect. Scleravenastrum	H. peloponnesiaca	
				A. hackelii	H. agropyroides	

two subgenera, Pubavenastrum and Avenula. He went further and distinguished two sections, Avenula and Scleravenastrum in the latter subgenus.

Various treatments of the genus Helictotrichon s.l. over a 92 year period are briefly summarized in Table III and all the species previously placed under each infrageneric taxon by Boissier (1884), St.-Yves (1931), Komarov (1963), Tzvelev (1976) and Holub (1980), are listed. My own treatment of the genus is shown in the final column of Table

Infrageneric groups in Helictotrichon and their descriptions

Subgenus Helictotrichon

Basal leaf blades strongly ribbed above, with more than 2 lines of bulliform cells along the mid-vein or bulliform cells not observable in intercostal zone. A ring of sclerenchyma surrounds the root endodermis. Lower glume 1-veined, upper glume 3-veined.

Sect. 1. Helictotrichon

Two series of vascular bundles present in leaf blades. A continuous layer of sclerenchyma present below the abaxial epidermis.

Type: H. sempervirens (Vill.) Pilger

Sect. 2. Unistrata M. Dogan

Vascular bundles one seried in leaf blades. With or without a continuous layer of sclerenchyma below the abaxial epidermis.

Type: H. desertorum (Less.) Nevski

Subgenus Avenula (Dumort.) M. Dogan

Basal leaf blades not ribbed above, with 2 lines of bulliform cells along mid-vein. Root endodermis not surrounded by a ring of sclerenchyma. Lower glume 3(-1)-veined, upper glume 3(-5)-veined.

Sect. 1. Pubavenastrum (Vierh.) Holub

Outer bundle sheath of mid-vein complete. Midrib observable. Without a continuous sclerenchymatous layer below the abaxial epidermis. Veins of lemma not reaching the upper margin. Awns terete at base. Palea glabrous and smooth on the keels. Rhachilla hairs 3-5 mm.
Type: H. pubescens (Hudson) Pilger

Sect. 2. Avenula

Outer bundle sheath of mid-vein interrupted from below or at both poles. Midrib observable. Without continuous sclerenchymatous layer below the abaxial epidermis. Veins of lemma reaching to upper margin. Awns dorso-ventrally compressed at base. Palea hairy on the keels. Rhachilla hairs less than 3 mm or absent.
Type: H. pratense (L.) Besser

Sect. 3. Blavia M. Dogan

Outer bundle sheath of mid-vein interrupted from below. Midrib observable. Leaf blades without a continuous layer of sclerenchyma below the abaxial epidermis. Veins of lemma reaching to upper margin. Awn dorso-ventrally compressed at base. Palea hairy on the keels. Rhachilla hairs 1.5-2.5 mm.
Type: H. blavii (Ascherson & Janka) C.E. Hubbard

Sect. 4. Scleravenastrum Holub

Outer bundle sheath of mid-vein interrupted from below. Midrib not observable. Leaf blades with a continuous layer of sclerenchyma below the abaxial epidermis. Veins of lemma reaching to upper margin. Awns dorso-ventrally compressed at base. Palea hairy on the keels. Rhachilla hairs 2.5-4 mm.

Type: H. hackelii (Henrig) Henrard

Discussion

All the perennial species of Avena s.l. are retained here under one genus, Helictotrichon. Investigations of internal morphology of vegetative organs (see Fig. 4-7, 11b-12) suggested that the two genera previously accepted by Holub in Flora Europaea, Helictotrichon and Avenula, are not separate genera. They may represent two major evolutionary pathways in the genus. They are given subgeneric rank on the basis of their external and internal vegetative characters.

In previous recent works, such as Tzvelev (1976) and Holub (1980), the species with a ribbed adaxial surface of the leaf blades and more than 2 lines of bulliform cells along the mid-vein, refer to either the genus Helictotrichon or to section Helictotrichon and have never been investigated for the purpose of infrageneric grouping. Here, I have recognised two sections on the basis of the number of vascular bundle layers and also the presence or absence of a continuous sclerenchymatous layer below the abaxial epidermis in the subgenus Helictotrichon. In the other subgenus, Avenula a new monotypic section Blavia (based on H. blavii) is recognised on its observable mid-vein and lack of any continuous sclerenchyma below the abaxial epidermis.

6.2. Infrageneric Classification in Alopecurus

Grisebach (1853), in his Flora Rossicae, recognised two sections, Colobachne and Eualopecurus in this genus. Boissier (1884) distinguished two groups, Annui and Perennes, and did not consider the previous work. Later Grisebach's infrageneric grouping was accepted in the work of Ascherson and Graebner (1898-1902). Komarov (1963), in his Flora of U.S.S.R. vol. 2, recognised 5 series, Vaginatae, Ventricosae, Pratensis, Alpinae and Annuae. In Flora Iranica Bor (1970) made an infrageneric grouping which is based on Boissier's treatment of Flora Orientalis, but in the perennial section he went further and recognised two subsections, Aristata and Acuta. Tzvelev (1976) accepted four sections, Colobachne, Alopecurus, Alopecurium and Pseudophalaris.

The previous infrageneric groupings in the genus Alopecurus are tabulated in Table IV and species previously placed under each of the infrageneric taxa by various botanists are also listed.

Infrageneric groups in Alopecurus and their descriptions

Sect. 1. Alopecurus

Usually perennial, rarely annual. Panicle oblong to cylindrical. Glumes acute to obtuse at apex, connate for $\frac{1}{4}$ or less of their length above base, not winged. Epidermal cells of glumes minutely sinuous, rectangular, with thin margins and small siliceous cells.
Type: A. pratensis L.

Sect. 2. Pseudophalaris Tzvelev

Usually annual, sometimes perennial. Panicle cylindrical, occasionally ovoid. Glumes acute to obtuse at apex, connate for 1/4 - 4/5 of their length above the base, usually with a rather narrow wing on the keel. Epidermal cells of glumes rather deeply sinuous, each

TABLE IV

Grisebach (1853)	Boissier (1884)	Asch. & Graeb. (1838-1902)	Komarov (1963)	Bor (1970)	Tzvelev (1976)	Tutin et al. (1980)	M. Dogan -
Sect. Colobachne A. gerardii A. vaginatus Sect. Eualopecurus A. lanatus A. alpinus A. brachystachyus A. glaucus A. pratensis A. ruthenicus A. geniculatus A. fulvus A. agrestis	Group Annui A. agrestis A. creticus A. utriculatus A. anthoxanthoides Group Perennes A. geniculatus A. fulvus A. arundinaceus A. lanatus A. gerardii A. vaginatus A. glacialis A. aucheri A. textilis	Sect. Colobachne A. gerardii A. utriculatus Sect. Eualopecurus A. myosuroides A. pratensis A. bulbosus A. geniculatus A. fulvus	Series Vaginatae A. vaginatus A. tiflisiensis A. textilis A. dasyanthus A. aucheri A. himalaicus A. brachystachyus A. glacialis Series Ventricosae A. mucronatus A. apiatus A. ventricosus A. serieceus A. gerardii Series Pratensis A. pratensis A. laxiflorus A. seravschanicus A. soongoricus Series Alpinae A. glacus A. pseudobrachystachyus A. tenuis A. rochevitzianus A. alpinus A. borealis A. stejnegeri Series Annuae A. myosuroides A. longiaristatus A. geniculatus A. amurensis A. aegualis	Sect. Annual A. aequalis A. nepalensis A. myosuroides A. utriculatus Sect. Perennial Subsect. Aristate A. dasyanthus A. tiflisiensis A. textilis A. himaliacus A. aucheri A. vaginatus Subsect. Acute A. mucronatus A. apiatus A. arundinaceus A. serraushanicus A. glacialis A. geniculatus A. pratensis	Sect. Colobachne A. ponticus A. vaginatus A. textilis A. glacialis A. albovii A. aucheri A. dasyanthus A. himalaicus Sect. Alopecurus A. mucronatus A. apiatus A. arundinaceus A. brachystachyus A. pratensis A. alpinus Sect. Alopecurium A. geniculatus A. aequalis A. longiaristatus A. nepalensis Sect. Pseudophalaris A. myosuroides A. borii	Sect. Alopecurus A. pratensis A. arundinaceus A. geniculatus A. aequalis A. bulbosus A. himalaicus A. alpinus A. utriculatus A. setarioides Sect. Pseudophalaris A. myosuroides A. creticus Sect. Tozzettia A. rendlei Sect. Colobachne A. gerardii A. vaginatus	Sect. Alopecurus A. geniculatus A. seravschanicus A. soongoricus A. mucronatus A. alpinus A. aequalis A. pratensis A. arundinaceus A. antarticus Sect. Pseudophalaris A. bulbosus A. japonicus A. borii A. nepalensis A. creticus A. myosuroides A. utriculatus Sect. Tozzettia A. rendlei A. setarioides Sect. Colobachne A. lanatus A. davisii A. laguroides A. gerardii A. glacialis A. apiatus A. vaginatus A. textilis A. aucheri A. himaliacus

cell almost equal in length and width, sinuous margins rather irregular and thick, siliceous cells very large.

Type: A. myosuroides Hudson

Sect. 3. Colobachne (Beauv.) Trin.

Perennial. Panicle ovoid to globular. Glumes terminating in an aristate point, connate for up to $\frac{1}{3}$ of their length, without a wing on keel, usually covered all over by silky hairs. Epidermal cells of glumes minutely sinuous, rectangular, margins thin, siliceous cells small.

Type: A. vaginatus (Willd.) Boiss.

Sect. 4. Tozzettia (Savi) Endl.

Annual. Panicle ovate to broadly cylindrical. Glumes acute, connate for $\frac{1}{3}$-$\frac{1}{2}$ of their length, without a wing on the keel, usually subcoriaceous (sometimes not), often gibbous at the sides, urceolate. Epidermal cells of glumes rather deeply sinuous or minutely sinuous, cells equal in length or rectangular, wall thin or thickened, siliceous cells very large or rather small.

Type: A. rendleii Eig

Discussion

Not much change has been made in Alopecurus. Four of the previously recognised sections are accepted here. These are Alopecurus, Pseudophalaris, Colobachne and Tozzettia. Some of the species from the Flora of Turkey area, where grasses have never been revised on a floristic basis since Boissier's time, are placed in their appropriate sections, such as Alopecurus davisii and Alopecurus lanatus in sect. Colobachne. Previously Alopecurus setarioides was included in the section Alopecurus, but I have transferred it to section Tozzettia. Another species,

A. utriculatus, was also placed in sect. Alopecurus in Flora Europaea, but its microscopical features demonstrate its close relationship to the species placed under section Pseudophalaris. Acceptance of A. utriculatus under the sect. Pseudophalaris is also supported by A. utriculatus subsp. anthoxanthoides, because this is the subspecies in which glumes have a winged keel.

6.3. Infrageneric classification in Phleum

Grisebach (1853), in Flora Rossicae, distinguished three sections, Achnodon, Chilochloa and Euphleum in Phleum. Boissier (1884) divided the genus into two groups, Annua and Perennia, on the basis of habit. Boissier also recognised another monotypic genus, Maillea, next to Phleum. In the works of Ascherson and Graebner 1902), the previously recognised sections, Euphleum and Chilochloa, were recognised and Maillea was accepted as an individual genus as it had been treated in Flora Orientalis. Komarov (1963), Bor (1970) and later Tzvelev (1976) did not make any change in the infrageneric grouping and recognised three sections, Achnodon, Chilochloa and Phleum. They also placed some of the species for the first time in their appropriate sections. Recently in Flora Europaea vol. 5 four sections were recognised, three of which are the sections recognised in the work of Tzvelev (op. cit.) and the fourth one, sect. Maillea, is based on M. crypsoides.

The previous treatments of Phleum have been compared in Table V.

Infrageneric groups in Phleum and their descriptions

Sect. 1. Phleum

Panicle branches adnate to main axis. Glumes not winged. Second rhachilla segment not prolonged beyond the floret. Lemma hairs attenuate to a fine point. Stamens 3.

Type: P. pratense L.

TABLE V

Grisebach (1853)	Boissier (1884)	Asch. & Graeb. (1898-1902)	Komorov (1963)	Bor (1970)	Tzvelev (1976)	Tutin et al. (1980)	M. Dogan -
Sect. Achnodon P. tenue Sect. Chilochloa P. arenarium P. asperum P. boehmeri P. michelii Sect. Euphleum P. pratense P. alpinum	Group Annua P. tenue P. exeratum P. graecum P. arenarium P. asperum P. gibbum P. echinatum Group Perennia P. boehmeri P. michelii P. pratense P. alpinum	Sect. Euphleum P. pratense P. alpinum P. echinatum Sect. Chilochloa P. boehmeri P. arenarium P. montanum P. michelii P. paniculatum P. subulatum	Sect. Achnodon P. tenue Sect. Chilochloa P. boissier P. arenarium P. paniculatum P. graecum P. phleoides P. montanum P. michelii Sect. Euphleum P. echinatum P. pratense P. alpinum	Sect. Achnodon P. subulatum Sect. Euphleum P. bertolonii P. pratense P. alpinum P. michelii P. iranicum P. montanum P. phleoides Sect. Chilochloa P. himalaicum P. paniculatum P. exeratum P. boissieri	Sect. Chilochloa P. hirsutum P. phleoides Sect. Achnodon P. himalaicum P. arenarium P. subulatum P. paniculatum Sect. Phleum P. pratense P. alpinum P. echinatum	Sect. Phleum P. pratense P. alpinum P. echinatum Sect. Chilochloa P. phleoides P. montanum P. hirsutum P. paniculatum P. arenarium P. graecum Sect. Maillea P. crypsoides Sect. Achnodon P. subulatum	Sect. Phleum P. echinatum P. pratense P. alpinum P. bertolonii Sect. Chilochloa P. himalaicum P. paniculatum P. arenarium P. phleoides P. montanum P. michelii P. hirsutum P. iranicum Sect. Maillea P. crypsoides Sect. Achnodon P. exeratum P. boissieri P. subulatum

Sect. 2. Chilochloa (Beauv.) Peterm.

Annual or perennial. Panicle branches free. Glumes not winged. Second rhachilla segments prolonged beyond floret. Lemma hairs attenuate to a fine point. Stamens 3.

Type: Chilochloa boehmeri Beauv. [= P. phleoides (L.) Karsten]

Sect. 3. Maillea (Parl.) Horn af Rantzien

Annual. Panicle branches free. Glumes winged on the keel. Second rhachilla segment prolonged beyond the floret. Lemma completely glabrous. Stamens 2.

Type: Maillea crypsoides (D'Urv.) Boiss. [= P. crypsoides (D'Urv.) Hackel]

Sect. 4. Achnodon (Link) Griseb.

Annual. Panicle branches free. Glumes not winged on the keel. Second rhachilla segments prolonged beyond floret. Lemma hairs clavate. Stamens 3.

Type: Achnodon bellardii (Willd.) Link [= P. subulatum (Savi) Ascherson & Graebner]

Discussion

The previously recognised four sections, Phleum, Chilochloa, Maillea and Achnodon, are accepted here. The habit of species has often created some confusion in infrageneric grouping. For example, Bor (1970) placed Phleum iranicum under the section Euphleum (= Phleum), but its micro-characters show that it belongs to section Chilochloa. Section Achnodon, based on Phleum tenue (= P. subulatum), includes another two species, P. exeratum and P. boissieri, which were previously placed in section Chilochloa by Bor (op. cit.) and even in Flora Europaea vol. 5.

My main findings are based on microscopical structure of the lemma

and particularly on its hair type (see Table V). In the sect. Maillea, the lemma surface is entirely glabrous, but in the three remaining sections the lemmas are covered by hairs. The type of hairs supporting our treatment of the sections proved to be unique within each section, being either clavate as sect. Achnodon, or tapering to a fine point in sections Phleum and Chilochloa.

CHAPTER VII

7. Revision of Turkish Aveneae Dum. (incl. Agrostideae Dum.), Milieae Endl., Phalarideae Benth. and Phleeae Dum.

7.1. Introduction

In the area covered by the Flora of Turkey and East Aegean Islands (Davis, 1965-), the tribes Aveneae (incl. Agrostideae), Milieae, Phalarideae and Phleeae are represented by 38 genera of which 37 have been revised in this thesis; the remaining genus Phalaris is excluded here since it has already been revised by A. Baytop (1969).

A large amount of material has been brought together for careful study. Among the collectors of this material, the most important are Akman, Y., Aznavour, G.V., Bagda, H., Balansa, B., Balls, E.K., Baytop, A. & T., Birand, H., Bocquet, G., Boissier, P.E.E., Bornmüller, J.F.N., Buttler, K.P., Coode, M.J.E. & Jones, B.M.G., Çetik, R., Davis, P.H., Demiriz, H., Ehrendorfer, F., Ekim, T., Huber-Morath, A., Karamanoglu (Bilger), K., Kasapligil, B., Krause, K., Leblebici, E., Peşmen, H., Post, B. & G., Seçmen, Ö., Sorger, F., Tobey, C., Yaltirik, F. and Yurdakulol, E. The large collections have provided the basis for this revision and without doubt have greatly improved our knowledge of the group in Turkey.

In order to collect some dried and living material, and to study species in the field, I made one trip to Turkey and a substantial amount of specimens was collected from S., C. and N.E. Anatolia. All previously collected grass specimens in the main Turkish herbaria (ANK, ISTE, EGE, HUB) were examined, and some of the collections were borrowed for further examination. Two trips were made to major herbaria in London and all the relevent material at Kew and British Museum (Nat. Hist.) was examined. Another visit was made to various major European

herbaria in Berlin, Geneva, Munich, Prague and Wien, and other Turkish material was studied in these herbaria.

The generic limits adopted in this revision are based on the data revealed from various investigations in Part I of the thesis. All the genera are arranged in as natural an order as a linear sequence allows. Infra-generic classifications for the genera Helictotrichon, Alopecurus and Phleum are given in Chapter VI. A synopsis of the sections occuring in Turkey is included in the species accounts where appropriate.

Type material is cited as it appears in the original publications, and the herbaria in which they are found are given, using the abbreviations adopted in Index Herbariorum (1964).

Only one specimen has usually been cited per grid square, as adopted by Davis in Flora of Turkey, but for new taxa all available specimens are cited. An exclamation mark after specimen citations, type material and synonyms means that material has been examined. Many of the previously published records turned out to be wrong, so as to minimise this problem I have usually only cited specimens that have been seen by me. In certain uncritical cases, literature records in the Flora Aegaea (1943) etc. have been accepted when no material was available from these localities.

All abbreviations used in this thesis are those adopted by P.H. Davis (1965-) in the Flora of Turkey.

A synopsis of general distribution of species inside and outside Turkey has been given.

Finally, observations are provided for some of the species in order to indicate their affinities or variation whenever it seemed helpful to do so, and to indicate where further investigation is needed.

7.2. Key to Genera

1. Spikelets usually with 1 floret (rarely 2)
  2. Inflorescence a lax panicle
    3. Spikelets dorsally compressed
      4. Lemma covered by clavate hairs ..... 29. Zingeria
      4. Lemma glabrous and shiny ..... 28. Milium
    3. Spikelets laterally compressed
      5. Rhachilla disarticulating below glumes; spikelets falling entire ..... 24. Polypogon
      5. Rhachilla disarticulating above glumes; glumes persistent
        6. Spikelets 4-6 (-7) mm; callus hairs usually as long as spikelet; glumes usually linear ..... 19. Calamagrostis
        6. Spikelets 1.5-3.8 mm; callus hairs usually short; glumes often lanceolate
          7. Annual; lemma rather tough ..... 21. Apera
          7. Perennial; lemma hyaline ..... 22. Agrostis
  2. Inflorescence a dense spike-like panicle
    8. Panicle seated in a cup-shaped toothed involucre ..... 33. Cornucopia
    8. Panicle not seated in a cup-shaped involucre
      9. Lemma longer than both glumes, terminating into a small mucro
        10. Panicle head-like, surrounded by sheaths; lemma covered by short clavate hairs ..... 37. Rhizocephalus
        10. Panicle cylindrical, not surrounded by sheaths; lemma hairs long, tapering to a point ..... 36. Pseudophleum

9. Lemma shorter than both glumes, not terminating into a small mucro

11. Glumes with a seta, arising from sinus, covered by a few stout hairs in the lower part

12. Spikelets persistent; setae of glumes 1.5-2 mm ..... 23.x Agropogon

12. Spikelets not persistent; setae of glumes 4-7 ..... 24. Polypogon

11. Glumes terminating in an aristate point, acute to acuminate, or truncate at apex; without stout hairs in the lower part

13. Spikelets 10-14 mm; leaf blades up to 60 cm, convolute ..... 20. Ammophila

13. Spikelets up to 7 mm; leaf baldes short and flat

14. Glumes rather swollen and rounded in lower part, but compressed and keeled in upper part ..... 26. Gastridium

14. Glumes not swollen and rounded in lower part, compressed and keeled all over

15. Lemma with 2 setae at apex; glumes 1-veined

16. Glumes pectinate-ciliate; panicle ovate in outline ..... 25. Lagurus

16. Glumes glabrous; panicle oblong to elliptic in outline ..... 27. Triplachne

15. Lemma without 2 setae at apex; glumes 1 (-3) to 3-veined

17. Lower glume 1-veined; upper glume 3-veined; lemma awned just below apex ..... 21. Apera

17. Both glumes 3-veined; lemma awnless or dorsally awned

18. Lemmas 3-veined, keeled, with an awn (usually);
rhachilla disarticulating below glumes ..... 32. Alopecurus

18. Lemma 5-7-veined, rounded dorsally, without an awn;
rhachilla disarticulating above glumes ..... 35. Phleum

1. Spikelets always with 2 or more florets

19. Annual

20. Both glumes shorter than spikelet

21. Spikelets 2 mm, with 2 florets ..... 14. Molineriella

21. Spikelets 7-18 mm, with 3-10 florets

22. Spikelets sessile on main axis; glumes 3-5 to 7-9-veined; lowest lemma awned ..... 4. Gaudinia

22. Spikelets pedicellate; glumes 3 (-5)-veined; lowest lemma awnless ..... 6. Gaudinopsis

20. At least one of the glumes as long as spikelet

23. Inflorescence a lax panicle

24. Spikelets longer than 10 mm (excl. awn)

25. Glume veins usually forming prominent longitudinal ridges; glumes aristate; lowest lemma terminating in an aristate point or bifid ..... 5. Ventenata

25. Glume veins not forming prominent longitudinal ridges; glumes acuminate; lowest lemma terminating in 2 aristate points or not ..... 1. Avena

24. Spikelets 1.3-4.5 mm (excl. awns)

26. Spikelets 1.3-1.6 mm; lemmas awnless ..... 15. Antinoria

26. Spikelets 2.5-4.5 mm; lemmas dorsally awned

27. Spikelets 4-4.5 mm; upper half of awn clavate ..... 17. Corynephorus

27. Spikelets 1.5-3.5 mm; upper half of awn tapering to a point

28. Spikelets with 2 or more florets; rhachilla prolonged beyond upper floret ..... 9. Parvotrisetum

28. Spikelets with 2 florets; rhachilla not prolonged beyond upper floret ..... 16. Aira

23. Inflorescence a dense spike-like panicle

29. Glumes equal or subequal

30. Glumes 3 (-5)-veined, usually winged on keel; lower 2 florets reduced to empty lemmas ..... *Phalaris

30. Upper glume 3-veined, lower one 1-veined; without a wing on keel; lower 2 florets not reduced to empty lemmas, but sometimes lowest floret male

31. Glumes with an apical seta; rhachilla disarticulating below glumes; lowest floret male and without an awn ..... 18. Holcus

31. Glumes without an apical seta; rhachilla disarticulating above glumes; lowest floret hermaphrodite and with an awn ..... 16. Aira

29. Glumes distinctly unequal

32. Spikelets with 3 florets, lower 2 florets sterile, awned and covered with long stiff hairs; only terminal floret hermaphrodite and awnless ..... 30. Anthoxanthum

32. Spikelets with 2-11 florets; florets all alike, fertile and awned

33. Lemmas with 2 setae at apex ..... 8. Trisetaria

33. Lemmas shortly bifid at apex

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* As Phalaris has been revised by A. Baytop (1969) the genus is not treated in this thesis.

34. Upper glume 4 x as long as lower one; lemmas rounded dorsally; palea ½ x as long as lemma ..... 10. Avellinia

34. Lower glume ½ to ¾ x as long as upper one; lemmas keeled; palea equaling lemma ..... 11. Rostraria

19. Perennial

35. At least one of the lemma in each spikelet with a subterminal, dorsal or subdorsal awn

36. Upper glume with a short setae at apex ..... 18. Holcus

36. Upper glume without a short setae at apex

37. Inflorescence a rather dense spike-like panicle; smelling of coumarin ..... 30. Anthoxanthum

37. Inflorescence a lax panicle; not smelling of coumarin

38. Lower floret male, upper floret hermaphrodite or female ..... 3. Arrhenatherum

38. At least the lower 2 florets hermaphrodite

39. Spikelets 10-30 mm, with 3-8 florets; caryopsis hairy at apex ..... 2. Helictotrichon

39. Spikelets 3-11 mm, with 2-4 florets; caryopsis glabrous at apex

40. Spikelets with 2 (-3) florets; lemmas truncate-denticulate at apex ..... 13. Deschampsia

40. Spikelets with 2-4 florets; lemmas 2-fid at apex ..... 7. Trisetum

35. Lemmas without an awn, sometimes with a terminal mucro

41. Glumes equaling spikelet; lower 2 florets reduced to empty lemmas, only uppermost one hermaphrodite

42. Inflorescence a rather dense spike-like panicle; lower 2 florets sterile, glabrous; not smelling of coumarin ..... *Phalaris

42. Inflorescence a lax panicle; lower 2 florets male, hairy on dorsal side; smelling of coumarin ..... 31. Hierochloë

41. Glumes shorter than spikelet; lower 2 florets fertile

43. Spikelets secund, arranged in 2 rows along 1 side of primary branches; pedicels glabrous; glumes equal ..... 34. Beckmannia

43. Spikelets growing in different directions; pedicels puberulent; glumes unequal and subequal ..... 12. Koeleria

7.3. Taxonomic Revision

1. AVENA L., Sp. Pl. 79 (1753)

Annual. Leaf blades flat, linear, acute to acuminate. Ligule membranous. Inflorescence a panicle. Spikelets with 1-5 florets. Glumes lanceolate, acuminate, subequal to unequal; lower glume 5-7-veined; upper glume 7-9-veined. Lemma coriaceous, 7-veined, 2-dentate or with 2 setae, dorsally awned; callus cushion-shaped in wild species, ± hairy; awn usually geniculate, twisted in lower half. Palea shorter than lemma, bifid, 2-keeled. Rhachilla disarticulating above glumes and sometimes between florets, fragile in wild species, but tough in cultivated ones. Lodicules 2. Stamens 3. Caryopsis oblong, hairy, with a groove on its adaxial surface; embryo $\frac{1}{3}$ of its length; hilum basal and punctiform.

Type: A. sativa L.

Literature:

Malzew, A.I. 1930. Wild and Cultivated Oats: Sectio Euavena Griseb. Bull. Appl. Bot. Pl. Breed. (Leningrad), Suppl. 38: 1-522.

Taborda De Morais, A. 1936. Estudios Nas Aveias I. As Aveias Portuguesas Da Seccao Euavena Griseb. Bol. Soc. Brot. ser. 2, 11: 49-72.

Taborda De Morais, A. 1939. Estudos Na Aveias II. As Aveias Portuguesas Da Seccao Euavena Griseb. Bol. Soc. Brot. ser. 2, 13: 573-709.

Baum, B.R. 1977. Oats: Wild and Cultivated. Ottawa.

Key to Species

1. Glumes unequal
   2. Spikelets with 2-3 florets; rhachilla disarticulating above glumes but not between florets ..... 1. eriantha

2. Spikelets with 3-5 florets; rhachilla disarticulating above glumes and between florets ..... 2. *clauda*

1. Glumes subequal

3. Lemma terminating in 2 setae

4. Spikelets 20-26 mm; lemma gradually terminating in 2 setae ..... 3. *barbata*

4. Spikelets 16-20 mm; lemma toothed below the 2 setae on margins ..... 4. *wiestii*

3. Lemma bifid or mucronate

5. Rhachilla disarticulating at maturity

6. Rhachilla disarticulating above glumes and between florets ..... 5. *fatua*

6. Rhachilla disarticulating above glumes but not between florets ..... 6. *sterilis*

5. Rhachilla not disarticulating at maturity

7. Spikelets 22-27 mm; rhachilla segments breaking at their apices and falling attached to lower floret; awn with a distinct column ..... 7. *sativa*

7. Spikelets 27-30 mm; rhachilla segments breaking at their base and falling attached to the upper floret; awn without a distinct column ..... 8. *byzantina*

1. *A. eriantha* Durieu in Duchartre, Rev. Bot. 1: 360 (1845).

Syn: *Trisetum pilosum* Roem. et Schultz, Syst. Veg. ed. 15, 2: 662 (1817);

Avena pilosa (Roem. et Schultz) Bieb., Fl. Taur.-Cauc. 3: 84 (1819).

Ic: Baum, Oats: Wild and Cultivated, t. 75 152 (1977).

Annual. Stem 13-60 cm, erect, solitary to fasciculate, glaucous, glabrous. Leaf blades 3-10 (-12) cm x 2-4 (-5) mm, pilose to glabrous, linear, acute; sheaths pilose to glabrous like blades; ligule 1.8-3 mm, obtuse. Panicle 6-15 cm x 4-6 cm, subsecund; pedicels 0.3-4.5 cm, glabrous. Spikelets 18-25 mm, with 2-3 florets. Glumes unequal; lower glume 11-15 mm, 3-5-veined; upper glume 20-25 mm, 7-veined. Lemma c. 20 mm (incl. setae), glabrous, terminating in 2 setae, dorsally awned; setae up to 7 mm; awn c. 30 mm, geniculate, twisted in lower half; callus hairs 4-4.5 mm. Palea c. 10 mm, densely ciliate on keels. Rhachilla disarticulating at maturity above glumes but not between florets. Fl. 4-5. Calcareous banks and steppe, in Quercus - Amygdalus scrub, near sea level & 500-1100 m.

Typus: "Habitat les memes lieux que A. clauda", Durieu [Iso. K!]

W. and C. Anatolia.

A2(A) Bursa: Uludag, Sint. 1883: 67!

B1 Manisa: Manisa Da., A. Baytop (ISTE 6371a)!

Izmir: Izmir, 30 iv 1854, Bal.!

C5 Içel: Içel, 18 iv 1855, Bal.!

C6 Gaziantep: Dülük Baba, 7 km N. of Gaziantep, 1100 m, D.28064!

Maras d. Pazarcik: between Narli and Karabiyikli, 600-700 m, D.27803!

C7 Urfa: halfway between Viransehir and Ceylanpinar, 500 m, D.42363!

C9 Siirt: Şirnak to Cizre, 14 km from Şirnak, 610 m, D.42688!

External distribution: N.W. Africa, Greece, Aegean, Cyprus, Crimea, Syrian Desert, N. Iraq, N. and W. Iran, Afghanistan.

2. A. clauda Durieu in Duchartre, Rev. Bot. 1: 360 (1845).

Ic: Bor, Fl. Iraq 9: 332, t. 122; 333, t. 123 (1968).

Like A. eriantha Durieu, but spikelets with 3-5 florets; rhachilla disarticulating above glumes and between florets.

Fl. 4-6. Calcareous soil on the coast, sea level.

Typus: "Habitat les lieux secs et montueux des terrains calcaires de l'ouest de l'Algerie", Durieu [Iso K!]

W. & S. Anatolia.

B1 Izmir: Izmir, 30 iv 1854, 31 vi 1855, Bal.!

C5 Içel: Içel, 27 iv 1855, Bal.!

External distribution: N.W. Africa, Bulgaria, Greece, Aegean, Cyprus, Palestine, Syrian Desert, N. Iraq, Iran, Khorasan, Trans-caspia, Turkestan.

3. A. barbata Pott ex Link in Schrad., Journ. Bot. 2: 315 (1799).

Annual. Stem 23-120 cm, solitary to fasciculate, geniculate to erect. Leaf blades 6-25 cm x 2-10 mm, linear, acute, pilose to glabrous; sheaths densely pilose; ligule 1-6 mm, obtuse. Panicle 8-36 cm x 2-15 cm, subsecund, rather effuse; branches up to 18 cm. Spikelets 20-26 mm, with 2-3 florets. Glumes subequal, lanceolate, acuminate; lower glume 20-25 mm, 5 (-7)-veined; upper glume 22-26 mm, 7 (-9)-veined. Lemma 20-22 mm (incl. setae), densely villous below awn attachment, narrowly lanceolate, 9-veined, gradually terminating in 2 setae; dorsally awned; setae 3-12 mm; awn 30-40 mm, geniculate, twisted in lower half. Palea 16-18 mm. Rhachilla disarticulating above glumes and between florets.

Key to subspecies

1. Terminal setae of lemma 3-5 mm ..... subsp. barbata

1. Terminal setae of lemma 6-12 mm ..... subsp. atherantha

subsp. barbata

Syn: A. strigosa subsp. barbata (Pott ex Link) Thell. in Vierteljahr. Naturf. Ges. Zurich 56: 330 (1911).

Ic: Bor, Fl. Iraq 9: 329, t. 120 (1968).

Fl. 4-7. Disturbed habitat, sandy and stony places, Quercus scrub, humid places, 0-900 m.

Typus: [Portugal] "Ex cult. mea 1796, hab. in Lusitania", Herb. Pott [LE]

Widespread, but rare in N. and Inner Anatolia.

A1(E) Edirne: Karaagaç to Edirne, A. Baytop (ISTE 6611)!

A2(E) Istanbul: Belgrad forest, Kayacik 46!

A3 Bilecik: between Osmaneli and Bilecik, A. Baytop (ISTE 9309)!

B1 Izmir: Karşiyaka to Bornova, T. Gözler (ISTE 19862)!

B3 Eskişehir: Sündiken Da., Gökçekaya dam, T. Ekim 516!

B9 Bitlis: Kermet Köy, 65 km S. of Bitlis, 4 vi 1967, J.G. Ross!

C2 Mugla: 13 km S. of Fethiye, O. Polunin 13993!

C3 Isparta: Dogandere, 900 m, M. Dogan 103!

C4 Antalya: Alanya Castle, A. Baytop (ISTE 9660)!

C5 Adana: 3-4 km N. of Pozanti, 200 m, Aberdeen Univ. Amanos Exp. M1 915!

C6 Hatay: Belen to Atik, G. Bayraktar (ISTE 7278)!

C7 Urfa: Birecik, Sint. 1888: 364!

Is. Rhodos: M. Profeta, 600 m, Rech. 7100

External distribution: W. and C. Europe, Mediterranean, Caucasia, Asia (except Siberia).

subsp. atherantha (C. Presl.) Rocha Afonso in Bot. J. Linn. Soc. 76: 358 (1978).

Syn: A. atheranthera C. Presl, Cyp. et Gram. Sic. 30 (1820).

Described from Sicily in fields.

Rare.

A2(E) Istanbul: Yildiz parki, A. Baytop (ISTE 7645)!

External distribution: S. part of Mediterranean. Probably not native to Turkey.

4. A. wiestii Steud., Syn. Pl. Glum. 1: 231 (1854).

Syn: A. strigosa subsp. wiestii (Steud.) Thell. in Vierteljahrs. Nat. Ges. Zürich 56: 333 (1912);

A. barbata subsp. wiestii (Steud.) Mansf., Die Kulturpfl. (Berlin), Beih. 2: 479 (1959);

A. nuda subsp. wiestii (Steud.) Löve and Löve in Bot. Not. 114: 50 (1961).

Ic: Bor, Fl. Iraq 9: 342, t. 128; 343, t. 129 (1968).

Annual. Stem 30-60 cm, geniculately ascending from base, usually tufted. Leaf blades 9-20 cm x 2-7 mm, linear, acuminate, glabrous to pilose; sheaths pilose like leaves; ligule 2-3.5 mm, obtuse. Panicle 5-11 cm x 4-6 cm, equilateral; branches 3-7.5 cm. Spikelets 16-20 mm, with 2 florets. Glumes subequal, lanceolate, acuminate; lower glume 16-21 mm, 3 (-5)-veined; upper glume 20-24 mm, 5-7-veined. Lemma 17-20 mm, lanceolate, 7-veined, with 2 setae at apex, beside each seta with a tooth on margin, dorsally awned, densely pilose in lower half; setae 3-6 mm; awn c. 40 mm, geniculate, twisted below. Palea 9.5-10.5 mm, ciliate on keel. Rhachilla disarticulating above glumes and between florets. Fl. 4-6. Stony field, sandy soil, sea level-1250 m.

Typus: "In Aegypto pauca specimina legi", Wiest.

S., W., and E. Anatolia, rare in N.W. Anatolia.

A2(A) Istanbul: Yakacik, 6 v 1894, Azn.!

A3 Zonguldak: Zonguldak, vi 1947, Dijkstra!

B1 Izmir: Büyük Yamanlar, S. Oflas 55!

B8 Siirt: 35 km from Siirt to Baykan, 800 m, D.43092!

B9 Bitlis: Kermet Köy, 65 km S. of Bitlis, 4 vi 1967, J.G. Ross!

C1 Aydin: S. shore of Bafa G., 40 m, K. Hormia 685

C2 Mugla: Marmaris, D.41422!

C3 Antalya: Bahceli Evler, 30 m, E. Hennipman et al. 533!

C4 Konya: Ermenek, 1250 m, M. Dogan 129

C5 Adana: Adana to Karatas, 9 km S. of Adana, Coode & Jones 219!

External distribution: Mediterranean area, Caucasia, S.W. Asia to Eastwards, Arabia.

5. A. fatua L., Sp. Pl. 80 (1753).

Annual. Stem 45-80 (-150) cm, erect to geniculately ascending, glabrous. Leaf blades 43-26 cm x 4-10 mm, linear, acute, scabridilous to glabrous; sheaths pilose to glabrous; ligule 4-6 mm, obtuse. Panicle 15-40 cm x 4-12 cm, equilateral; branches patent. Spikelets 22-27 mm, with 2-3 florets. Glumes subequal, lanceolate, acute, 7-9-veined; lower glume 22-25 mm; upper glume 24-27 mm. Lemma 16-20 mm, 7-veined, lanceolate, bidenticulate to almost bifid, dorsally awned, hairy in lower half; awn 20-35 mm, geniculate, twisted below. Palea 13-16 mm, ciliate on keel. Rhachilla disarticulating above glumes and between florets. Fl. 6-8. Cultivated fields, shingle beach, tea plantation, 0-1510 m.

Key to varieties

1. Lemmas hairy especially in lower half ..... var. fatua
1. Lemmas completely glabrous ..... var. glabrata

var. fatua

Ic: Bor, Fl. Iraq 9: 335, t. 124 (1968);

Fiori, Ic. Fl. Ital. 1: 29, f. 243 (1895).

Typus: "Hab. in Europae agris inter segetes" [Hb. Linn. 9/95!]

Inner & N.E. Anatolia.

A8 Coruh: Hopa, D.29829!

B6 Sivas: 55 km S.W. of Sugehri, 1510 m, D. Spencer 402!

C5 Nigde: 3 km N.W. of Ulukişla, 1400 m, F. Holtz et al. 634!

var. glabrata Peterm., Fl. Bienitz 13 (1841).

Typus varietatis: Ignotus.

N.E. and N.W. Anatolia.

A2(A) Bursa: Bursa, Thirke

A8 Rize: Cimil, Balansa

Is. Imroz, Forsk.

External distribution: Europe, Mediterranean, S.W. Asia eastwards to E. Asia. Introduced in N. America.

6. A. sterilis L., Sp. Pl. ed. 2, 118 (1762).

Annual. Stem 30-130 (-150) cm, erect, slightly geniculate at base, glabrous. Leaf blades 5.5-30 cm x 3-10 mm, linear, acuminate, glabrous, slightly ciliate on margins; sheaths hairy to glabrous; ligule 3-8 mm, obtuse. Panicle 6-30 cm x 4-12 cm, pyramidal, equilateral to subsecund; branches patent to contracted. Spikelets 20-45 mm, with 2-3 florets. Glumes subequal, 7-11-veined, lanceolate, acuminate; lower glume 19-42 mm; upper glume 22-45 mm. Lemmas 20-35 mm, lanceolate, bifid, densely hairy in lower $\frac{2}{3}$, dorsally awned; awn 5-7 cm, geniculate and twisted in lower half. Palea 16-25 mm, ciliate on keels. Rhachilla disarticulating above glumes but not between florets.

Key to subspecies

1. Spikelets 30-45 mm; lowest lemma 25-35 mm
..... subsp. sterilis

1. Spikelets 20-30 mm; lowest lemma 20-25 mm
..... subsp. ludoviciana

subsp. sterilis

Syn: A. fatua var. sterilis (L.) Fiori et Paoletti, Ic. Fl. Ital. 1: 29 (1895);

A. sativa subsp. fatua var. sterilis (L.) Fiori, Nuov. Fl. Anal. Ital. 1: 109 (1923).

Fl. 3-8. Limestone slopes, cultivated land, pebble beach, 50-1800 m.

Typus: Regio Mediterranea. /Hb. Linn. 12/95!/

Mainly W. and S. Anatolia, Islands.

A2(E) Istanbul: Yildiz Parki, A. Baytop (ISTE 7643)!

B1 Izmir: Bornova, K. Bremer (Hels. 1152184)!

C3 Isparta: Egridir, 1250 m, M. Dogan 79

C5 Adana: Karataş, 10 m, Coode & Jones 271!

C7 Urfa: 8 km from Urfa to Hilvan, 600 m, D.28194!

C8 Diyarbakir: 18 km S. of Diyarbakir, 1050 m, D. Spencer 301!

C9 Mardin: 9 km from Cizre to Idil, 560 m, D.42886!

External distribution: C. Europe, Mediterranean, S. Russia, Crimea, Caucasia, S.W. Asia eastwards to E. Asia.

subsp. ludoviciana (Durieu) Gill. et Magne, Nouv. Fl. Fr. ed. 3, 532 (1875).

Syn: A. ludoviciana Durieu in Act. Soc. Linn. Bordeaux 20: 41 (1855).

Ic: Bor, Fl. Iraq 9: 337, t. 125; 339, t. 126 (1968).

Fl. 4-8. Sandstone cliffs, Quercus scrub, edge of cornfields, fallow fields, courtyards, tea plantation, 40-1800 m.

Typus: "Tres commun sur la rive droite de la Garonne, dans le sol calcaire et l'alluvium. Moins repandu sur les terrains silicieux de la rive gauche" /Juni 1855/, Durieu /Iso K!/

Mainly S. and E. Anatolia, rare in W. Anatolia.

A8 Rize: Gündogdu, 40 m, M. Dogan 320!

A9 Kars: between Kars and Susuz, 1800 m, D.30648!

B2 Manisa: Demirci, 700 m, Coode & Jones 2759!

B8 Siirt: Silvan to Kurtalan, D.22125!

C3 Antalya: Antalya, 24 iv 1860, E. Bourgeau!

C4 Antalya: Alanya, 50 m, D.25872!

C5 Adana: Yumurtalik, sea level, Coode & Jones 717!

C6 Hatay: Kirikhan to Hamam, 100 m, Coode & Jones 579!

C7 Urfa: 22 km from Urfa to Viransehir, 500 m, D.42282!

C8 Mardin: 12 km from Mardin to Nusaybin, 750 m, D.28486!

C9 Mardin: 5 km E. of Cizre, 350 m, D.42712!

External distribution: C. Europe, Mediterranean, S. Russia, Crimea, Caucasia, S.W. Asia eastwards to E. Asia.

7. A. sativa L., Sp. Pl. 79 (1753).

Syn: A. fatua var. sativa (L.) Hausskn. in Mitt. Geogr. Ges. Thür. 3: 238 (1885);

A. sativa subsp. sativa (L.) Thell. in Vierteljahrs. Nat. Zürich 65: 325 (1911).

Ic: Fiori, Ic. Fl. Ital. 1: 29, f. 242 (1895);

Bor, Fl. Iraq 9: 341, t. 127 (1968).

Annual. Stem 40-180 cm, smooth, glabrous, erect, solitary to fasciculate. Leaf blades 14-30 (-40) cm x 4-10 (-15) mm, linear, acuminate, glabrous, sometimes margins scabridulous; sheaths usually glabrous; ligule 3-6 mm, obtuse. Panicle 20-40 cm x 9-16 cm, effuse or unilateral; branches patent to contracted. Spikelets 22-27 mm, with 2-3 florets. Glumes subequal, 7-9-veined, lanceolate, acuminate; lower glume 22-25 mm; upper glume 25-27 mm. Lemma 15-17 mm, bidenticulate, tough, glabrous; callus hairy; awn dorsally attached or absent, 25-35 mm, geniculate, twisted in lower half. Palea 13-16 mm, ciliate on keel. Rhachilla segments breaking at their apices and falling attached to lower floret. Fl. 7-8. Cultivated lands, nr. sea level-1900 m.

Typus: non indicatus [Hb. Linn. 95/6, photo!]

Mainly in S. Anatolia and N.W. Anatolia, Turkey-in-Europe. Widespread.

A2(E) Istanbul: Halkali, 13 vi 1895, Azn.!

A2(E) Istanbul: Büyükçekmece to Catalca, A. Baytop (ISTE 13091)!

A2(A) Istanbul: Soganli to Kartal, 2 vii 1893, Azn.!

A9 Kars: 5 km N. of Kars, 1810 m, D. Spencer 102!

C3 Konya: nr. Seydisehir, J. Bordaz 9!

C5 Içel: Bolkar Da., Gölpinar, 10 km S.W. of Arslanköy, 1900 m, Peat et al. 218-11-76!

External distribution: N., W. & C. Europe, Mediterranean, C. & S. Russia, Crimea, Caucasia, N. Iraq, N. & C. Iran, W. Pakistan, E. Asia. Introduced in N. America. Widely cultivated.

8. A. byzantina C. Koch in Linnaea 21: 392 (1848).

Syn: A. sterilis subsp. byzantina (C. Koch) Thell. in Vierteljahrs. Naturf. Ges. Zürich 56: 316 (1911).

Annual. Stem 60-150 cm, suberect, sometimes geniculately ascending from base, glabrous. Leaf blades up to 30 cm x 2-6 mm, flat, glabrous, scabridulous on margins; ligule 3-7 mm. Panicle 15-25 cm long; branches ± patent. Spikelets 27-30 mm, with 3-4 florets. Glumes subequal; lower glume 25-30 mm, 7-veined; upper glume 28-33 mm, 9-veined. Lemma 15-20 mm, narrowly lanceolate, glabrous, with teeth at apex c. 1.5 mm, dorsally awned; callus hairs 3-5.5 mm; awn 25-35 mm, without distinct column, straight to slightly curved. Palea 12-15 mm, ciliate on keels. Rhachilla not disarticulating at maturity, but breaking up at the base of segments below each floret and falling attached to the upper floret. Fl. 7. Cultivated, in tea plantation, 0-40 m.

Typus: [Turkey] "Konstantinopel", C. Koch

N.W. Anatolia.

A2(A) Istanbul: Burgaz ada, A. Baytop

A2(A) Bursa: Bursa, Thirke

A8 Rize: Gündogdu, 0-40 m, M. Dogan 326!

External distribution: N.W. Africa, Aegean, W. Iran, W. Pakistan.

2. HELICTOTRICHON Besser ex Roemer & Schultes, Syst. Veg. 2: Mant. Addit. 1: 526 (1827).

Syn: Avena sect. Avenastrum Koch, Syn. Fl. Germ: 795 (1837);
Avenastrum (Koch) Opiz, Seznam Rostl. Kvet. Ceske: 20 (1852);
Avenula (Dumort.) Dumort. in Bull. Soc. Bot. Belgique 7: 68 (1868);
Avenochloa Holub in Acta Horti Bot. Prag 82 (1962).

Perennial. Leaf blades either ribbed on upper surface with several rows of small bulliform cells between ribs, or with 2 lines of bulliform cells, flat to conduplicate or convolute, glabrous to ± hairy; ligule hyaline, acute to truncate. Inflorescence a ± lax panicle. Spikelets with 3-8 florets, upper 1-2 florets sterile, laterally compressed. Glumes subequal, lanceolate, acute; lower glume (-1) 3-veined; upper glume 3 (-5)-veined. Lemma 5-7-veined, lanceolate, rather tough but hyaline in upper part, dorsally awned; callus hairy; awn geniculate and twisted in lower half, usually compressed at base but sometimes not. Palea 2-veined, shorter than lemma, keeled, bifid. Rhachilla disarticulating above glumes and below florets. Lodicules 2. Stamens 3. Caryopsis hairy at apex, oblong.

Type: H. planiculme (Schrader) Pilger
(Avena planiculmis Schrader).

Literature:

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Gervais, C. 1973. Contribution a l'etude cytologique et taxonomique des Avoines vivaces. Denkschr. Schweiz. Naturf. Ges. 88: 1-166.

Holub, J. 1976. A Newly Adopted Restriction of Illegitimity in Generic Names and its Consequence for Avenochloa Holub 1962. Folia Geobot. Phytotax. 11: 281-300.

Sauer, W. & Chmelitschek, H. 1976. Beitrage Zur Kenntnis Ausdauernder Wildhafer: Die Gattung Avenula (Dumort.) Dumort. in Den Ostalpen. Mitt. Bot. Staatssamm. (München) 12: 513-608.

Holub, J. 1977. Notes on some species of Avenula and Helictotrichon. Preslia 49: 203-221.

Key to Species

1. Leaf blades with a few lines of bulliform cells along midvein on upper surface, convolute, up to 1 mm wide ..... 1. convolutum

1. Leaf blades with 2 lines of bulliform cells along midvein on upper surface, condulpicate, wider than 1 mm

2. Rhachilla hairs 3-5 mm; awn terete at base; keels of palea glabrous ..... 6. pubescens

2. Rhachilla hairs shorter than 3 mm or absent; awn compressed at base; keels of palea ciliate

3. Rhachilla segments glabrous ..... 2. compressum

3. Rhachilla segments hairy

4. Stem compressed at base; rhachilla hairs 1.5-2.5 mm; spikelets variegated with brown and violet ..... 8. planiculme

4. Stem terete at base; rhachilla hairs up to 1 mm; spikelets brownish to green

5. First rhachilla segment 4-5 mm; spikelets 20-30 mm ..... 4. armeniacum

5. First rhachilla segment 1.5-2.6 mm; spikelets 10-23 mm

6. Lemma green to pale in lower half ..... 5. pratense

6. Lemma reddish-brown in lower half

7. Spikelets 10-15 mm; panicle ± ovate ..... 7. versicolor

7. Spikelets 17-19 mm; panicle oblong ..... 3. argaeum

1. H. convolutum (C. Presl) Henrard in Blumea 3: 430 (1940).

Syn: Avena convoluta C. Presl, Gram. et Cyp. Sic. 31 (1820);

Avenastrum convolutum (C. Presl) Halácsy, Consp. Fl. Graec. 3: 369 (1904).

Caespitose perennial. Stem 47-103 cm, erect, glabrous and smooth, rather shiny. Leaf blades 14-50 cm x 0.5-1 mm, convolute, ± glaucous, smooth beneath, persistent; sheaths rather tough; ligule 0.3-0.5 mm, truncate, glabrous to slightly hairy. Panicle 6-15.5 cm x 1.5-4 cm, rather silvery; branches 2-6 cm, erecto-patent to ± flexuous, especially the primary ones; pedicels 3-12 mm, aculeolate, clavate. Spikelets 10-15 mm. Lower glume 9-9.5 mm; upper glume 10-11 mm. Lemma 9-21 mm,

dorsally awned; callus hairs 2-3.5 mm; awn 15-20 mm, twisted in lower half, compressed at base. Anthers 4-6 mm. Fl. 4-6. Dry mountain slopes, inside Pinus brutia forest, 1150 m.

Typus: /Sicily/ "Hab. in rupibus montis Cucii Panormi", C. Presl.

S. Anatolia.

C2 Antalya d. Elmali: Avlan Göl, 80 km S.W. of Antalya, 1150 m, E. Hennipman et al. 734!

Antalya: Gömbe to Kaş, H. & E. Walter 3996!

C6 Hatay: Amanus Mountains, Gökmustafa peak, 1150 m, Y. Akman (ISTE 12238)!

External distribution: Italy, Sicily, Jugoslavia, Albania, Greece, Aegean. E. Mediterranean element.

2. H. compressum (Heuffel) Henrard in Blumea 3: 429 (1940).

Syn: Avena compressa Heuffel in Flora 18: 244 (1835);

Avenochloa compressa (Heuffel) Holub in Acta Horti Bot. Prag. 84 (1962);

Avenula compressa (Heuffel) W. Sauer & Chmelitschek in Mitt. Bot. Staatssamm. (München) 12: 582 (1976).

Ic: Reichb., Ic. Fl. Germ. 1: t. 76 f. 210 (1850).

Densely caespitose perennial. Stem 15-58 cm, erect, slender, slightly compressed at base, glabrous and smooth, 1-2-noded. Leaf blades 3-10 cm x 1-4 mm, usually conduplicate, linear, acute, glaucescent; cauline leaf blades 0.8-6 cm long, appressed to stem; sheath galbrous; ligule 1-10 mm, lanceolate, acuminate. Panicle 4-12.5 cm x 0.5-3 cm, oblong, brownish, with 7-17 spikelets; pedicels 1-7 mm, scabridulous. Spikelets 14-24 mm, with 3-6 (-9) florets. Lower glume 8-11 mm; upper glume 10-13 mm. Rhachilla segment 1-2.5 mm. Lemma 9-13 mm, indurate, reddish-brown, scabrid, prominently veined, bifid,

subobtuse, dorsally awned; callus hairs 0.5-1 mm, reaching to base of lemma; awn c. 16 mm, twisted below. Palea 7.5-10 mm; keels glabrous. Anthers 4-6 mm. Fl. 4-5. Dry soil, on sand strand, open places in Pinus sylvestris forest, 0-1500 m.

Typus: /Romania/ "Hab. locis arenosis glareosisque montanis inter vineas infra arcem ad Verschetz in Banatu", Heuffel Mai. Jun.

Turkey-in-Europe, N.W. & adjacent C. Anatolia.

A1(E) Kirklareli: Demirköy, A. Baytop (ISTE 5470)!

A1(A) Çanakkale: Lapseki, 7 km from Lapseki, Y. Akman & Quezel 9262!

A2(E) Istanbul: Kilyos, 15 m, F. Sorger 62-10-16!

A2(A) Istanbul: Yakacik to Aydos, A. Baytop (ISTE 8655)!

A2(A) Kocaeli: Pendik, 20 v 1894, Azn.!

B3 Eskisehir: Sundiken Da., Kuzucuk göl, 1500 m, T. Ekim 932!

External distribution: C. Europe, Bulgaria, Greece, Aegean, Crimea.

3. H. argaeum (Boiss.) Parsa, Fl. Iran 5: 641 (1951).

Syn: Avena argaea Boiss., Fl. Or. 5: 546 (1884)!;

Avenula argaea (Boiss.) Holub in Folia Geobot. Phytotax. (Praha) 11: 294 (1976).

Laxly caespitose perennial. Stem 17-48 cm, erect, sometimes decumbent at base, glabrous and smooth. Leaf blades 3-11 cm x 1-3 mm, linear, obtuse, conduplicate, glaucous-green, scabridulous on margins; sheaths glabrous, lower ones undivided; ligule lanceolate, acuminate, lower ones 1-2 mm, upper ones 2.5-4 mm. Panicle 3.5-7 cm x 0.5-2 cm, oblong, rather contracted, with 5-16 spikelets; pedicels 1-8.5 mm, glabrous to slightly scabridulous. Spikelets 16-19 mm, oblong, with 4-6 florets, pale green to dark brown. Glumes subequal, lanceolate, acute; lower glume 10-13 mm; upper glume 12-16 mm. Rhachilla segment

1.6-2.4 mm, covered with short hairs (up to 0.2-0.3 mm). Lemma 10-12 mm, indurate; callus hairs up to 0.6 mm; awn 14-15 mm, twisted below. Palea 7.5-9 mm, ciliate on keel. Anthers 4-4.7 mm. Fl. 7-8. High mountain slopes and meadows, 2400-3000 m.

Typus: [Turkey B5 Kayseri] "Hab. in regione alpine montis Argaei Cappadociae, 1280 m", [9 vii 1856], (Balansa 847, sub A. pratensi) [Holo G!]

N. and E. Anatolia.

A7 Giresun: Balaban Da. (Kiliç Tepe) above Tamdere, 2900 m, D.20546!

A8 Rize: Rize to Ispir, 3000 m, Stn. & Hend. 6274!

Artvin: Magara Y. Şavval tepe, Murgul, 2400 m, Stn. & Hend. 6030!

A8 Erzurum: Kop Da. pass, 2743 m, P. Furse 3803!

A9 Artvin: Yalnizcam Da. W. side of pass between Ardahan and Artvin, 2400 m, D.32537!

Endemic. Ir.-Tur. element.

4. H. armeniacum (Schischk.) Grossh., Fl. Cauc. ed. 2, 1: 214 (1939).

Syn: Avena armeniaca Schischk. in Ber. Tomsker Staats-Univ. 81: 418 (1929);

Avenastrum armeniacum (Schischk.) Roshev. in Komarov, Fl. U.R.S.S. 2: 274 (1934);

Avenochloa armeniaca (Schischk.) Holub in Acta Horti Bot. Prag.: 83 (1962);

Avanula armeniaca (Schischk.) Holub in Folia Geobot. Phytotax. (Praha) 11: 294 (1976).

Ic: Fl. URSS (transl.) 2: 222, t. 21 f. 3 (1976)

Takhtadzhyan & Federov, Flora Erevana 354, t. 111 (1972).

Caespitose perennial, fibrous. Stem 50-82 (-103) cm, glabrous, shiny, 2-noded. Leaf blades 7-14 cm x 1-3.5 (-4) mm, linear, acuminate,

conduplicate, scabrous on lower surface; sheaths glabrous, deeply channeled, sometimes retrorsely short-pubescent; ligule 2-5 mm, lanceolate. Panicle 8-15 cm x 8-12 mm, with 6-10 spikelets; branches erecto-patent to slightly contracted, 2.6-4.6 cm; pedicels usually 1.5-20 mm, scabridulous. Spikelets 20-30 mm, with 5-8 florets. Glumes lanceolate, acuminate, scabridulous on veins; lower glume 15-18 mm; upper glume 18-23 mm. Rhachilla segments 4-5 mm. Lemma 16-19 mm; callus hairs 1 mm; awn 16-17 mm, geniculate and twisted below. Palea 11 mm, ciliate on keels. Fl. 7. High mountain slopes, 2000-2170 m.

Type: [Turkey A9 Kars] "Hab. Armenia, in pratis prope opp. Sarikamis, alt. 2170 m", [7 vii 1916], Saposhnikov. [Holo LE]

External distribution: Caucasia / Euro-Sib. element.

5. H. pratense (L.) Bess. in Rzut Oka Jeogr. Fiz. Wol. Pod.: 10 (1828).

Syn: Avena pratensis L., Sp. Pl.: 80 (1753);

Avenastrum pratense (L.) Opiz, Seznam Rostl. Květ. České: 20 (1852);

H. pratense (L.) Pilger in Feddes Rep. 45: 6 (1938);

Avenochloa pratensis (L.) Holub in Acta Horti Bot. Prag: 84 (1962).

Ic: Reichb., Ic. Fl. Germ. 1: t. 102 f. 207 (1850);

Hubbard, Grasses:232 (1968).

Densely caespitose perennial. Stem 30-85 (-100) cm, erect, slender, glabrous, smooth, with 1-2-nodes in lower part. Leaf blades 4-25 cm x 1-3 (-5) mm, conduplicate, obtuse, glabrous; sheaths glabrous; ligule 0.5-5 (-7) mm, acuminate to obtuse. Panicle 7-18 cm x 1.5-6 cm, with 6-19 spikelets; branches up to 5 cm; pedicels 2-27 mm, scabridulous. Spikelets 12-23 mm, oblong, with 3-5 (-8) florets. Glumes lanceolate to oblong-lanceolate; lower glume 10-15 mm; upper glume 12-19 mm. Rhachilla segments 2-3 mm, covered by short hairs. Lemma (10-) 12-15 mm,

bifid; awn 12-21 mm, geniculate; callus hairs 1-2 mm. Anthers 5-8 mm.

Mountain slopes, 200(?)-2000 m.

Typus: "Hab. in Europae pascuis siccis apricis" [Hb. Linn. 95/17!]

Inner and S. Anatolia.

B6 Sivas: Sarikişla, N. slope of Güldede Da., 2000 m, T. Ekim & A. Düzenli 3850!

B8 Erzurum: Palandöken Da., S. slope of Eregli Da., A. Tatli (ISTE 31299)!

C6 Hatay: Iskenderun, Amanos Mount., Ilica distr., 200(?) m, Y. Akman 298!

External distribution: Europe, N.W. Africa, C. Russia, Caucasia, N.W. and W. Iran. Euro-Sib. element.

6. H. pubescens (Hudson) Pilger in Feddes Rep. 45: 6 (1938).

Laxly caespitose perennial, fibrous to shortly stoloniferous. Stem 30-98 cm, erect, slightly decumbent at base, smooth, 2-3-noded. Leaf blades 3-40 cm x 2-5 mm, linear, subobtuse at apex, conduplicate, pubescent, sometimes glabrous; sheaths shortly hairy; ligules of lower leaves up to 1.5 mm, truncate, but upper ligules 5-8 mm and acuminate. Panicle 6-13 cm x 2.5-5 cm, rather open, with 10-21 spikelets; branches 2-6.5 cm; pedicels 4-26 mm, slightly scabridulous. Spikelets 11-25 mm, pale green or with purple stripes, with 2-4 florets. Glumes thin, lanceolate; lower glume 9-16 mm, acuminate; upper glume 15-20 mm, acute. Rhachilla hairs 3-5 mm. Lemma 9-20 mm, oblong-lanceolate, 2-fid, dorsally awned; callus hairs 2-3 mm; awn c. 20 mm, twisted in lower half. Palea 10-11 mm, ciliate on keel. Anthers 5-8.5 mm.

Key to subspecies

1. Spikelets 11-17 mm; lower glume 9-12 mm

..... subsp. pubescens

1. Spikelets 20-26 mm; lower glume 14-16 mm

..... subsp. longifolia

1. subsp. pubescens

Syn: Avena pubescens Hudson, Fl. Angl. 42 (1762);

Avenastrum pubescens (Hudson) Opiz, Seznam Rostl. Květ. České: 20 (1852);

Avenula pubescens (Hudson) Dumort. in Bull. Soc. Bot. Belg. 7: 68 (1868);

Avenochloa pubescens (Hudson) Holub in Acta Horti Bot. Prag. 84 (1962).

Ic: Reichb., Ic. Fl. Germ. 1: t. 213 (1850);

Hubbard, Grasses 230 (1968).

Fl. 5-8. Grassy slope, in Abies-Pinus-Fagus forest, limestone slopes, volcanic rock, water meadows, 1800-2350 m.

Type: [England] "Hab. in pratis et pascuis siccioribus, supra Banstead Downs copiose", Hudson.

N. and W. Anatolia.

A2(A) Bursa: Uludag, 1300 m, Bornm. 5648!

A3 Ankara: Beypazari, Egriova to Benli road, 1400 m, Y. Akman 8729!

A4 Cankiri: Ilgaz Da., 1630-1680 m, Hub.-Mor. 14096!

A5 Amasya d. Merzifon: Bohça armut Y., 1000 m, O. Alpay 374!

A8 Rize: Cimil, 2000 m, 18 vii 1866, Bal.!

A9 Kars: Yagmurlu Da. between Sarikamiş and Karaurgan, 2300 m, D.30812!

B2 Kütahya: Gediz, Murat Da., between hamam and Cukurören köy, 1500 m, E. Leblebici & Ö. Seçmen (EGE 16353)!

B3 Konya: Akşehir, Sultan Da. above Telkke, 1940 m, A. Baytop (ISTE 37433)!

C6 Hatay: Amanos Mount., 800 m, Y. Alman 5016!

External distribution: Europe, C. and S. Russia, Crimea, Caucasia.

Euro-Sib. element.

2. subsp. longifolia (Boiss.) M. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: Avena hirtifolia Boiss., Diagn. Ser. 1 (4): 128 (1859);

Avena pubescens var. longifolia Boiss., Fl. Or. 5: 545 (1884);

Avena pubescens var. hirtifolia Boiss., Fl. Or. 5: 545 (1884).

Fl. 5-7. Mountain slopes.

Typus: [Turkey B2 Kütahya] "Hab. in monte Tchabandagh prope Cuedis Phrygiae " Balansa [Solo G!]

Central (western part) Anatolia.

B2 Kütahya: Gedis, Şaphane Da., 19 vii 1897, Bal.!

B3 Konya: Akşehir, nr. Telkke köy, G. Dökmeci (ISTE 28777)!

Endemic.

7. H. versicolor (Vill.) Pilger in Feddes Rep. 45: 7 (1938).

Syn: Avena versicolor Vill., Prosp. Pl. Dauph.:17 (1779);

Neuffelia scheuchzeri Schur, Enum. Pl. Transs.:763 (1866);

Avenastrum versicolor (Vill.) Fritsch, Exkursionsfl. Oesterr.: 53 (1897);

Avenochloa versicolor (Vill.) Holub in Acta Horti Bot. Prag. 1962 :85 (1962).

Ic: Fiori, Ic. Fl. Ital. 1: 29, f. 245 (1895).

Laxly caespitose perennial, with extravaginal shoots. Stem 27-41 (-50) cm, slender, smooth, usually without node. Leaf blades 2-10 cm x 2-3 (-4) mm, smooth, glaucescent, with 3-4 lateral veins on each side of mid-vein, linear, acuminate, conduplicate; sheaths glabrous,

basal ones entire in lower part; ligule 1.5-5 mm. Panicle 4.5-6 (-8) cm x 8-15 mm, ovate, rather dense, bearing 7-10 spikelets; branches patent, 1.5-3 cm; pedicels 4-11 mm, glabrous. Spikelets 10-15 mm, with 4-6 florets, brown and shiny. Lower glume 8.5-9 mm; upper glume 9.5-12 mm. Rhachilla segments 1.5-2.6 mm. Lemma 8-11 mm, indurate, conspicuously veined in lower half, bifid, dorsally awned; callus hairs c. 1 mm; awn 14-17 mm, geniculate, twisted in lower half. Anthers 4-4.5 mm.

Fl. 7-9. Alpine meadows, 2000-2659 m.

Typus: "Non indicatus". Described from France.

Inner and N.E. Anatolia.

A6 Sivas: Yildiz Da., 2000 m, F. Sorger 69-58-67!

A8 Rize: Bozdogan Da., 2659 m, viii 1866, Bal.!

Rize: Ikizdere to Ispir, 2400 m, Ehrend. et al. 787-157-14!

B5 Nigde d. Aksaray: Hasan Da., 2500 m, A. Düzenli 414!

External distribution: W., C. and S. Europe, S. Russia. Euro-Sib. element.

8. H. planiculme (Schrader) Pilger in Feddes Rep. 45: 6 (1938).

Syn: Avana planiculmis Schrader, Fl. Germ. 1: 381 (1806);

Avenastrum planiculme (Schrader) Opiz, Seznam Rostl. Květ. České: 20 (1852);

Avenochloa planiculmis (Schrader) Holub in Acta Horti Bot. Prag: 84 (1962);

Avenula planiculmis (Schrader) Holub in Folia Geobot. Phytotax. (Praha) 11: 30 (1976).

Ic: Reichb., Ic. Fl. Germ. 1: t. 104 f. 211 (1850);

Kulczynski, Atlas Fl. Polsk. 4 (3): 426 (1936).

Caespitose perennial, with creeping rhizomes. Stem (70-) 80-120 cm, robust, scabrid, usually 1-noded, compressed at base. Leaf blade

4-27 cm x 3-7 mm, linear, acute, conduplicate, scabrid on cartilaginous margins; sheaths scabrid, especially basal ones; ligule 3-11 mm, oblong, pointed. Panicle (7-) 14-16 cm x 10-20 mm, compound, often interrupted below, with 12-26 spikelets; branches 3-7.5 cm, erect; pedicels 5.5-15 mm, slightly compressed, scabrid. Spikelets 17-22 mm, lanceolate, with 4-5 (-8) florets, usually variegated with brown and violet. Glumes lanceolate, acuminate; lower glume 11-16 mm, upper glume 14-20 mm. Rhachilla segments 3 mm, with hairs (c. 1.5-2.5 mm). Lemma 14-20 mm, indurate, distinctly veined in lower half; awn 15- 22 mm, geniculate, twisted in lower half. Anthers 5.5-8 mm. Fl. 8. Mountain slopes 2000-2250 m.

Typus: [Germany] "In humidis montis Schneeberg in Comit. Glazensi Silesiae", Seliger

N.E. Anatolia.

A8 Rize: Cimil, 2000 m, viii 1866, Bal.!

A8 Gümüshane: Soganli pass between Caykara and Bayburt, 2250 m, F. Holtz 1129!

External distribution: C. Europe, Jugoslavia, Bulgaria, S. Russia.

3. ARRHENATHERUM Beauv., Ess. Agrost. 55, t. 11 f. 5 (1812)

Perennial. Leaf blades flat. Inflorescence a panicle. Spikelets laterally compressed, usually with 2 sexually differentiated florets, sometimes with a third rudiment. Glumes unequal, acute to acuminate; lower glume 1-veined; upper glume 3-veined, equaling spikelet. Lower floret usually male, with a hairy callus and geniculate dorsal or subbasal awn. Upper floret female or hermaphrodite, covered by long or short hairs or glabrous, with a subterminal straight awn. Both florets sometimes hermaphrodite. Lemma usually 7-veined. Palea shorter than lemma, 2-dentate at apex, ciliate on keels. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis oblong, ± terete, hairy; embryo 1/6 x as long as caryopsis. Hilum linear, $\frac{1}{2}$-$\frac{2}{3}$ x as long as caryopsis.

Type: A. avenaceum (Scop.) Beauv. = A. elatius (L.) J. et C. Presl.

Literature:

Fernandes, R.B. 1950. Notas Sobre A Flora De Portugal. Mem. Soc. Brot. 6: 6-11.

Kitanov, B. 1951. Kritische Bemerkungen Uber Die Vertreter Der Gattung Arrhenatherum P.B. Auf Der Balkanhalbinsel. Bull. Soc. Bot. Bulg. 2: 195-208.

Key to Species

1. Second rhachilla segment 0.5-1 mm; awn of lower floret 10-20 mm, arising in lower $\frac{1}{3}$ of lemma; upper floret glabrous to slightly hairy ..... 1. elatius

1. Second rhachilla segment 1.5-2.5 mm; awn of lower floret 20-40 mm, arising nearly from base of lemma; upper floret densely hairy

2. Glumes acute; awn of lower floret 20-28 mm ..... 2. palaestinum

2. Glumes acuminate; awn of lower floret 25-40 mm ..... 3. kotschyi

1. A. elatius (L.) Beauv. ex J. & C. Presl, Fl. Cechica 17 (1819).

subsp. elatius

Syn: Avena elatior L., Sp. Pl. 79 (1753).

Ic: Bor, Fl. Iraq 9: 324, t. 118 (1968).

Laxly caespitose perennial. Stem 25-50 (-150) cm, rather stout, usually erect, smooth, sometimes hairy at nodes, shiny, 3-5-noded. Leaf blades 4-9 (-30) cm x 2-4 (-10) mm, linear, acuminate, usually glabrous, sometimes pilose to ± scabrid, pale or dark green; sheaths glabrous; ligule 1-3 mm, obtuse. Panicle (7-) 11-21 (-30) cm x 1-6 cm, lanceolate to oblong, purplish green, shiny; branches 2-6 cm, nodding; pedicels 0.2-1.5 cm, aculeolate. Spikelets (7-) 8-8.5 (-9) mm, gaping. Glumes acute; lower glume 6-6 mm, oblong-lanceolate; upper glume 6.8-9.5 mm, ovate-lanceolate. Rhachilla segment 0.5-1 mm. Lemmas 6.5-10 mm, oblong-lanceolate, 2-dentate at apex, glabrous to slightly pilose (c. up to 1 mm); awn of upper lemma 2-5 (-8) mm, straight; awn of lower lemma 10-20 mm, geniculate, twisted in lower half, arising in lower ⅓ of lemma. Anthers 4-5 mm. Fl. 6-7. Open mountain slopes and meadows, sea level-1600 m.

Described from: In Europae maritimis et apricis. /Hb. Linn. 95/2!/

N.W., W. S. and Inner Anatolia.

A2(A) Istanbul: Hünkar Iskelesi, nr. Anadolu Hisar, 29 vi 1895, Azn.!

A3 Ankara: Beypazari above Karasar, 1 vii 1972, Y. Akman!

A4 Ankara: Çubuk, E. of Karagöl, 500 m, S. Erik 194!

A5 Tokat: Zile nr. Kasin Köy, 1250-1300 m, M. Dogan 282!

A9 Kars: Kagizman, Grossheim I: Map 196

B1 Balikesir: Kaz Da., Sint. 1883: 585!

B3 Eskişehir: Türkmen Da., Kaplan Deresi, 1500 m, T. Ekim 2259!

C3 Isparta: Egridir, Yaka Köyu, 1700 m, H. Pegmen & A. Guner 1548!

C4 Konya: Eregli, Zootechnic Research Station, 900 m, Y. Akman 6292!

C6 Adana: Amanus-Gebirge (Nur Da.), 1550-1650 m, Ehrend et al. 787-42-7!

External distribution of subsp. elatius: Eruope, N. Africa, Russia, Caucasia, N. Iraq, W. Iran. Introduced in N. America.

The presence of A. elatius subsp. bulbosum (Willd.) Schübler & Martens in the East Aegean Islands (Kalymos), has been published by A. Hansen (1980), but so far it was observed in the field and has not been collected. A bulbous species, A. palaestinum, does not grow in the European mainland, but occurs sporadically in the Aegean region and is often confused with A. elatius subsp. bulbosum. Further collecting needs to be done before accepting the presence of this subspecies from the E. Aegean.

2. A. palaestinum Boiss., Diagn. ser. 2 (13): 51 (1853).

Syn: A. elatius var. palaestinum Boiss., Fl. Or. 5: 550 (1884)!

Caespitose perennial. Stem 17-54 (-100) cm, erect or stems slightly geniculate in lower part, smooth and glabrous. Leaf blades 5-22 cm x 1.4-4.5 (-8) mm, linear, acuminate, glabrous to pilose or scabrid; sheaths glabrous; ligule up to 3 mm, obtuse, slightly hairy on dorsal side. Panicle 7-16.5 (-27) cm x 2-6 cm, usually oblong, rather lax; branches 3-4 cm; pedicels 1-15 mm, aculeolate. Spikelets 11-14 mm, with 2 florets. Rhachilla segment 1-2.5 mm. Glumes acute; lower glume 5.5-6.5 mm; upper glume 9-12 mm. Lemmas 8-14 mm, oblong to lanceolate, bidentate at apex. Upper lemma covered with hairs; awn of upper lemma 4.5-6 mm, or absent. Lower floret glabrous; awn 20-28 mm, twisted in lower half, geniculate. Anthers 3.5-5.5 mm.

Fl. 5-6. On limestone rock, volcanic cliffs with scattered Quercus, dry grassland, 500-1230 m.

Typus: "Hab. in Palaestina loco non notato", [1847], Boissier [Holo G!]

Widespread except N. and easternost Anatolia.

A2(A) Bilecik: nr. Gölümbe, A. Baytop (ISTE 9321)!

B1 Balikesir: Kaz Da., Menderes Dere, Sint. 1883: 104!

B2 Kütahya: 12 km from Kutahya to Bozöyük, 900 m, Hub.-Mor. 12488!

B5 Kayseri: Ali Da., 1350 m, A. Baytop (ISTE 37635)!

B7 Tunceli: between Pertek and Elazig, 7 km S.W. of Pertek, 1200 m, E. Hennipman et al. 1550!

C2 Aydin: between Bozdogan to Cine, nr. Topcambaba forest fire tower, 1485 m, T. Uslu 5748!

C3 Isparta: Devrek Da., above Sou Köy, A. Baytop (ISTE 9645)!

C4 Konya: Bozkir, Haydar Da., 2000 m, R. Çetik 145!

C5 Içel d. Taraus: Gulek Bogaz, 820 m, Hub.-Mor. 14097!

C6 Hatay: Nur Da., Belen pass, 700-850 m, K.P. Buttler 13020!

C7 Urfa: Birecik, Sint. 1888: 541!

C8 Mardin: 24 km from Mardin to Diyarbakir, 1000 m, D.28854!

Is. Lesvos: Mt. Ordimnos, at Ipsilon Monastery, 500 m, J.R. Edmondson 2628!

External distribution: Mainly in East Mediterranean area, Bulgaria, Jugoslavia, Syrian Desert. E. Mediterranean element.

3. A. kotschyi Boiss., Diagn. ser. 1 (7): 122 (1846).

Ic: Bor, Fl. Iraq 9: 326, t. 119 (1968);

Bor, Fl. Iranica (Gramineae) 70, t. 51 (1970).

Laxly caespitose perennial with fibrous rhizome. Stem 17-30 (-100) cm, erect, bulbous at base, 1-2-noded. Leaf blades 6-25 cm x 1-4 mm,

linear, acuminate, glabrous to slightly scabridulous; sheaths glabrous; ligule 1.5-2.5 mm, obtuse-truncate. Panicle 6-15 (-20) cm x 2-5 cm, rather dense with a few spikelets; pedicels curved, scabrid. Spikelets 12-16 mm, gaping. Glumes lanceolate, acuminate; lower glume 6.5-9 mm; upper glume 12-13.5 mm. Rhachilla segment 1.5-2 mm, covered with long hairs (c. 5-7 mm). Lemma 13-15 mm, terminating into 2 aristate points (c. 1-2.5 mm); awn 25-40 mm, arising from above base, geniculate and twisted in lower half. Upper lemma subterminally awned; awn 10-16 mm, straight, not twisted in lower half. Anthers 2.3-4.6 mm. Fl. 4-5.

Dry mountain slopes.

Typus: [Iran] "Hab. in rupestribus et glareosis prope ruinas Persepolis", [20 iv 1842], Kotschy 272 [G!; Iso B!]

Rare in E. Anatolia.

B7 Sivas: Divrigi, Dumluca Da., T. Baytop (ISTE 12878)!

External distribution: Caucasia, W. Syria, Syrian Desert, N. Iraq, Iran, Afghanistan.

4. GAUDINIA P. Beauv., Ess. Agrost. 95 (1812)

Annual. Leaf blades flat. Ligule hyaline. Inflorescence a distichous spike. Rhachis fragile and disarticulating above insertion of the spikelet. Spikelets laterally compressed, sessile, ± appressed to rhachis, usually with 4-7 florets, upper florets abortive. Glumes unequal; lower glume 3(-5)-veined; upper glume 5-7 (-11)-veined, shorter than spikelet, nearly twice as long as lower glume. Lemma lanceolate, obscurely 7-9-veined, hyaline on margin with a long geniculate dorsal awn. Palea shorter than lemma, hyaline, 2-veined, keeled, bifid at apex. Lodicules 2. Stamens 3. Caryopsis oblong.
Type: G. fragilis (L.) Beauv.

G. fragilis (L.) Beauv., Ess. Agrost. 164 (1812).
Syn: Avena fragilis L., Sp. Pl. 80 (1753).
Ic: Sibth. & Sm., Fl. Graeca 1, t. 88 (1808); Reichb., Ic. Fl. Gram. 1: t. 140 f. 168 (1850).

Annual. Stem 10-33 cm, erect or ascending from base, glabrous, smooth, shiny. Leaf blades 1-6.5 cm x 0.6-4 mm, narrowly linear, acuminate, villous especially on lower surface; sheaths ± villous; ligule 0.5-0.7 mm, truncate. Inflorescence 6-15 cm x 4-15 mm. Spikelets 7-18 mm. Glumes glabrous to scabrid on veins or sometimes villous; lower glume 3.2-5 mm, lanceolate, acute; upper glume 5-10 mm, oblong, obtuse, bifid at apex. Rhachilla segments 2-3 mm, glabrous. Lemma 4.3-8 mm, lanceolate, glabrous or villous; callus hairless; awn up to 15 mm, arising in upper $\frac{1}{3}$-$\frac{1}{4}$ of lemma, geniculate and slightly twisted in lower part. Palea 3.5-7.5 mm, ciliate on keels. Anthers 2.5-5 mm. Caryopsis 0.5-3 mm, oblong. Fl. 5-7. Lightly grazed damp grassy slopes on volcanic rock and sandy soil near sea, 0-1485 m.

Described: "in Lusitania, Hispania" Loefling [Hb. Linn. 95/16!]

Turkey-in-Europe, mainly S. and W. Anatolia, rare in N.E.; Islands.

A1(E) Kirklareli: Demirköy, A. Baytop (ISTE 5463)!

A2(E) Istanbul: Yedikule, 22 v 1904, Azn.!

A7 Trabzon: Soguksu, 550 m, E.K. Balls 403!

B1 Izmir: Göztepe, 7 v 1906, Bornm. 10187!

B2 Balikesir: Kertil near Sindirgi, A. Baytop (ISTE 10105)!

B4 Nevşehir: Göreme, A. Baytop (ISTE 27098)!

C2 Aydin: Topçambaba between Bozdogan and Çine, 1485 m, T. Uslu 5745!

C3 Antalya: between Manavgat and Alanya, A. Baytop (ISTE 9786)!

Is. Kos: Lampi, A. Hansen et al. 47

External distribution: C., N. & W. Europe, N. W. Africa, Aegean, Latakia, Crimea.

5. VENTENATA Koel., Descr. Gram.: 272 (1802)

Syn: Pilgerochloa Eig in Repert. Eur. et Med. 2 (27): 417-431 (1929).

Annual. Leaf blades involute or folded. Ligule membranous. Inflorescence a ± lax panicle. Spikelets laterally compressed, with 2-3 florets. Glumes unequal, lanceolate, acuminate; lower glume (3-) 5-7-veined; upper glume (5-) 7-9-veined, nearly as long as spikelet; both glumes shortly aristate at apex. Lemma 5-veined, chartaceous, with a scabrous margin; lowest lemma unawned or with a dorsal awn, terminating in an aristate point or 2 setae; other lemmas dorsally awned, terminating in 2 setae; callus covered by shiny hairs. Palea shorter than lemma. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis elliptic.

Type: V. avenacea Koel. (= V. dubia (Leers) Coss.).

Key to Species

1. Lowest lemma dorsally awned, bifid at apex ..... 3. eigii
1. Lowest lemma awnless, with an aristate point at apex
  2. Lower glume ¾-4/5 x as long as the upper one, 5-7-veined; upper glume 7-9-veined ..... 1. dubia
  2. Lower glume ½ x as long as the upper one, 3-veined; upper glume 5-veined ..... 2. subenervis

1. V. dubia (Leers) Cosson, Durieu Expl. Sci. Algerie 2: 104 (1855).

Syn: Avena dubia Leers, Fl. Herborn.: 41 (1775).

Ic: Fiori, Ic. Fl. Ital. 1: 28, f. 241 (1895);
Zangheri, Fl. Ital. 2: 186, f. 6788-6789 (1976).

Annual. Stem 20-56 cm, slender, erect, glabrous. Leaf blades 2-6 cm x 0.8-3 mm, narrowly linear, acuminate, hairy on upper surface; ligule 5-6 mm, acute, lacerate. Panicle up to 20 cm, pyramidal, rather open; branches 4-10 cm, with 2-5 spikelets borne near the end of

the branch; pedicels 2-17 mm, clavate, scabrid all over. Spikelets 10-16 mm (excl. awn). Glumes lanceolate, acuminate; lower glume 4.5-7 mm; upper glume 6.3-11 mm. Rhachilla segments glabrous. Lowest lemma 6.5-15 mm, terminating in an aristate point (c. 2-3 mm); callus hairs up to 1.5 mm, dense. Upper lemmas terminating in 2 setae (up to 2-3 mm); awned from back; awns 20-25 mm, geniculate and twisted. Palea 6-7 mm. Anthers 1-2 mm. Fl. 5-7. Open gravelly places at the sub-alpine meadows, wet places, 1200-1550 m.

Typus: /Germany/ "Hab. in collibus siccis, apricis, in arvis sterilibus passim. Floret Junio", Leers.

Turkey-in-Europe, W. Anatolia, rare in S. Anatolia.

A1(E) Edirne: between Edirne and Havza, A. Baytop (ISTE 6548)!

A2(E) Istanbul: Kagithane, 23 v 1892, Azn.!

A3 Ankara: Beypazari, Egriova, 1550 m, Y. Akman 8727!

A4 Ankara: Çamkoru, 1300 m, O. Alpay 86!

B1 Izmir: Yamanlar Da., Karagöl, R. Alava & G. Bocquet 5072!

B3 Eskişehir: Türkmen Da., Belce district, T. Ekim 2314!

B6 Adana: Saimbeyli to Göksun, 56 km E. of Saimbeyli, 1520 m, Hub.-Mor. 11622!

External distribution: Mediterranean (except E. Mediterranean), C. Europe, Crimea, Caucasia, S. Russia.

2. V. subenervis Boiss. et Bal. in Bull. Soc. Bot. Fr. 4: 305 (1857).

Annual. Stem 7-43 cm, slender, erect. Leaf blades up to 4-5 cm, narrowly linear, hairy on upper surface, involute; ligule up to 4 mm, acute, somewhat lacerate. Panicle 6-14 cm x 3-5 cm, pyramidal, rather lax; branches 2-6 cm, with 1-3 spikelets borne at end of each branch; pedicels 5-18 mm, clavate, scabrid. Spikelets 9.5-13 mm. Glumes lanceolate, acuminate; lower glume 3.5-5.5 mm; upper glume 7.6-10 mm. Lowest lemma 9-13 mm (incl. seta), with an apical seta. Upper lemmas

terminating in 2 apical setae (up to 2-2.5 mm) awned from back; awn 14-21 mm, geniculate and twisted in lower half. Palea 4-4.8 mm. Anthers 1.4-1.8 mm. Fl. 4-5. Dry hillsides and cultivated land, nr. sea level-700 m.

Typus: [Turkey B1 Izmir] "Tres abondant sur les collines pierreuses bordant le fond du golfe de Smyrne", [8 v 1854], Balansa [Iso E!]

W. Anatolia.

B1 Izmir: Cesme, 50 m, K.P. Buttler 12327!

B1 Manisa: Manisa Da., T. Baytop (ISTE 6392)!

B2 Uşak: Kara Güzel Dere, 700 m, Bal. 1336!

Is. Lesvos: Udja, Plati, Candargy

Endemic to Turkey and the East Aegean Islands. E. Mediterranean element.

3. V. eigii (H. Scholtz) M. Dogan (ined.)

Syn: Pilgerochloa eigii H. Scholtz in Wildenowia (1982, in press).

Resembles V. subenervis, but differs in a number of characters, such as the lowest lemma bifid and with a long dorsal awn, anthers short (c. 0.3 mm). Fl. 7.

Typus: [Turkey B7/B8 Elazig] "Kerucu Gecidi, 30 km weslich Bongöl, 14 vii 1981, Raus 4014 [B!]

Endemic. Ir.-Tur. element.

6. GAUDINOPSIS Eig in Feddes Rep. 26: 74 (1929)

Annual. Leaf blades involute or folded. Ligule membranous. Inflorescence a raceme or rather dense panicle. Spikelets with 4-10 florets, laterally compressed, hermaphrodite. Glumes subequal, lanceolate, acute; lower glume 3-veined; upper glume 3 (-5)-veined, longer than lower glume but shorter than floret. Lemma 5-veined, rather firm, rounded on the back; lowest lemma shorter than others, awnless, acute at apex; lemma of upper florets with an awn from below bifid apex; awns geniculate and twisted in lower half. Palea 2-veined, keeled, shorter than lemma, bifid at apex. Rhachilla disarticulating above glumes and between florets. Lodicules 2. Stamens 3. Caryopsis elliptic-oblong.

Type: G. macra (Stev. ex M. Bieb.) Eig

Key to Species

1. Lemmas all without an awn in each spikelet ..... 3. sorgeri
1. Lemmas (except lowest lemma) all with a dorsal awn in each spikelet
   2. Panicle lax and spreading; lowest lemma in each spikelet with a mucro from sinus (c. 1 mm) ..... 4. huber-morathi
   2. Panicle rather dense; lowest lemma in each spikelet without a mucro from sinus
      3. Glumes and lowest lemma in each spikelet acuminate; upper lemmas and rhachilla segments hairy ..... 2. quercetorum
      3. Glumes acute; lowest lemma acute to shortly bifid; upper lemmas and rhachilla segments glabrous ..... 1. macra

1. G. macra (M. Bieb.) Eig in Feddes Rep. 26: 74 (1929).

Annual. Stem 9-43 cm, erect, sometimes slightly geniculate at base, glabrous, solitary or tufted, 2-noded. Leaf blades 2-6.5 cm x 1-3 mm, linear, acuminate, pubescent on upper surface, usually involute or folded; ligule 3-5 mm. Inflorescence 3-11.5 cm x 0.5-1.5 cm, narrowly oblong; pedicels 1-7 mm, clavate, glabrous. Spikelets 6-17 mm. Lower glume 3.4-6.5 mm; upper glume 4-7 mm. Lowest lemma 4.5-7.5 mm. Awns 3.5-10 mm. Palea 4-5 mm. Anthers 1.5-2.5 mm.

Fl. 4-6. Open dry places, fallow fields, under Pinus or Tamarix scrub, 0-1750 m.

Key to subspecies

1. Spikelets 8-17 mm, usually green; glumes 4-7 mm; stem up to 43 cm ..... subsp. macra

1. Spikelets 6-8 mm, always dark purple; glumes 3-4 mm; stem up to 13 cm ..... subsp. antalyensis

subsp. macra

Syn: Avena macra M. Bieb., Fl. Taur.- Cauc. 1: 77 (1808);
Ventenata macra (M. Bieb.) Boiss., Fl. Or. 5: 540 (1884).

Ic: Bor, Fl. Iraq 9: 345, t. 130 (1968);
Bor, Fl. Iranica (Gramineae) 70, t. 50 (1970).

Fl. 4-6. Open dry places, fallow fields, under Pinus and Tamarix scrub, 0-1750 m.

Typus: [Caucasus] "Hab. in Iberia", Steven [Holo LE!]

Widespread in Anatolia, but rare in N.

A5 Sinop: Kargi, Kös Da., 400 m, Tobey 2716!

A9 Kars: 15 km from Tuzluca to Kagizman, 950 m, D.43606!

B4 Ankara: 36 km from Ankara to Polatli, 900 m, Coode & Jones 2224!

B5 Kayseri: Bakir Da. above Kisge, 1400 m, D.19258!

B8 Siirt: 28 km from Siirt to Baykan, 800 m, D.43191!

B9 Van: Timar to Bendimahi, 50 km from Erciş, 1750 m, D.44200!

C2 Antalya: 31 km S.W. of Elmali, 1200 m, F. Sorger 67-23-3!

C6 Hatay: Rabat nr. Dörtyol, Coode & Jones 476!

C7 Urfa: Birecik, Kefre, Sint. 543!

C8 Mardin: Savur, 900 m, D.28563!

External distribution: Greece, Crimea, Caucasia, Latakia, Syrian Desert, N. Iraq, Turkestan.

subsp. antalyensis M. Dogan (ined.)

Fl. 6-7. Rocky slopes, 800-1350 m.

Typus: [Turkey C3 Antalya] "15 km südlich Korkuteli in Richtung Elmali, stark von Ziegen beweidetes Odland, 1350 m", [4 vii 1973], F. Holtz (494), P. Hanel & T. Kesercioglu [Iso E!]

S.W. Anatolia.

B2 Burdur: 51 km N. of Fethiye, Altinyayla, 1000 m, Hub.-Mor. 5546!

C3 Antalya: 6 km from Elmali to Korkuteli, R. Alava & G. Bocquet 5256!

C3 Antalya: 3 km S. of Hafizpaşa, 800 m, Hub.-Mor. 5547!

Local endemic. E. Mediterranean element.

	subsp. macra	subsp. antalyensis
Stem	up to 43 cm	7-13 cm
Spikelet	8-17 mm	6-8
L. Glume	4-6.5 mm	3-3.5 mm
U. Glume	5-7 mm	4-4.5 mm
Lemma	5-7.5 mm	4.5-5 mm
Awn	7-10 mm	3.5-7 mm

2. G. quercetorum (Boiss.) M. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: Ventenata quercetorum Boiss. et Bal., Diagn. ser. 2 (4): 130 (1859).

Annual. Stem 12-14 cm, erect to geniculately ascending, rather slender, 2-noded in lower half. Leaf blades 1.3-2.4 cm x 0.5-1 mm, convolute, pubescent on upper surface, glabrous below; sheaths glabrous; ligule 2.5-4 mm, lanceolate. Inflorescence 4-5 cm x 1-1.4 cm, elliptic; pedicels 1.2-5.5 mm. Spikelets 8.5-10 mm, with 5 florets. Lower glume 4.5 mm; upper glume 6 mm. Lemma c. 7 mm, glabrous, upper ones covered by pubescence especially in lower part and margins; awn c. 8 mm, geniculate and twisted in lower half. Anthers 2.4-3.1 mm.

Fl. 6-7. Quercus scrub, 950 m.

Typus: [Turkey B2 Denizli] "Hab. copiose in quercetis circa Bulghar Keui [Bolkar Köy] Phrygiae, 950 m", [14 vi-8 vii 1857], Balansa [Holo G!, Iso K!]

Endemic. E. Mediterranean element.

3. G. sorgerae M. Dogan in Notes R.B.G. Edinb. 40(1); 85-86 (1982)

Annual. Stem 7.5-16 cm, erect, rather slender, glabrous and smooth but slightly puberulent below panicle and nodes, 2-3-noded, purplish. Leaf blades 1.2-3 cm x 0.6-1.2 mm, convolute, hairy on upper surface, glabrous beneath; sheaths glabrous, slightly inflated; ligule 1.5-3.5 mm, acute. Panicle 2.5-5.5 cm x 0.8-1.7 cm, lanceolate, rather interrupted; pedicels 2-8.5 mm, puberulent. Spikelets 4.5-10 mm, lanceolate, with 3-8 florets. Lower glume 3-4 mm; upper glume 3.7-4.8 mm. Lemmas 4.2-5.5 mm, lanceolate, awnless, slightly hairy on dorsal side; callus hairs up to 0.5 mm; rhachilla segments 1 mm, glabrous. Palea 3.8-4.8 mm, hairy on keels. Anthers 2.1-3 mm. Caryopsis 1.7 mm, elliptical from dorsal side, ventrally compressed.

with fine white 4-6 mm hairs. Caryopsis enclosed by lemma and palea.

Fl. 6-8. Sand dunes, sea level.

Syntypes: /Spain/ Algeciras, in arenosis maritimis prope oppidum.

/Sicily/ Rometta prope oppidum Messina, in litore arenoso maris.

/Morocco/ Tanger, in arenosis maritimis.

Turkey-in-Europe, W. Anatolia, Islands.

A1(E) Çanakkale: Ariburnu, A. Baytop (ISTE 14770)!

A1(E) Edirne: Enez, A. Baytop (ISTE 15733)!

A1(E) Kirklareli: Igneada, A. Baytop (ISTE 13980)!

A2(E) Istanbul: Florya, 20 vii 1890, Azn. 2382!

B1 Izmir: Çeşme, C. Regel 18929!

C1 Aydin: Kusadasi, Güzelcamli dunes, T. Uslu 3926

Is. Kos: Lampi, A. Hansen 60

External distribution: Mainly S. Europe, Romania.

21. APERA Adans. Fam. 2: 495 (1763)

Slender glabrous annuals. Leaf blades linear, acuminate, somewhat involute. Ligule hyaline. Inflorescence an open or contracted dense panicle. Spikelets with 1 (-2) florets. Glumes unequal, acuminate or aristate; lower glume 1-veined, linear-lanceolate; upper glume 3-veined, lanceolate. Lemma obscurely 5-veined, chartaceous, rounded on dorsal, with a subterminal awn, very occasionally awn almost terminal; callus glabrous or hairy. Palea 2-keeled, equaling lemma, hyaline. Rhachilla disarticulating above glumes, shortly prolonged. Lodicules 2. Stamens 3. Caryopsis elliptic.

Type: A. spica-venti (L.) Beauv.

Key to Species

1. Panicle rather open; branches up to 11 cm; callus hairy ..... 1. spica-venti
1. Panicle dense, contracted or interrupted; branches up to 6 cm; callus hairy or not
   2. Both glumes with aristate points
      3. Aristate points of glumes 1.5-2.5 mm; awn of lemma always subterminal, 6.5-7.3 mm ..... 5. triaristata
      3. Aristate points of glumes 0.4-1.5 mm; awn of lemma usually almost terminal, 1-2.3 mm ..... 4. baytopiana
   2. Glumes acute, acuminate or only upper glume with a short aristate point
      4. Glumes acuminate, upper one with an aristate point; callus glabrous at maturity; anthers 1.5 mm ..... 3. intermedia
      4. Glumes acute, upper one without an aristate point; callus hairy; anthers 0.2-0.4 mm ..... 2. interrupta

1. A. spica-venti (L.) P. Beauv., Ess. Agrost. 151 (1812).

Syn: Agrostis spica-venti L., Sp. Pl. 61 (1753)!

Ic: Kulczynski, Atlas Fl. Polsk. 4 (2): 403 (1932);

Hubbard, Grasses 290 (1968).

Annual. Stem 20-70 (-100) cm, tufted or solitary, erect to geniculate at nodes, slander or ± stout, glabrous and smooth, 3-noded. Leaf blades 7-25 cm x 3-10 mm, linear, acuminate, scabrid above or on both surfaces; sheaths smooth or scabrid above, often ± purplish. Ligule 3-7 mm, oblong. Panicle 7-20 cm x 1.5-11 cm, ovate to oblong, rather open; branches patent, up to 7 cm, numerous; pedicels 0.5-3 mm, slightly scabrid. Spikelets 2.5-3.1 mm, narrowly oblong, green or purplish. Glumes lanceolate, acute, scabrid on keel in upper half; lower glume 2.2-2.5 mm, upper glume 2.5-3.1 mm. Lemma 2.1-2.8 mm, oblong-lanceolate, scabridulous above the middle; callus shortly hairy; awn 5.4-8.4 mm. Anthers 1-1.5 mm. Fl. 6-7. Cultivated ground, wet places, sandy soil in P. nigra forest, 0-1400 m.

Described from in Europa inter segetes /Hb. Linn. 84/1!/

Turkey-in-Europe, W. Anatolia.

A1(E) Edirne: Enez, A. Baytop (ISTE 15793a)!

A1(E) Kirklareli: Demirköy, A. Baytop (ISTE 5465)!

A1(E) Tekirdag: Gölcük Köyü, A. Baytop (ISTE 13501)!

A2(E) Istanbul: Yeşilköy, 12 vi 1916, Azn.!

A3 Ankara: d. Beypazari, Deliyer, Cuma deresi, 1400 m, Y. Akman 15!

B3 Eskisehir: Türkmen Da., Lütfiye köyü, 1300 m, T. Ekim 2254!

B3 Afyon d. Bayat: Asar tepe, N.W. slope, 1280 m, M. Vural 57!

External distribution: Most of Europe, N.W. Africa, Caucasus, N.W. Iran.

2. A. interrupta (L.) P. Beauv., Ess. Agrost. 151 (1812).

Syn: Agrostis interrupta L., Syst. Nat. ed. 10, 2: 872 (1759).

Ic: Reichb., Ic. Fl. Germ. 1: t. 73 f. 123 (1850);

Hubbard, Grasses 292 (1968).

Annual. Stem 7.5-14 (-26) cm, tufted, branched or solitary, erect to geniculate only at base, ratherslender, smooth and glabrous, 3-noded. Leaf blades linear, acuminate, 3-10 cm x 1-4 mm, flat or convolute, scabrid above, smooth beneath; sheaths smooth, often purplish; ligule 2-5 mm, lacerate. Panicle 3-6 (-11) cm x 0.5-1 (-1.5) cm, contracted, interrupted. Spikelets 2-2.8 mm, green or purplish. Glumes lanceolate, acute, scabrid on keel in upper half; lower glume 2-2.2 mm, upper glume 2.5-2.8 mm. Lemma oblong-lanceolate, 2-2.4 mm, scabridulous above the middle; callus shortly hairy, awn 4-8 mm. Anthers 0.2-0.4 mm.

Fl. 6. Sandy soil, fields, 1200-1500 m.

Described from France and Italy.

W. and N.E. Anatolia.

A9 Kars: Kagizman, Grossheim I: Map 181

B1 Izmir: Manisa Da., 1200-1500 m, A. Baytop (ISTE 9963)!

External distribution: Europe, N.W. Africa, Caucasia, Iran, Turkestan, Afghanistan, W. Pakistan.

3. A. intermedia Hackel in Ann. Nat. Hofmus. Wien 20: 430 (1905).

Ic: Bor, Fl. Iraq 9: 298, t. 107 (1968);

Bor, Fl. Iranica (Gramineae) 70 t. 46 (1970).

Annual. Stem 10-60 cm, slender, erect or geniculately ascending from base, smooth and glabrous, 3-4-noded. Leaf blades 2-12 cm x 1-4 mm, narrowly linear, rather flat; ligule 2-6 mm, lacerate. Panicle 3-20 cm x 0.7-5 cm, rather narrow, contracted. Spikelets 2.2-2.8 mm, lanceolate. Glumes acuminate; lower glume 2.3-2.7 mm, upper glume

2.6-2.8 mm, with a short aristate point at apex. Lemma 2.2-2.5 mm, scabrid towards apex, glabrous at base; callus glabrous at base; callus glabrous; awn 9-9.5 mm. Anthers 1.2-1.5 mm. Fl. 5-7. Dry slopes, sandy river banks, open places, woodlands, 1000-1860 m.

Typus: [Turkey B5 Kayseri] "Erciyas Da., zwischen Soisalyund Ewerek c. 1100 m", [10 vi 1902], Penther & Zederbauer [WU!]

Widespread except in S. Anatolia.

A2(E) Istanbul: Yeşilköy, 12 vi 1861, Azn.!

A9 Kars: Kagizman, Grossheim I: Map 179

B2 Kutahya: 15 km from Gediz to Uşak, 1140 m, Hub.-Mor. 12495!

B3 Afyon: 18 km from Çay to Afyon, 1000 m, Coode & Jones 2377!

B4 Konya: Yavşan Memlehasi nr. Tuz Gölü, D.18690A!

B5 Nevsehir: Aciksaray nr. Gülşehir, 1150 m, J. Roper 133!

B6 Maraş: Göksun to Elbistan, 1400 m, Stn. & Hend. 5582!

B7 Erzincan: Egin (Kemaliye), Sint. 1890 2645!

B9 Bitlis: Tatvan, 1890 m, Tong 16!

C4 Konya d. Ermenek: Ermenek to Karaman, 1580 m, Hub.-Mor. 10348!

C8 Mardin: 24 km from Mardin to Diyarbakir, 2000 m, D.28730!

C9 Hakkari: Zab gorge, 22 km from Hakkari to Van, 1300 m, D.44873!

C10 Hakkari: 9 km S. from Hakkari/Yüksekova road junction, 1550 m, D.44662!

External distribution: Caucasia, N. Iraq, N. Iran.

4. A. baytopiana M. Dogan in Notes R.B.G. Edinb. 40(1): 79 (1982)

Annual. Stem 16-41 cm, usually erect, sometimes slightly geniculate at base, solitary to tufted, rather slender, glabrous and smooth, usually 3-4-noded. Leaf blades 2-5.7 cm x 0.7-1.5 mm, linear, acuminate, flat to convolute, upper surface shortly ciliate on veins, glabrous beneath; sheaths shorter than internodes, glabrous; ligule 1.2-3.7 mm,

acuminate, becoming lacerate. Panicle 2.2-6.2 cm x 3-6 mm, cylindrical; branches 4.5-15 mm, contracted; pedicels 0.3-1.1 mm, slightly scabrid. Spikelets 2.4-3.7 mm. Lower glume 2.9-3.6 mm (incl. aristate point), linear; aristate point 0.8-1.5 mm. Upper glume 3.3-3.5 mm, lanceolate; aristate point 0.4-0.7 mm. Lemma 1.5-2.1 mm, rather firm, scabrid especially on upper half, almost terminally awned; awn 1-2.3 mm, straight, slightly scabrid. Palea 1.4-1.6 mm. Anthers 1.5-1.8 mm. Caryopsis 1.2-1.5 mm. 2n = 14. Fl. 6. River banks.

Type: [Turkey C2 Mugla] "Köycegiz to Gökova, Karabögürtlen", [30 vi 1979], E. Leblebici, Ö. Seçmen & L. Bekat 2857! (Holo ISTE 43921!)

Endemic. E. Mediterranean element. Only known from the original collection. Cultivated at Royal Botanic Garden, Edinburgh, 1980.

5. A. triaristata M. Dogan in Notes R.B.G. Edinb. 40(1): 81 (1982)

Annual. Stem 13-23 cm, solitary to tufted, glabrous and smooth, usually erect, 3-noded below the middle. Leaf blades 3-8 cm x 1-2.5 mm, linear, acuminate, slightly rough on both sides; sheaths glabrous; ligule 4-6 mm, lacerate at maturity. Panicle 3.5-8 cm x 1.5-3 cm, lanceolate, rather dense; branches up to 2.5 cm, patent; pedicel 0.1-1 mm, scabrid. Spikelets 2.6 (excl. aristate point). Glumes lanceolate, acuminate. Lower glume 1.9-2.1; aristate point 2.2-2.5 mm. Upper glume 2.4-2.6 mm; aristate point 1.5-1.7 mm. Lemma 2-2.4 mm, lanceolate, minutely rough above the middle on dorsal side, subterminally awned; callus glabrous; awn 6.5-7.3 mm, straight or slightly bent, scabrid. Palea 2 mm. Anthers 1.5-1.6 mm. Fl. 6. Dry places, 1000 m.

Type: [Turkey C2 Denizli] "Acipayam, 39 km S. of Denizli, 1000 m, 16 vi 1954", Huber-Morath 12496! [Hb. Huber-Morath!]

Endemic. E. Mediterranean element. Only known from the type.

22. AGROSTIS L., Sp. Pl.: 61 (1753)

Perennial. Leaf blades flat or involute. Ligule hyaline. Inflorescence a rather lax or contracted panicle. Spikelets laterally compressed, with 1 (-2) florets. Glumes equal to subequal, lanceolate, acute, longer than lemma; lower glume 1-veined; upper glume 3-veined. Lemma 5 (-3)-veined, scarious, truncate, lateral veins somewhat excurrent, awnless or awned, glabrous or hairy; callus glabrous or hairy. Palea hyaline, 2-veined, or sometimes completely missing. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis elliptic to ovoid.

Type: A. alba L. = A. stolonifera L.

Literature:

Philipson, W.R. 1937. A revision of the British species of the genus Agrostis L. J. Linn. Soc (Bot.) 51: 73-151.

Paunero, E. 1947. Las especies espanolas del genero Agrostis. Anal. Inst. Bot. Cavanilles 7: 561-644.

Björkman, S.O. 1960. Studies in Agrostis and Related Genera. Symb. Bot. Upsal. 17 (1): 1-112.

Widen, K.-G. 1971. The genus Agrostis L. Eastern Fennoscandia. Taxonomy and Distribution. Fl. Fenn. 5: 1-209.

Key to Species

1. Callus hairs as long as lemma; anthers 0.3-0.5 mm .... 1. olympica
1. Callus hairs short or absent; anthers 0.6-2 mm
  2. Palea absent or up to ¼ as long as lemma
    3. Spikelets 2-2.5 mm; lemma 1.7-2 mm, without an awn ..... 2. canina
    3. Spikelets 3-3.4 mm; lemma 2.2-2.4 mm, with a long exserted awn ..... 3. planifolia
  2. Palea longer than ¼ as long as lemma

4. Lateral 2 veins of lemma excurrent ..... 4. castellana

4. Lateral 2 veins of lemma not excurrent

5. Plant with long stolons ..... 9. stolonifera

5. Plant with rhizomes

6. Lemma with long exserted awn

7. Panicle dense; branches 0.5-1.5 cm; anthers 0.6-0.8 mm ..... 7. lazica

7. Panicle lax; branches 2.5-7 cm; anthers 1-1.5 mm

8. Spikelets 3-3.5 mm; palea $\frac{1}{3}$ as long as lemma ..... 8. balansae

8. Spikelets 1.5-2.5 mm; palea $\frac{1}{2}$-$\frac{2}{3}$ as long as lemma ..... 6. capillaris

6. Lemma without awn, or awn not exserted

9. Ligules of non-flowering shoots longer than wide; paniole branches aculeolate ..... 5. gigantea

9. Ligules of non-flowering shoots usually broader than long; panicle branches smooth ..... 6. capillaris

1. A. olympica (Boiss.) Bor in Arbok Univ. Bergen, Math-Naturv. Ser. 2: 4 (1961).

Syn: Calamagrostis olympica Boiss., Diagn. ser 1 (5): 70 (1844)!;
Pentatherum olympicum (Boiss.) Nab. in Publ. Fac. Sci. Univ. Masaryk (Brno) no. 111: 9 (1929).

Ic: Bor, Fl. Iraq 9: 285, t. 101 (1968);
Bor, Fl. Iranica (Gramineae) 70, t. 45 (1970).

Caespitose perennial, with fibrous roots. Stem 4-20 cm, erect, smooth and glabrous. Leaf blades 1-8 cm x 0.6-2.4 mm, linear, acute, flat to filiform, green, usually glabrous, somewhat slightly scabrid on margins and upper surface, especially on veins; sheaths glabrous;

ligule 1.7-2 mm, obtuse. Panicle 1-4 cm x 0.2-0.8 cm, rather dense; branches short, 0.8-1.5 cm; pedicel 0.3-2 mm, slightly scabrid. Spikelets 1.5-2.3 mm, elliptic, acute, dark purplish. Glumes subequal. Lemma 1.6-2 mm, pilose hairy on dorsal surface, with dorsal awn; callus hairs as long as lemma; awn c. 2 mm, geniculate. Palea equaling lemma. Anthers 0.3-0.5 mm. Fl. 7-8. Damp alpine meadows, 2150-2800 m.

Typus: [Turkey A2(A) Bursa] "Hab. in rupestribus regionis alpine Olympi Bithyni sat rara, legi floriferam" [July 1842], Boissier [Holo G!]

N., C. and E. Anatolia.

A2(A) Bursa: above Kilimli Göl, A. Baytop (ISTE 20936)!

A8 Gümüşhane: 23 km N. of Aşkale on road to Trabzon, 2390 m, P. Uotila 19645!

Rize: Cimil, c. 2500 m, viii 1866, Bal. 1543!

B5 Kayseri: Erciyas Da., c. 2150 m, F. Sorger 77-75-15!

C5 Nigde: Bulgar Maden, 22 vii 1855, Bal.

C10 Hakkari: Sat Da. (above Yüksekova), 2800 m, Duncan & Tait 57!

External distribution: Lebanon, Caucasia, Transcaspia, Iran, Afghanistan, W. Pakistan. Euro-Sib. (mt.) element.

2. A. canina L., Sp. Pl. 62 (1753).

Ic: Reichb., Ic. Fl. Germ. 1: t. 74 f. 128 (1850); Hubbard, Grasses 296 (1958).

Laxly caespitose perennial, with stolons. Stem 23-50 (-70) cm, erect to geniculately ascending from base, smooth and glabrous. Leaf blades 2-12 cm x 0.5-4 mm, usually flat, sometimes involute, scabrid; sheaths glabrous; ligule 0.9-4.5 mm, ovate-oblong, acute. Panicle 3.5-11 cm x 0.8-2.2 cm, usually pyramidal to ovate, rather lax; branches patent, scabrous, c. 3 cm, in clusters of 3-6; pedicel 0.4-1.2 mm.

Spikelete 2-2.5 mm. Glumes lanceolate, acute, dark purple, subequal, sometimes scabrid on keel. Lemma 1.7-2 mm, awnless; callus hairs very short. Palea about 1/5 to 2/5 as long as lemma or absent. Anthers 1-1.5 mm. Fl. 7-8. Wet mountain meadows and by streams, 1250-1800 m.

Typus: "In Europae pascuis humidiusculis", /Hb. Linn. 84/12!/

N.W., C. and E. Anatolia.

A2(A) Bursa: Uludag, 1800 m, A. Baytop (ISTE 33691)!

A4 Bolu: Çamkoru, 81 km from Bolu to Ankara, M. Tanker (ISTE 6534)!

Ankara: Kizilcahaman, Alis Da., 1250 m, Khan et al. 572!

B9 Bitlis: Nemrud Da., 10 viii 1906, Azn. 708!

External distribution: N., W., C. and S. Europe, S. Russia, Caucasia, Iran, eastwards to Siberia and E. Asia. Introduced in N. America. Euro-Sib. element.

3. A. planifolia C. Koch in Linnaea 21: 380 (1848).

Syn: A. calamagrostoides Regel in Index Sem. Horti Petrop. 38 (1865);

A. canina var. spiculis-majoribus Bal. in Bull. Soc. Bot. Fr. 21: 12 (1874);

Calamagrostis agrostoides Boiss., Fl. Or. 5: 522 (1884)!;

Calamagrostis agrostoides var. pontica Boiss., Fl. Or. 5: 522 (1884)!;

A. ruprechtii Boiss., Fl. Or. 5: 517 (1884);

A. vinealis subsp. planifolia (C. Koch) Tzvel., Poaceae 337 (1976).

Ic: Fl. U.R.S.S. (transl.) 2: 147, t. 13 f. 3 (1963).

Laxly caespitose perennial, with long stolons. Stem 41-61 cm, usually erect, sometimes slightly geniculate at lower node, glabrous and smooth, rather slender, 2-noded. Leaf blades 6.5-11 cm x 1-3 mm, linear, acuminate, convolute, scabrid on margins and veins; sheaths glabrous; ligule 4-5 mm, obtuse-truncate. Panicle 5.5-9 cm x 0.9-1.8cm,

lanceolate, rather dense, dark purplish; branches 1.5-4.3 cm, erect; pedicels 1-2.5 mm, scabrid. Spikelets 3-3.4 mm, Glumes lanceolate, acute. Lemma 2.2-2.4 mm, elliptic-oblong, dorsally awned; callus hairs 0.2-0.4 mm; awn 3-3.5 mm, slightly geniculate, attached to lemma in lower $\frac{1}{3}$ of its length. Palea absent. Anthers 1.5-1.7 mm. Fl. 8. Wet alpine meadows, 2100 m.

Typus: "Auf dem Südabhange des unteren Kaukasus, auf Trachyt, 1524 m", C. Koch

N.E. and E. Anatolia.

A8 Rize: Cimil, 2100 m, viii 1866, Bal. 621!

A9 Kars: Sarikamis, Grossheim I: Map 167

B8 Mus: Kupak, 20 vii 1916, C. Koch

External distribution: Caucasia, Afghanistan. Euro-Sib. element.

4. A. castellana Boiss. & Reuter, Diagn. Pl. Nov. Hisp. 26 (1842).

Caespitose perennial with short fibrous rhizomes. Stem 18-50 cm, erect to decumbent only at base, glabrous and smooth. Leaf blades 2.5-10 cm x 0.5-1.8 mm, linear, acuminate, flat to involute, glabrous to scabrid on ribs and margins; sheaths glabrous; ligule 1-3.5 mm, ovate. Panicle 5-15 cm x 0.8-6 cm, oblong, lax; branches up to 8 cm, patent, often with spikelets in lower half; pedicels 1-2.3 mm, scabrid. Spikelets 2.3-2.7 mm. Glumes subequal, elliptic, acute, slightly aculeolate on keel, purplish. Lemma 1.6-1.8 mm, usually glabrous, awnless, lateral veins excurrent. Palea more than $\frac{1}{2}$ as long as lemma. Anthers 1.1-1.5 mm.

Key to subspecies

1. Leaf blades flat; spikelets with an awn ..... subsp. castellana

1. Leaf blades involute; spikelets awnless ..... subsp. byzantina

1. subsp. castellana

Ic: Rep. Missouri Bot. Gard. 8, t. 51-56 (1897);

Husnot, Gram. t. 33 (1899).

Fl. 7. Mountain pastures, 1900 m.

Typus: [Spain] "Hab. in collibus et arenosis et dumosis planitiesiet regionis montanae [Hispania] vulgatissima", Reuter [G!]

E. Anatolia.

B8 Mus: S.W. foot of Bingöl Da., 1900 m, D.46203!

External distribution: Mainly S. Europe.

2. subsp. byzantina (Boiss.) Hackel apud Kneucker in Allg. Bot. Zeitschr., 10 (1901).

Syn: A. byzantina Boiss., Diagn. ser. 1 (13): 46 (1853)!;

A. castellana var. byzantina (Boiss.) Hackel in Allg. Bot. Zeitschr., 10 (1901).

Fl. 6-7. Dry hillsides, sea level-600 m.

Typus: "Hab. prope Byzantium, [1844], Noë 225 [Polo G!]

W. and N.W. Anatolia, Turkey-in-Europe.

A2(E) Istanbul: Şişli to Kagithane, Azn. 2374!

B1 Balikesir: Kaz Da., (near Edremit), 600 m, A. Baytop (ISTE 6051)!

B2 Bursa/Kütahya: Kocayayla, between Inegöl and Tavşanli, T. Baytop (ISTE 5688)!

External distribution: Balkan peninsula. Euro-Sib. element.

5. Agrostis gigantea Roth. Fl. Germ. 1: 31 (1788).

Ic: Bor, Fl. Iraq 9: 283, t. 100 (1968);

Hubbard, Grasses 302 (1968).

Loosely tufted perennial with numerous creeping rhizomes. Stem 40-90 (-120) cm, erect or geniculately ascending from base, occasionally

procumbent at base, slender to stout, smooth and glabrous. Leaf blades 3.5-20 cm x 1.3-5 (-8) mm, linear, acuminate, flat, dull green, glabrous to slightly scabrous, firm; sheaths glabrous; ligule 1.5-4 (-6) mm, obtuse at apex, toothed when mature. Panicle 6-28 cm x 1-12 cm, usually pyramidal, very lax; branches up to 9 cm, aculeolate; pedicel 0.7-3.5 mm, clavate. Spikelets 2-3.5 mm, lanceolate, dark purple to brownish. Glumes subequal, lanceolate, acute, dorsally aculeolate. Lemma 1.6-2.5 mm, ovate to oblong, truncate at apex, minutely hairy at base, usually awnless, with a somewhat subterminal awn. Palea $\frac{1}{2}$-$\frac{2}{3}$ as long as lemma. Anthers 1-1.5 mm. Fl. 7-8. Marshy ground, on sand of river bed, mountain slopes, near sea level to 2350 m.

Typus: [Germany] "Ad ripas Visurgis Ducatus Bremensis", Roth

Mainly N. and E. Anatolia.

A2(A) Istanbul: Aydos, A. Baytop ISTE 4129)!

A4 Kastamonu: Ilgaz Da., 1524 m, P. Furse 4171!

A6 Ordu: Çambaşi, 2200 m, Tobey 1425!

A8 Rize d. Ikizdere: Yetimhoca (Cimil), 2100 m, D.21007!

B6 Sivas d. Gürün: Gök Pinar, 1600 m, F. Sorger 77-101-14!

B8 Erzurum: Palandöken D. 25 km from Çat to Erzurum, 2350 m, D.47378!

C9 Van: Başkale to Cölömerik, 50 km from Başkale, 1800 m, McNeill 697!

External distribution: Europe to E. Asia. Introduced in N. America and New Zealand. Euro-Sib. element.

6. A. capillaris L., Sp. Pl. 62 (1753).

Perennial, with short rhizomes at base, bearing more than 3 scale leaves. Stem 8-58 cm, erect to geniculately ascending, smooth. Leaf blades (1.5-) 2-13 (-15) cm x 1-2.5 mm, linear, acute, flat or involute; sheaths smooth; ligule 0.6-2 mm, truncate, ligules of non-flowering shoots shorter than wide. Panicle 2-15 cm x (0.5-) 2-4 cm,

oblong to pyramidal, open and very lax; branches up to 7 cm, patent, usually smooth, somewhat aculeolate; pedicels 1-3 mm, clavate in shape, smooth. Spikelets 1.5-2.5 mm, lanceolate to oblong, purplish-brown to greenish. Glumes lanceolate, acute, equal to subequal, slightly aculeolate on keel. Lemma 1.5-1.8 mm, ovate-elliptic, usually awnless, sometimes with a short dorsal awn; callus shortly hairy. Palea $\frac{1}{2}$-$\frac{2}{3}$ as long as lemma. Anthers 1-1.5 mm. Fl. 6-8. Edge of forests, dry pastures, alpine slopes, 265-2800 m.

Key to varieties

1. Lemma without an awn ..... var. capillaris
1. Lemma with a dorsal awn ..... var. aristata

1. var. capillaris

Syn: A. tenuis Sibth., Fl. Oxon. 36 (1794);
A. vulgaris With., Arrang. Brit. Pl., ed. 3, 2: 132 (1796).

Ic: Hubbard, Grasses 300 (1968);
Zangheri, Fl. Ital 2: 184, f. 6711 (1976).

Described from: In Europae pratis, [Hb. Linn. 84/15!]

N. and Inner Anatolia.

A4 Kastamonu: N. side of Ilgaz Da., 1950 m, D.38332!

A5 Amasya: Ak Da., Kestepe area, 1650 m, K. Alpinar (ISTE 152)!

A7 Giresun: Balaban Da., above Tamdere, 1800 m, D.20501!

A8 Rize: Kaçkar Da., N. side of range, 2591 m, A.J. Riddell et al. 42!

B5 Kayseri: Erciyas Da., 2150 m, F. Sorger 77-75-14!

B6 Sivas: Yildizeli, 1600-1800 m, T. Ekim & A. Düzenli 3760!

B8 Erzurum: Palandöken Da., 2350-2560 m, K.P. Buttler 16120!

. var. aristata (Boiss.) M. Dogan

Syn: A. vulgaris var. aristata Boiss., Fl. Or. 5: 515 (1884).

Typus: "Hab. in alpinis Graeciae, Olympus Thessalus", Aucher 3052

W. Anatolia.

B1 Balikesir d. Edremit: Kaz Da., 25 vii 1967, A. Pamukçuoglu (HUB)!

External distribution: N. Africa, Europe, Caucasia eastwards to Afghanistan. Introduced in N. America.

A specimen identified as A. vulgaris With. collected from N.E. Anatolia (Balansa 619) has a denser panicle and smaller spikelets. During my trip to N.E. Anatolia I have collected similar material from A Rize: Ikizdere (M. Dogan 378). These plants come closest to var. capillaris, but further study is needed to settle their status.

7. A. lazica Balansa in Bull. Soc. Bot. Fr. 21: 12 (1874).

Ic: Fl. Grusii I: t. 13 (1941).

Caespitose perennial, rhizomatous. Stem 5-30 cm, erect to geniculately ascending from base, glabrous and smooth. Leaf blades 2-7.5 cm x 0.8-2 mm, linear, acuminate, plicate, glabrous below, slightly scabrid on veins; sheaths glabrous; ligule 1.5-2 mm, truncate. Panicle 2-8 cm x 0.4-2 cm, narrowly linear to oblong-pyramidal; branches 0.5-3 cm, slender, erect; pedicel 0.5-1.5 mm, glabrous; Spikelets 2-2.5 mm, elliptic to lanceolate, acute, scabrid on keel. Lemma 1.8-2 mm, awned in lower $\frac{1}{3}$; awn 2-2.5 mm, usually straight, exserted; callus hairs 0.1-0.2 mm. Palea 0.8-1 mm. Anthers 0.6-0.8 mm. Fl. 8-9. Alpine meadows, 2500-3300 m.

Typus: "dans la region alpine du Lazistan, 2500 m", Balansa 1543!

/Iso G!/

N.E., C. and E. Anatolia.

B5 Kayseri: Erciyas Da., 2870 m, K.P. & E. Buttler 20208!

B9 Bitlis: Süphan Da., 3300 m, D.24762a!

External distribution: Caucasia. Euro-Sib. (mt.) element.

Often confused with other species, particularly A. balansae, but differing from the latter in its relatively dense panicle, short panicle branches (0.5-1.5 cm) and shorter anthers (0.6-0.8 mm).

8. A. balansae (Boiss.) Tzvel. in Novit. Syst. Pl. Vasc., Acad. Sci. U.R.S.S. 6: 20 (1970).

Syn: Calamagrostis balansae Boiss., Fl. Or. 5: 522 (1844)!;
Penthatherum balansae (Boiss.) Nevski in Acta Inst. Bot. Acad. Sci. U.R.S.S. Ser. I, fasc. 3, 148 (1937).

Caespitose perennial with short rhizomes. Stem 28-75 cm, erect to geniculately ascending from base, glabrous and smooth. Leaf blades (4-) 5-27 cm x 3-6 mm, linear, acuminate, rather lax, glabrous, yellowish green; sheaths glabrous; ligule 3-4.5 mm, obtuse at apex. Panicle 5.5-15 cm x 1.5-3 cm, linear; branches 2.5-5 cm, erect, scabrid; pedicels 1-3 mm. Spikelets 3-3.5 mm, purple. Glumes equal, lanceolate, acute, scabrid on keel. Lemma 2-2.3 mm, denticulate at apex, awned subdorsally; awn 3.2-4 mm, geniculate and twisted below, attached to lemma in lower $\frac{1}{4}$; callus hairs 0.7-1 mm. Palea $\frac{1}{3}$ as long as lemma. Anthers 1.2-1.4 mm. Caryopsis 1.3-1.6 mm. Fl. 7-9. Wet alpine meadows, 2100-2500 m.

Typus: "Hab. in Ponto Lazico supra Djimil, 2100 m, et supra Khabaçkar, 2500 m", [Sept. 1866], Balansa [Syntype G!]

N.E. and E. Anatolia.

A9 Kars: Sarikamiş, 2100 m, D.30781!

External distribution: Caucasia and Soviet Armenia. Euro-Sib. (mt.) element.

9. A. stolonifera L., Sp. Pl. 62 (1753).

Syn: A. alba non L., Sp. Pl. 62 (1753);

A. scabriglumis Boiss. & Reuter, Pugillus 125 (1852)!;

A. karsensis Litw. in Sched. ad Herb. Fl. Ross. 8, fasc. 54: 147 (1922)!;

A. alba var. armena Schischk. in Ber. Tomsk. Staat. Univ. 81: 417 (1929);

A. alba var. karsensis (Litw.) Schischk. in Ber. Tomsk. Staat. Univ. 81: 417 (1929)!

Ic: Kulczynski, Atlas Fl. Polsk. 4 (2): 404 (1932);

Hubbard, Grasses 304 (1968).

Caespitose perennial with numerous long stolons. Stem 30-70 (-120) cm, erect to geniculately ascending from base, glabrous and smooth. Leaf blades (1-) 4-9 (-10) cm x 2-5 mm, linear, acute, usually flat, somewhat involute, smooth to scabrid; sheaths glabrous; ligule 1-5 (-6) mm, obtuse. Panicle 5-24 cm x 1-4 cm, linear-lanceolate to oblong; branches patent up to 8 cm, usually aculeolate; pedicel 0.5-2 mm, aculeolate. Spikelets densely clustered, 1.7-3 mm, greenish to purplish. Glumes aculeolate on keel, lanceolate, acute, equal to subequal. Lemma $\frac{2}{3}$-$\frac{3}{4}$ as long as glumes, ovate-oblong, truncate, usually awnless, rarely with a short subterminal awn. Palea $\frac{1}{3}$-$\frac{2}{3}$ as long as lemma. Anthers 1-1.5 (-2) mm. Fl. 6-8. Moist meadows and wet places, 30-2390 m.

Typus: "Hab. in Europa", [Herb. Linn. 84/14!]

Widespread.

A1(E) Kirklareli: between Demirköy and Igneada, A. Baytop (ISTE 5493)!

A2(E) Istanbul: between Bakirköy and Yedikule, 11 vii 1893, Azn.!

A3 Adapazari: Arifiye, 30 m, D.36255!

A4 Ankara: 2 km S. of Kizilcahamam, 950 m, F. Sorger 77-59-13!

A7 Trabzon d. Maçka: Bekçiler Yayla near Hamsiköy, 1600 m, R. Anşin (ISTE 31281)!

A8 Gümüshane: 23 km from Aşkale to Trabzon, 2390 m, P. Uotila 14700!

B2 Kutahya: between Inegöl and Tavşanli, T. Baytop (ISTE 5688a)!

B3 Afyon: Bayat, Kurtlaralanitepe, 1480 m, M. Vural 78!

B6 Maraş s. Elbistan: Kapidere, D.20403!

B7 Tunceli: Ovacik, 1400 m, D.31437!

B9 Bitlis: Tatvan, 2134 m, Tong 107!

C4 Konya: Aslim Batakligi nr. Cihanbeyli, 900 m, T. Ekim 3337!

C5 Adana d. Feke: Göksu gorge below Himmetli, 700-800 m, D.19830!

External distribution: Europe and Mediterranean area, S.W. Asia to Siberia. Introduced in Japan and N. America.

A. karsensis, borrowed from Leningrad, turned out to be A. stolonifera. A. subaristata, known only from one locality in Turkey (McNeill 781), is not the one described originally by Aitch. & Hemsl. as A. subaristata. It is typical A. stolonifera. Quite a few new varieties have been recognised in this species over the years, but it seems to be difficult to distinguish some of these when large amount of material is examined.

23. x AGROPOGON P. Fourn., Quatre Fl. Fr.: 50 (1934)

Perennial. Leaf blades flat. Ligule membranous. Inflorescence a dense spike-like panicle. Spikelets with 1 floret, sterile, persistent and laterally compressed. Glumes equal, elliptic, 1-veined, chartaceous, scabrid, longer than lemma, with an awn arising from sinus, apex of glume acute not emarginate. Lemma 5-veined, truncate at apex, hyaline with a subterminal awn. Palea 2-veined, hyaline, shorter than lemma. Rhachilla not prolonged. Stamens 3. Caryopsis elliptic.

Type: A. littoralis (Smith) C.E. Hubbard

A. littoralis (Smith) C.E. Hubbard in J. Ecol. 33: 333 (1946).

Syn: Polypogon littoralis Smith, Comp. Fl. Brit. 13 (1816);

Agrostis subaristata non Aitch. & Hensl. in J. Linn. Soc. (Bot.) 19: 192, t. 29 (1881).

Ic: Reichb., Ic. Fl. Germ. I: t. 75 f. 1716 (1850);

Hubbard, Grasses 308(1968).

Perennial. Stem 19-35 (-40) cm, smooth, glabrous, 4-7-noded, geniculately ascending, branches in lower part. Leaf blades 1.6-9 cm x 2-5 mm, linear, acuminate, glabrous; sheaths smooth; ligule 3-5 mm, obtuse at apex, becoming lacerate later. Panicle 3.5-4.3 cm x 7-12 mm, rather dense, somewhat lobed; pedicels 0.5-0.7 mm, scabrid. Spikelets (2-) 2.2-2.5 (-3) mm (excl. awns). Glumes acute, scabrid; terminal awn of glumes 1.5-2 mm. Lemma 1,5 mm, denticulate; awn 1.6-2.1 mm. Palea 1 mm. Anthers 0.5-0.7 mm. Fl. 5-7. Damp places, in saline habitat, sea level.

Typus: "Marit lutos", J.E. Smith

N.W. and S. Anatolia, rare.

A2(A) Istanbul: Kartal, Asn. 2377!

C5 Adana: 1 km N. of Karatas, 5 m, K.P. Buttler 12893!

External distribution: W. & S.W. Europe, Aegean, Romania. Mediterranean element.

This is an intergeneric hybrid between Agrostis stolonifera and Polypogon monspeliensis. In fact it looks more like Polypogon, but differs from the latter in its persistent spikelets.

24. POLYPOGON Desf., Fl. Atlant. 1: 66 (1798)

Annual or perennial. Leaf blades flat. Ligule membranous. Inflorescence a dense panicle, bearing numerous spikelets, oblong-ovoid or cylindrical in outline, sometimes lobed. Spikelets with 1 floret, hermaphrodite, laterally compressed, falling entire at maturity. Glumes subequal, 1-veined, chartaceous, longer than lemma, rounded on back in lower half but keeled above, with a subterminal awn arising from sinus or awnless. Lemma elliptic-truncate, 5-veined, hyaline, shining, awnless or with a short terminal awn. Palea hyaline, 2-veined. Rhachilla disarticulating below glumes, not prolonged beyond floret. Lodicules 2. Stamens 3. Caryopsis elliptic to rounded.

Type: P. monspeliensis (L.) Desf.

Key to Species

1. Glumes unawned; perennial ..... 1. viridis
1. Glumes awned; annual
  2. Lemma awnless; margin of glumes densely ciliate in upper half ..... 2. maritimus
  2. Lemma with a short terminal awn; margin of glume slightly ciliate in upper half ..... 3. monspeliensis

1. P. viridis (Gouan) Breistr. in Bull. Soc. Bot. Fr. 110: 56 (1963).

Syn: Agrostis viridis Gouan, Hort. Monsp. 546 (1762);
Phalaris semverticillata Forskal, Fl. Aeg.-Arab.: 17 (1775);
Agrostis verticillata Vill., Prosp. Pl. Dauph.: 16 (1779);
Polypogon semiverticillatus (Forsk.) Hyl., Nomenkl. ü. Syst. Nord. Gefässpl. in Uppsala Univ. Arsskr. n. 7: 74 (1945).

Ic: Trin. Sp. Gram. 1 (3): 36 (1828); Hubbard, Grasses 306 (1968).

Perennial stoloniferous. Stem 10-90 cm, loosely tufted, smooth

and glabrous, decumbent at base, rooting from lower nodes. Leaf blades 2-13 cm x 1-6 mm, linear, acuminate; sheaths glabrous; ligule up to 5 mm, obtuse to truncate. Panicle 2-10 (-15) cm x 1.2-2 (-3) cm, ovate-oblong or pyramidal, lobed, pale green or purplish; branches semi-verticillately arranged. Spikelets 1.5-1.9 mm, oblong. Glumes elliptic, obtuse, unawned, scabrid on back. Lemma c. 1 mm, denticulate, unawned. Palea as long as lemma. Anthers 0.5-0.7 mm. Caryopsis 0.7-0.8 mm. Fl. 4-8. Damp water meadows, 50-1300 m.

Typus: [France] "Habitat au mont Saint Loup", Gouan.

Widespread.

A1(E) Tekirdag: 25 km from Tekirdag to Marmaraereglisi, D.39260!

A2(E) Istanbul: Şişli to Kagithane, Azn.!

A4 Cankiri: Şabanözü, 1190 m, K.P. Buttler 15543!

A5 Amasya: Kirazlidere, M. Tanker (ISTE 4575)!

A8 Erzurum: 5 km N. of Tortum Göl, 1000 m, D.47635!

B1 Balikesir: Kaz Da., A. Baytop (ISTE 6055)!

B2 Manisa: 13.5 km from Salihli to Ödemiş, 440 m, K.P. Buttler 17288!

B5 Nevşehir: nr. Nevşehir, K. Karamanoglu 5139!

B6 Sivas: 2 km S. of Sincan (Divrigi), 1400 m, F. Sorger 70-27-8!

C2 Denizli: Pamukkale, R. Alava 5298!

C3 Antalya: Alanya, fidanlik road, A. Baytop (ISTE 9584)!

C5 Adana: 8 km from Adana to Karataş, A. Baytop (ISTE 15018)!

C6 Adana: Nur Da., 1200-1300 m, K.P. Buttler 17717!

C7 Adiyaman: 20 km from Adiyaman to Besne, A. Baytop (ISTE 40112)!

C8 Mardin: 23 km S. of Savur, 1000 m, D. Spencer 601!

Is: Gokceada, Todori fountain, 200 m, 17 vi 1976 E. Leblebici & Ö. Seçmen (EGE)!

External distribution: Mediterranean, C. Europe, Crimea, C. Russia, N.W. & C. Iran, Afghanistan, W. Pakistan. Introduced into N. America.

2. P. maritimus Willd. in Ges. Naturf. Freunde Berlin Neue Schr. 3: 442 (1801).

Annual. Stem 2-42 cm, usually tufted, sometimes solitary, erect or geniculately ascending from base, slender and smooth, glabrous, 3-4 noded. Leaf blades 0.5-9 cm x 0.5-5 mm, linear, acuminate, scabrid; sheaths glabrous and smooth, usually the uppermost one inflated; ligule up to 7 mm. Panicle 1-7 cm x 0.5-1.7 cm, oblong, sometimes lobed, often purple-tinged. Spikelets 2-3.2 mm. Glumes 2-fid at apex, lobes acute to acuminate and up to 1.5 mm, pilose on margins, covered by rather stout hairs on dorsal side, especially in lower half; arista arising from sinus, 6-7 mm. Lemma 1 mm, awnless. Caryopsis 0.7-0.9 mm.

Key to subspecies

1. Callus of glumes 0.1-0.2 mm; spikelets 1.7-2.2 mm ..... subsp. maritimus

1. Callus of glumes 0.8-1.5 mm; spikelets 2.5-3.5 mm ..... subsp. subspathaceus

1. subsp. maritimus

Syn: P. monspeliensis var. maritimus (Willd.) Cosson et Dur., Expl. Sci. Alg., Glum. 2: 70 (1855).

Ic: Bor, Fl. Iraq 9: 316, t. 114 (1968).

Fl. 5-6. Sand dunes, serpentine cliff, 0-400 m.

Typus: [France] "Ich erhielt diese Art von Herrn Bonpland, der sie zu Rochelle am Meeresstrand gefunden hat", Willdenow [B!]

W. Turkey, S. Anatolia.

A1(E) Edirne: Enez, sea level, Coode & Jones 2904!

B1 Izmir: Foça, 10 m, K.P. Buttler 17201 !

B1 Manisa: Marmara Göl, Akhisar, H. Peşmen 706!

B1 Izmir d. Menemen: Çamalti, H. Birand (ANK. 1168)!

C1 Mugla: Datça to Marmaris, 20 km from Emecik, 100 m, Dudley 35453!

C2 Denizli: Pamukkale, 400 m, F. Sorger 63-15-32!

C3 Antalya d. Manavgat: Çavus Köy road junction on road to Alanya, A. Baytop (ISTE 9780)!

C5 Adana: Karataş, Regel (ECE 16367)!

External distribution: W. Europe, Mediterranean, Caucasia, N. Iraq, W. Iran, Afghanistan, Turkestan, Sinai, S. Russia, Siberia, E. Asia. Introduced into N. America.

2. subsp. subspathaceus (Req.) Aschers. & Graebn., Syn. Mitteleur. Fl. 2 (1): 162 (1899).

Syn: P. subspathaceus Req. in Ann. Sci. Nat. Bot. 1, 4: 386 (1825); P. maritimus var. longipes Boiss., Fl. Or. 5: 520 (1884).

Ic: Zangheri, Fl. Ital. 2: 184, f. 6689 (1976).

Fl. 4-5. Sandy soil on the coast, sea level.

Typus: "Described from Islands of Laveiro near Bonifacio", P.M. Requien.

Turkey-in-Europe, A. & S. Anatolia.

A2(E) Istanbul: Eyüp to Silahtaraga, Agn. 2379B!

B1 Izmir: Izmir, Bal. 143!

C3 Antalya: Dudenbas, 9 km N. of Antalya, 40 m, E. Hennipman et al. 337!

C4 Antalya: Antalya to Gazipaşa, Hub.-Mor. 14093!

External distribution: Mainly on the Aegean Islands.

3. P. monspeliensis (L.) Desf., Fl. Atl. 1: 67 (1798).

Syn: Alopecurus monspeliensis L., Sp. Pl. 61 (1753).

Ic: Sibth. & Sm., Fl. Graeca 1: t. 62 (1808); Bor, Fl. Iraq 9: 317, t. 115 (1968).

Annual. Stem 6-64 cm, loosely tufted or solitary, smooth and glabrous, erect to geniculately ascending from base, 3-5 noded. Leaf blades 0.5-15 cm x 1-7 mm, linear, acuminate, scabrid on both sides; sheaths glabrous, uppermost one sometimes inflated; ligule 2.5-10 mm. Panicle 1-10 cm x 0.5-3 cm, cylindrical or oblong, sometimes lobed, greenish. Spikelets 2-2.7 mm. Glumes emarginate at apex, ciliate on margins, with a few rather stout hairs on dorsal side especially in the lower half; arista arising from sinus, c. 4-7 mm. Lemma 1-1.1 mm, glabrous, denticulate at apex, with a terminal awn; awn c. 1-1.5 mm. Anthers 0.4 mm. Caryopsis 0.8-0.9 mm. Fl. 4-8. Damp places, in irrigated or waste land, chalky mountain slopes, 0-1200 m.

Typus: [France] "Habitat Monspeli" [Hb. Linn. 82/7!]

Widespread.

A1(E) Edirne: Enez, B. & V. Burbidge 150!

A2(E) Istanbul: Araplidere, near Degirmen Köy, A. Baytop (ISTE 14446)!

A8 Erzurum: 34 km S. of Tortum Göl, 1150 m, D.47510!

B1 Izmir: Inciralti, A. Baytop (ISTE 10014)!

B2 Manisa: between Salihli and Ödemiş, 13.5 km from Salihli, 440 m, K.P. Buttler 17285!

B3 Eskişehir: Turkmen Da., Kizilinler, 800 m, T. Ekim 2205!

B4 Ankara: Sereflikoçhisar, nr. Tuz Gölü, 900 m, S. Erik & A. Güner (HUB)!

B5 Nevşehir: Açiksaray nr. Gulşehir, 1150 m, J. Roper 134!

B6 Malatya: Gürün to Malatya, 40 km S. of Derende, 1000 m, McNeill 438!

B7 Tunceli: nr. Firat river, M. Ranker (ISTE 5575)!

C2 Mugla: Fethiye, E. Leblebici (ISTE 14846)!

C3 Konya: Beyşehir, Kurucuova near Beyşehir Göl, 1200 m, H. Peşmen & A. Güner 2301!

C4 Icel: Silifke, Aliaga Göl, T. Uslu 1445!

C5 Adana: Adana-Karataş road, 14 km from Adana, A. Baytop (ISTE 15034)!

C6 Hatay: 2-3.5 km N. of Iskenderun, D.26954!

External distribution: Europe, Mediterranean, Caucasia, Asia. Introduced into N. America.

25. LAGURUS L., Sp. Pl. 81 (1753)

Annual. Leaf blades flat. Ligule hyaline. Inflorescence a rather dense, ovoid-oblong to subglobose spike-like panicle. Spikelets with 1 floret, laterally compressed. Glumes subequal, rather narrow, terminating in an aristate point, covered by long dense hairs, 1-veined. Lemma 5-veined, membranous, hairy on the callus, with 2-setae at apex, dorsally awned. Palea usually equaling lemma, somewhat shorter, 2-veined, keeled. Rhachilla disarticulating above glumes, prolonged, ciliate. Lodicules 2. Stamens 3. Caryopsis elliptic-oblong.
Type: L. ovatus L.

L. ovatus L., Sp. Pl. 81 (1753).
Ic: Sibth. & Sm., Fl. Graeca 1: t. 90 (1808); Hubbard, Grasses 314 (1968).

Annual. Stem 8-60 cm, erect to ascending from base, simple or branched, slender ± pubescent. Leaf blades 1.4-17 cm x 2-10 mm, linear-lanceolate, acute to acuminate, pubescent; sheaths pubescent, uppermost sheaths inflated; ligule up to 4 mm, obtuse to truncate, ± lacerate, villous. Panicle 1-2 cm x 1-1.7 cm. Spikelets 6-9 mm (excl. awns). Glumes narrowly linear, terminating in an aristate point, persistent, villous on the back. Lemma 3-4 mm (excl. awn and apical setae), lanceolate, with long apical setae up to 4 mm. Awn 10-17 mm, geniculate and twisted in lower half, slightly scabridulous. Palea 3-4 mm, oblong. Anthers 1-2 mm. Fl. 4-6. Sandy soils, 0-50 m.
Described from: "Italia, Gallia, Sicilia, Lustitania" /BM. Hort. Cliff.!/

N. Anatolia, Turkey-in-Europe, W. Anatolia, S. Anatolia, Islands.
A1(E) Tekirdag: between Tekirdag and Malkara, 3-50 m, D.34672!

A2(E) Istanbul: Kilyos, Simen deresi, A. Baytop (ISTE 17721)!

A6 Samsun: near Kizilay camp site, 5 m, Tobey 255!

B1 Izmir: Urla, 23 iv 1962, G. Regel (ISTE 12394)!

C1 Mugla d. Marmaris: E. of Datça, sea level, D.41343!

C3 Antalya: Alanya-Manavgat road, Çavuşköyü road junction, A. Baytop (ISTE 9781)!

C5 Içel: 27 km from Silifke to Içel, sea level, Coode & Jones 1088!

Is. Rodhos: Faliraki, B. & V. Burbidge 126!

Tokmakia island (N.E. of Lesvos): Aspronisos, 30 m, J.R. Edmondson 2528!

External distribution: Mainly Mediterranean area, but occuring in Crimea and Transcaspia.

26. GASTRIDIUM P. Beauv., Ess. Agrost. 21 (1812)

Annual. Leaf blades flat. Ligule membranous. Inflorescence a spike-like panicle, cylindrical, sometimes lobed. Spikelets with 1 floret, laterally compressed, hermaphrodite. Glumes subequal to unequal, subulate, acute, shining, swollen and coriaceous at base, membranous above, 1-veined. Lemma 5-veined, elliptical, truncate-dentate at apex, much shorter than glumes, ± hairy on dorsal surface or glabrous, usually with a twisted subterminal awn or awn absent. Palea 2-veined, keeled, equaling lemma. Rhachilla disarticulating above the glumes at maturity, very shortly prolonged. Lodicules 2. Stamens 3. Caryopsis elliptic. Type: G. australe Beauv. [= G. ventricosum (Gouan) Schinz et Thell.]

Key to Species

1. Lemmas usually glabrous and awnless; panicle 0.4-0.7 cm wide, strongly contracted ..... 1. scabrum
1. Lemmas usually ± hairy on dorsal surface, with a subterminal awn; panicle 0.6-1.4 cm wide, not contracted
   2. Spikelets (5-) 6-8 mm; awns 6-8 mm ..... 2. phleoides
   2. Spikelets 2.5-5 mm; awns up to 4 mm ..... 3. ventricosum

1. G. scabrum C. Presl, Fl. Sic. 21 (1820).

Ic: Fiori, Ic. Fl. Ital. 1: 23, f. 194 (1895) as G. lendigerum var. scabrum; Zangheri, Fl. Ital. 2: 184 f. 6692 (1976).

Annual. Stem 3.5-40 cm, erect or geniculately ascending from base, usually tufted, simple or branched, glabrous. Leaf blades 2.5-21 cm x 1-4 mm, linear, acuminate, glabrous; sheaths glabrous; ligule 1-3.5 mm. Panicle 2-5 cm x 0.4-0.7 cm, contracted. Glumes subequal, coriaceous, scabrid on keel, acute, 2.5-3 mm. Lemma 1-1.2 mm, glabrous, awnless.

Palea equaling lemma. Anthers 0.7-0.8 mm. Fl. 5-7. Dry places on coast or nearby, sea level.

Typus: [Sicily] "Hab. in arvis incultis Panormi", Presl.

N.W. Anatolia.

A2(E) Istanbul: Halkali to Safraköy, 19 vi 1898, Azn.! Yeniköy, 23 vi 1895, Azn.!

A2(A) Istanbul: Erenköy, 6 vii 1897, Azn.! Aydos, 21 v 1952, A. Berk & T. Baytop (ISTE 4000)! Maltepe, 4 vi 1961, A. Baytop (ISTE 6704)!

External distribution: N.W. Africa, Spain, S. France, Italy, Greece, Aegean, Latakia. Mediterranean element.

2. G. phleoides (Nees & C.A. Meyer) C.E. Hubbard in Kew Bull. 9: 375 (1954).

Syn: Lachnagrostis phleoides Nees & C.A. Meyer in Nova Acta Acad. Leop.-Carol. 19, Suppl. 1: 146 (1843);

G. ventricosum subsp. phleoides (Nees & C.A. Meyer) Tzvelev in Bot. Churn. 51, 8: 1104 (1966).

Ic: Bor, Fl. Iraq 9: 305, t. 110 (1968).

Annual. Stem 20-35 cm, usually simple, sometimes branched, solitary or loosely tufted, erect or geniculately ascending from base, smooth and glabrous. Leaf blades 2-12 cm x 0.9-2.3 mm, linear, acuminate, scabrous; sheaths smooth; ligule 4-6 mm, acute. Panicle 3.5-11 cm x 0.6-1.3 cm, rather dense, shining. Spikelets (5-) 6-8 mm. Glumes unequal, acuminate; lower glume 4.5-6.4 mm; upper glume 5.7-8 mm. Lemma 1-1.3 mm, densely pilose on dorsal surface; awn 6-8 mm. Palea equaling lemma. Anthers 0.5-0.6 mm. Fl. 5-7. In fallow fields, roadsides, 65 m.

Typus: [Chile] "Valparaiso in republica Chilensi", Meyer.

Mainly W. & S. Anatolia.

A2(A) Istanbul: Büyük ada, 27 v 1905, Azn.!

B1 Çanakkale: Kaz Da., Papazli, Sint. 964!

C1 Aydin: Dilek peninsula, Ilyas Da., 65 m, T. Uslu 3611!

C2 Mugla: Marmaris, Khan et al. 15!

C3 Antalya: Aytop between Demirtaş and Gazipaşa, A. Baytop (ISTE 9705)!

C4 Içel: Kaledran (Anamur), A. Baytop (ISTE 9727)!

C5 Icel: Buluklu, 8 vi 1855, Bal.!

External distribution: Cyprus, Palestine, N. Iraq, N. & W. Iran. Introduced into N. America.

3. G. ventricosum (Gouan) Schinz et Thell. in Viert. Naturf. Ges. Zurich 58: 39 (1913).

Syn: Agrostis ventricosa Gouan, Hort. Monsp. 39 (1762);
Milium lendigerum L., Sp. Pl. ed. 2, 91 (1762);
Gastridium australe Beauv., Ess. Agrost. 164 (1812);
Gastridium lendigerum (L.) Desv., Obs. Pl. Angers: 48 (1818);
Gastridium lendigerum (L.) Gaud., Fl. Helv. 1: 176 (1828).

Ic: Reichb., Ic. Fl. Germ. 1: t. 73 f. 122 (1850) as G. lendigerum; Hubbard, Grasses 312 (1968).

Annual. Stem 6-45 cm, erect or geniculately ascending from base, simple or branched at base, smooth and glabrous, 2-4 noded. Leaf blades 1.5-7 cm x 0.9-3 mm, linear, acuminate, glabrous, slightly scabrid on upper surface; sheaths glabrous; ligule 1-3 (-6) mm, acute. Panicle 2-8 cm x 0.7-1.4 cm, dense, sometimes lobed. Spikelets 3-5 mm. Glumes unequal, slightly scabrid on keel, constricted above ventricose base; lower glume 2.4-3.5 mm; upper glume 3-5 mm. Lemma c. 1 mm, sparsely hairy on sides, with a subterminal awn; awn 3-4 mm. Anthers 0.7-1 mm.

Caryopsis 0.6-0.9 mm. Fl. 4-5. Grassy open hillsides, arable fields, 0-490 m.

Type: [France] "Hab. Monspelii au Puy de Loup et a droite au dela de Prades", Gouan.

Turkey-in-Europe, W. & S. Anatolia, Islands.

A1(A) Balikesir: Avsa Adaşi, A. Çubukçu et al. (ISTE 10501)!

A2(E) Istanbul: Balta liman, 10 vi 1892, Azn.!

A2(A) Istanbul: Burgaz Adasi, A. Baytop (ISTE 6724)!

C1 Aydin: Erbeyli, Çariklar, 490 m, T. Uslu 5145!

C4 Antalya: nr. Gazipaşa, A. Baytop (ISTE 9720)!

Is. Rhodos, 450 m, Reich 7262!

Kos: C. Psalidi, A. Hansen et al. 265

External distribution: W. & C. Europe, Mediterranean, Syrian desert, N. Iraq.

27. TRIPLACHNE Link, Enum. Hort. Berol. Alt. 2: 241 (1833)

Annual. Leaf blades flat. Ligule membranous. Inflorescence a spike-like panicle. Spikelets with 1 floret, laterally compressed. Glumes subequal, longer than floret, 1-veined, not swollen at the base. Lemma very short, 5-veined, scarious, with a geniculate subdorsal awn, 2 outer veins excurrent at truncate apex. Palea equaling lemma. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis elliptic.

Type: T. nitens (Gussone) Link

T. nitens (Guss.) Link, Enum. Hort. Berol. Alt. 2: 241 (1833).

Syn: Agrostis nitens Guss., Fl. Sic. Prodr. 1: 60 (1827);
Gastridium nitens (Guss.) Cosson & Dur. ex Coss. in Ann. Sci. Nat. Ser. 4, 1: 229 (1854).

Ic: Fiori, Ic. Fl. Ital. 1: 23, f. 195 (1895); Zangheri, Fl. Ital. 2: 184, f. 6693-6694 (1976).

Annual. Stem 4-25 cm, erect or geniculately ascending from base, usually with 4 nodes. Leaf blades 1-7 cm x 1-3.5 mm, linear, acute, scabrid; sheaths somewhat inflated; ligule up to 3 mm, obtuse. Panicle 1-5 cm x 0.5-1.3 cm, cylindrical to ovoid, sometimes elliptic; pedicels 0.8-3.5 mm, slightly scabrid. Spikelets 3.5-4 mm. Glumes lanceolate, acute, subventricose, scabrid on keel; lower glume 3.1-3.5 mm; upper glume 3.7-4 mm. Lemma 1.2-1.5 mm, ovate, denticulate at apex, villous on dorsal side; awn 3.3-4 mm, brown and twisted in lower half, hyaline in upper half; apical setae about as long as lemma; callus shortly hairy. Anthers 0.5-0.7 mm. Fl. 5. Sandy soil near sea, sea level.

Typus: [Sicily] "In herbidis, et arenosis maritimis; Trapani tra l'Acquedotto ed il mare, S. Croce alla Spiaggia del Braccetto" Gussone.

S. Anatolia.

C5 Içel: Viranşehir, A. Baytop (ISTE 15113)!

C5 Içel: Anamur, v 1872, Peronin 124!

External distribution: Mediterranean area. Mediterranean element.

28. MILIUM L., Sp. Pl. 61 (1753)

Annual or perennial. Leaf blades flat. Ligule hyaline. Inflorescence a panicle. Spikelets with 1 floret, hermaphrodite, elliptic, slightly compressed dorsally. Glumes equal, persistent, membranous, longer than floret, rounded on dorsal side, 3-veined. Lemma 5-veined, coriaceous, shiny, enveloping palea, rounded on dorsal surface, without an awn. Palea 2-veined, equalling lemma, coriaceous. Rhachilla disarticulating above the glumes. Lodicules 2. Stamens 3. Caryopsis elliptic.

Type: M. effusum L.

Key to Species

1. Annual; stem 10-50 cm; leaf blades 1-5 mm wide; ligule acute
   2. Pedicels 0.5-5 mm ..... 4. vernale
   2. Pedicels usually 8-25 mm ..... 3. pedicellare
1. Perennial; stem 60-120 cm; leaf blades 5-14 mm wide; ligule obtuse
   3. Panicle branches rather effuse; spikelets green; glumes glabrous ..... 1. effusum
   3. Panicle branches ± patent to erecto-patent; spikelets dark green to purplish; glumes scabrid ..... 2. schmidtianum

1. M. effusum L., Sp. Pl. 61 (1753).

   Ic: Hubbard, Grasses 276 (1968); Reichb., Ic. Fl. Germ. 1: t. 73, f. 159 (1850).

Perennial. Stem 60-120 cm, loosely tufted, erect, sometimes slightly bent at base, slender to stout, 3-5-noded, smooth and glabrous. Leaf blades 8-28 cm x 5-14 mm, linear, acuminate, dull green, glabrous but slightly rough on margins and veins; sheaths smooth, shorter than internodes; ligules 3-5 mm, obtuse. Panicle 18-22 cm x 7-11 cm,

lanceolate to ovate or oblong, very loose; branches 1.5-7.5 cm; pedicels (1-)2.5-6 mm. Spikelets 3-3.8 mm, elliptic to ovate. Glumes green, whitish, glabrous, ovate to elliptic-ovate, acute. Lemma lanceolate to elliptic from back view. Anthers 2-3 mm. Fl. 6-7. Moist soil inside forest.

Typus: "Hab. in Europae nemoribus umbrosis" [Hb. Linn. 83/3!]

Turkey-in-Europe and N.W. Anatolia.

A1(E) Kirklareli: near Demirköy, A. Baytop (ISTE 5418)!

A2(A) Bursa: above Bursa, vii 1874, Pichler 252!

External distribution: Europe, Cyprus, Caucasia, C. Russia, Siberia, Afghanistan, W. Pakistan, E. Asia. Introduced into N. America.

2. M. schmidtianum C. Koch in Linnaea 21: 438 (1848).

Syn: M. caucasicum Somm. et Levier in Nuovo Gior. Bot. Ital. 4: 209 (1897).

M. effusum subsp. schmidtianum (C. Koch) Tzvelev, Poaceae 294 (1976).

Perennial, with thick creeping rhizomes. Stem 80-120 (-150) cm, erect solitary, smooth, glabrous all over but scabrid just below the nodes, 4-6 noded. Leaf blades 6-20 (-30) cm x 4-9 (-15) mm, linear, acuminate, flaccid, glabrous all over but slightly scabrid on the margins; sheaths glabrous; ligule 4-5 mm, obtuse. Panicle 10-23 cm x 1-8 cm, rather contracted and dense; branches 2-7.5 cm, arranged semi-verticillately; pedicels 0.7-3 mm, densely scabrid. Spikelets 3.5-4 mm, elliptic. Glumes densely scabrid, usually dark-green to purplish. Lemma 2.4-3.2 mm, elliptic, obtuse. Anthers 2.2-2.8 mm. Fl. 8. Subalpine meadows, 2000 m.

Typus: [Crimea & Caucasia] "Hab. in Tauria et provinciis caucasicis" M. bieberstein (LE).

N.E. Anatolia.

A8 Rize: Cimil, 2000 m, 8 viii 1866, Bal.!

External distribution: Caucasia, W. Iran.

3. M. pedicellare (Bornm.) Rozhev. ex Melderis in Rech. fil., Ark. Bot. ser. 2, 2: 291 (1952).

Syn: M. vernale M. Bieb. var. pedicellare Bornm. in Beih. Bot. Centr. 31: 267 (1914).

Ic: Bor, Fl. Iraq 9: 279, t. 98 (1968); Bor, Fl. Iranica (Gramineae) 70: t. 39 (1970).

Annual. Stem 30-50 cm, erect, solitary, smooth and glabrous, 3-noded. Leaf blades 3-8 cm x 2-4 mm, linear, acute, rounded at base, flaccid; ligule 3-5 mm, acute. Panicle 9-17 cm x 2-13 cm, rather lax, flabelliform; branches up to 8 cm or longer, ascending, finally spreading almost at right angles; pedicels (3-) 8-25 mm, very scabrid. Spikelets 2.8-3.4 mm, elliptic, green. Glumes slightly scabrid on back, membranous. Lemma 2-2.1 mm, elliptic, obtuse, very smooth, glabrous and shining. Anthers c. 1.5 mm. Fl. 5. Mountain slopes, with Quercus & Juniperus, on limestone, 1000-1400 m.

Typus: [Lebanon] "Antilibanon, westl. Abhange bei Baalbek, 12-1300 m, Bornmüller 12925".

S. & S.E. Anatolia.

C4 Içel: Mut, Adras Da. between Mut and Ermenek, 1300 m, Coode & Jones 969!

C8 Mardin: 19 km from Mardin, 930 m, H. Birand 86!

C9 Mardin: Cudi Da., above Hessana (d. Silopi), 1200-1400 m, D. 42857A!

External distribution: Cyprus, Palestine, Lebanon, Syrian Desert, W. Iran. Ir.-Tur. element.

4. M. vernale M. Bieb., Fl. Taur.-Cauc. 1: 53 (1808).

Annual, with frbrous roots. Stem 10-50 cm, erect, slender, glabrous, smooth or scabrid at nodes, usually 2-noded in lower half, often branched at base. Leaf blades 2-7 cm x 1-5 mm, linear, acute to acuminate, glabrous, green; sheaths scabrid, often purplish, with a wide scarious margin; ligule 2-4 mm, acute. Panicle 7-12 cm x 2-10 cm, rather lax; branches 1.5-7 cm, erect to erecto-patent; pedicels 0.5-4 (-5) mm. Spikelets 2-3.3 mm, bright green or purplish, elliptic. Glumes ovate, acute, scabrid. Anthers 1.3-1.8 mm.

Key to subspecies

1. Panicle branches 1-3.5 cm; spikelets 2.3-2.5 mm
..... subsp. vernale

1. Panicle branches 3-7 cm; spikelets 3-3.3 mm
..... subsp. montianum

subsp. vernale

Ic: Bor, Iraq 9: 277, t. 97 (1968); Reichb., Ic. Fl. Germ. 1: t. 87 f. 160 (1850).

Fl. 4-5. Calcareous steppe, inside Quercus woodland, 200-1100 m.

Typus: Described from Caucasia [Iso K!]

Turkey-in-Europe, W. and S. Anatolia, Islands.

A1(E) Kirklareli: Kirklareli to Pinarhisar, 200 m, D. 41981!

B1 Çanakkale: Kaz Da., Sint. 1883: 269!

C2 Antalya: Elmali, 18 v 1860, E. Bourgeau!

C6 Gaziantep: Dülük Baba, 7 km N. of Gaziantep, 1100 m, D. 28058!

Is. Lesvos: Mt. Ordimnos, at Ipsilon monastery, 500 m, J.R. Edmondson 2637!

External distribution: W. and C. Europe, Mediterranean, Crimea, Caucasia, N. Iraq, N. and W. Iran, S. Russia, Turkestan.

2. subsp. montianum (Parl.) Jahandiez & Maire, Cat. Pl. Maroc. 1: 36 (1931).

Syn: M. montianum Parl., Fl. Ital. 1: 156 (1848).

Fl. 5-6. Rocky mountain slopes, inside Pinus nigra forest, wet places, 620-1750 m.

Typus: /Sicily/ "Ficuzza al bosco del Cappidderi e al bosco di Pizzo nero e nelle Madonie".

W., C. and S. Anatolia.

A3 Ankara: Beypazari, Cuma De. near Seytan bridge, Y. Akman 10!

A4 Ankara: Kizilcahamam, Çamkoru, K. Karamanoglu 5228!

B1 Izmir: Kemalpaşa to Ovaçik, 620 m, F. Holtz (EGE 12747)!

B3 Konya: Sultan Da., Domuz Y., 1700 m, A. Baytop (ISTE 29353)!

C3 Isparta: Egridir, 2 km S. of Yaka Köy, 1400-1500 m, H. Peşmen & A. Güner (HUB 1261)!

C4 Içel: Mut, Sertavur pass, 1600 m, M. Dogan 179!

C6 Hatay: Dörtyol, Karagöz Y., 1750 m, Y. Akman 68!

External distribution: Aegean, Cyprus, W. Syria, N. Iraq, N. Iran.

29. ZINGERIA P. Smirnov in Bull. Soc. Nat. Mosc. n.s., 67 (1946)

Annual. Leaf blades convolute to flat. Ligule hyaline. Inflorescence a lax panicle. Spikelets with 1 floret, hermaphrodite, small, dorsally compressed. Glumes subequal, membranous, as long as floret or slightly shorter, ovate to elliptic, acute to obtuse at apex but sometimes upper glume terminating in a mucro; lower glume 1-veined; upper glume 3-veined. Lemma elliptic, 3-veined, covered by clavate hairs on dorsal surface, becoming chartaceous later. Palea 2-veined, like lemma. Rhachilla disarticulating above glumes, not prolonged beyond the floret. Lodicules 2. Stamens 3. Caryopsis elliptic to ovate. Type: Z. biebersteiniana (Claus) P. Smirnov

Key to Species

1. At least 10-20 branches arising from each node; upper glume with a mucro ..... 3. verticillata
1. Only a few branches arising from each node; upper glume usually acute
   2. Panicle branches erecto-patent; pedicel 0.7-4 (-8) mm; glumes with large hyaline margins ..... 1. pisidica
   2. Panicle branches effusus; pedicel 5-13 mm; glumes without hyaline margins ..... 2. trichopoda

1. Z. pisidica (Boiss.) Tutin in Bot. J. Linn. Soc. 76: 365 (1978).

Annual. Stem 4-41 cm, erect, glabrous, smooth and slender, usually tufted, 2-3-noded. Leaf blades 2-14 cm x 1-3 mm, linear, acuminate; sheaths glabrous; ligule 1-3 mm, obtuse. Panicle 2-16 cm x 2-7 cm, rather lax; branches 1.5-10 cm, erecto-patent; pedicels 0.8-8 mm, clavate and glabrous. Spikelets 1.5-2.3 mm. Glumes ovate, acute, largely hyaline on margins. Lemma as long as glumes.

Anthers 0.5-0.8 (-1) mm. Caryopsis 1.5-1.6 mm, ovate-elliptic.

Key to subspecies

1. Spikelets 1.7-2.3 mm; branches relatively long, patent; pedicels 1.5-4 mm ..... subsp. pisidica

1. Spikelets 1.5-1.6 mm; branches short, making 90° angle with main axis; pedicels 0.7-2 (-2.5) mm ..... subsp. poaeforme

subsp. pisidica

Syn: Agrostis pisidica Boiss. in Tchihat., Asie Min. Bot. 2: 625 (1860);
Agrostis trichoclada var. pisidica Boiss., Fl. Or. 5: 516 (1884)!

Ic: Tchihat., Asie Min. Bot. (& Atlas) 2: 625, t. 43 (1860)!

Fl. 5-8. Wet grassy meadows, rocky open slopes with scattered P. nigra, marshes, inside ditch, 1350-2400 m.

Typus: [Turkey C3 Isparta] "Hab. in Pisidia inter Tchukur et Ahyrkievi ad extremitatem meridionalem lacus Egridir" [1854], Tchihatcheff [Holo G!]

N.E. and Inner Anatolia, rare in S. Anatolia.

A3 Ankara: Beypazari, 1600 m, Y. Akman 15!

A4 Ankara: Karagöl, 72 km N. of Ankara, 1600 m, Coode & Jones 2197!

A7 Giresun: Balaban Da., above Tamdere, Avşar Y., 2400 m, D.20660!

A9 Kars: Yalnizçam, 1900 m, D.30298!

B3 Eskişehir: Türkmen Da., Hasar De., 1300 m, T. Ekim 2231!

B6 Sivas: Yildizeli, 1350 m, A. Baytop (ISTE 29653)!

B9 Bitlis: Tatvan, 1829-2134 m, Tong 105!

C5 Nigde: Pertek, 2000 m, W. Siehe 594!

External distribution: Romania, Caucasia.

subsp. poaeforme (Boiss.) M. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: Milium trichopodum var. poaeforme Boiss., Fl. Or. 5: 511 (1884)!

Fl. 6. Open places in Pinus sylvestris forest, slopes, 1200-1350 m.

Typus: [Turkey B2 Uşak] "Hab. in campis humidis ad Yachamichlar koui prope Ouchak Phrygiae, 1200 m", [5 vi 1857] Balansa 1331 [Iso. M!]

C. Anatolia.

A4 Ankara: Kisilcahaman, A. Bayton (ISTE 15492)!

B3 Eskişehir: Sündiken Da., Çatacik, 1350 m, T. Ekim 934!

Endemic.

2. Z. trichopoda (Boiss.) P. Smirnov in Bull. Soc. Nat. Mosc. n.s. 2, 51: 67 (1946).

Annual. Stem 8-38 cm, erect, smooth, glabrous, 3-noded. Leaf blades 0.8-7 cm x 0.4-2 mm, linear, acuminate; sheaths glabrous; ligules 0.9-3.5 mm, obtuse. Panicle 4-15 cm x 3-18 cm, rather diffuse; branches 1.5-10 cm, erecto-patent, trichotomously arranged; pedicels 5-13 mm, clavate, glabrous. Spikelets 1.3-2 mm. Glumes mainly elliptical, acute to subobtuse, glabrous. Anthers 0.5-0.7 mm. Caryopsis ovoid, with pitted surface.

Key to subspecies

1. Spikelets 1.6-2 mm; leaf baldes flat; glumes ovate-elliptic, acute ..... subsp. trichopoda

1. Spikelets 1.3-1.5 (-1.6) mm; leaf blades convolute; glumes ovate, obtuse ..... subsp. bieberstainiana

subsp. trichopoda

Syn: Milium trichopodum Boiss., Diagn. Ser. 1 (13): 45 (1854)!

Ic: Bor, Fl. Iraq 9: 281, t. 99 (1968);

Bor, Fl. Iranica (Gramineae) 70 t. 40 (1970).

Fl. 6-7. Edge of marshy fields and damp places, 1300-2300 m.

Typus: [Turkey C7 Urfa] "Siverek, 1841", Kotschy: 41 [Iso. K!]

Inner, S. and E. Anatolia.

B6 Sivas: Pinirhisar to Gürün, 30 km from Gürün, 1600 m, A. Baytop (ISTE 37725)!

B6 Malatya: Kangal to Hekimhan, 1300 m, Stn. & Hend. 5384!

B6 Kayseri: Binboga Da., S.W. of Saris, 2300 m, E.M. Rix 684!

B9 Bitlis: Pelli, 2200 m, D.22399!

C6 Adana: 56 km N. of Saimbeyli, 1520 m, Hub.-Mor. 11632!

C10 Hakkari: 30 km from Semdinli to Yüksekova, 1950 m, D.45059!

External distribution: Syrian Desert, N. Iraq, Caucasia, N. and W. Iran, Transcaspia, Siberia.

subsp. bieberesteiniana (Claus) M. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: Agrostis bieberesteiniana Claus in Beitr. Pfl. Russ. Reich. 8: 264 (1851);

Agrostis trichoclada Griseb. in Ledeb., Fl. Ross. 4: 439 (1852).

Fl. 7. Open places in Quercus infectoria wood, volcanic rocky places, 1650-1750 m.

Typus: [Caucasus] "Circa Sareptam, 1850", K. Claus [Iso LE!]

E. Anatolia.

A8/B8 Erzurum: Tasligedik, 24 vii 1916, Sapozhnikov

A9 Kars: Sarikamis, 7 vii 1916, Sapozhnikov

B9 Bitlis: Tatvan, Sorgun above Lake Van, 1650-1750 m, H. Pesmen 2990!

B9 Mus: Malazgirt, 10 vi 1916, Saposhnikov

External distribution: Crimea, Caucasia, S.E. Russia.

3. Z. verticillata (Boiss. et Bal.) Chertek in Novit. Bot. Horti. Bot. Univ. Carol. Prag. 1963, 3 (1963).

Syn: Milium verticillatum Boiss. et Bal., Diagn. ser. 2 (4): 126 (1859)!

Annual. Stem 11-28 cm, erect, usually tufted, sometimes solitary, 2-noded, rather rigid. Leaf blades 0.8-4 cm x 1-2 mm, narrowly linear, acuminate; sheaths glabrous; ligule 1.5-4 mm, acute. Panicle 2-12 cm x 0.2-7.5 cm, pyramidal; branches up to 5 cm, verticillately arranged, 3-17 branches from same node; pedicels 4-23 mm, glabrous, slender, Spikelets 1.8-2 (-2.2) mm. Lower glume 1.3-1.5 mm, lanceolate, acute. Upper glume 1.6-1.8 mm, ovate to oblong, mucronate. Lemma larger than glumes, ovate to oblong, obtuse. Palea as long as lemma. Anthers 0.6-0.7 mm. Caryopsis c. 1.3 mm, ovate. Fl. 6-7. Hillsides, 1200 m.

Typus: [Turkey B2 Kütahya] "Hab. in pratis regionis montanae jugorum Almadagh et Mourad dagh Phrygiae, 1200 m", Balansa [Holo G!]

Anatolia.

B3 Afyon: Bayat, S. slope of Otlugedik, 1550 m, M. Vural 82!

B3 Ankara: Aydos Y., H. Bagda (ANK 988)!

Endemic.

30. ANTHOXANTHUM L., Sp. Pl. 28 (1753)

Annual to perennial, smelling of coumarin. Leaf blades flat. Ligule hyaline. Inflorescence a spike-like panicle. Spikelets laterally compressed, with 3 florets, uppermost floret fertile, other two lower florets sterile. Glumes unequal, membranous; lower glume 1-veined, ovate; upper glume 3-veined, ovate-elliptic, as long as spikelet. Lemmas of sterile florets 3-veined, with a dorsal awn, 2-lobed at apex and each lobe obtuse, adpressed pilose. Lemma of fertile floret awnless, 5-7-veined, shorter than others. Palea 1-veined. Rhachilla disarticulating above glumes. Lodicules absent. Stamens 2. Caryopsis elliptic in side view. Embryo $\frac{1}{4}$ as long as caryopsis.

Type: A. odoratum L.

Literature:

Teppner, H. 1969. Anthoxanthum alpinum und seine Verbreitung in der Steiermark. Phyton 13: 305-312.

Teppner, H. 1970. Karyotypen europäischer, perennierender Rippen der Gramineen-Gattung Anthoxanthum. Österr. Bot. Zeitschr. 118: 280-292.

Key to Species

1. Perennial, with non-flowering shoots at anthesis ..... 1. odoratum
1. Annual without non-flowering shoots at anthesis
   2. Spikelets 9-12 mm; awn of upper sterile floret 20-22 mm; panicle rather loose, bearing 4-9 spikelets ..... 2. gracile
   2. Spikelets 6-7 mm; awn of upper sterile floret 7-7.5 mm; panicle dense, bearing more than 9 spikelets ..... 3. aristatum

1. A. odoratum L., Sp. Pl. 28 (1753).

Caespitose perennial. Stem 10-47 (-100) cm, erect, 1-3-noded, smooth. Leaf blades 1-16 cm x 2-6 mm, linear, acuminate, glabrous to puberulent; ligule 1-4 (-5) mm, obtuse. Panicle 2-7 cm x 7-20 mm, oblong-cylindrical to ovate, green to purple. Spikelets 6-9 (-10) mm, lanceolate. Glumes persistent with green keel; lower glume 3.7-4.8 (-5) mm; upper glume 5.8-9 mm, enclosing florets. Lemmas of sterile florets 3-4 mm, narrowly oblong, brownish all over except 2-lobed white membranous apex; lower lemma awned above middle, awn 2-3 mm, straight; upper lemma subdorsally awned, awn 7-9 mm, geniculate, strongly twisted below. Lemma of fertile floret 2-2.5 mm, awnless, suborbicular, smooth shining. Palea as long as lemma. Anthers 3-4.6 mm.

Key to subspecies

1. Leaf blades pilose; glumes adpressed-puberulent .. subsp. odoratum
1. Leaf blades and glumes glabrous ..... subsp. alpinum

subsp. odoratum

Ic: Trin. Sp. Gram. 1 (2): 14 (1828);

Hubbard, Grasses 270 (1968).

Fl. 4-5. Dry dune slacks, grassy banks, in shade of P. nigra, 10-1500 m.

Described from in Europae pratis, /Hb. Linn. 46/1!7

Turkey-in-Europe, W. and S.W. Anatolia.

A1(E) Edirne: 3 km from Süloglu to Kavankaya, A. Baytop (ISTE 31802)!

A2(E) Istanbul: Belgrad forest, Kayacik 40!

B1 Izmir: Yamanlar Da., 1000 m, Dudley 34897!

C1 Aydin: d. Selçuk: Çamlik to Yeniköy, 250 m, T. Uslu 4450!

C3 Antalya: nr. Akseki, A. Pamukçuoglu & Quezel (HUB)!

C3 Isparta: Egridir, 2 km S. of Yaka köy, 1400-1500 m, H. Peşmen & A. Güner 1312!

Is. Psara: 10-20 m, W. Greuter 10939!

Lesvos: 1 km W. of Ayiassos, S. of Kasteli, 550 m, J.R. Edmondson 2251!

External distribution: N.W. Africa, N.S. and C. Europe, Crimea, S. and C. Russia.

subsp. alpinum (A. et D. Löve) B. Jones et Meld. in Proc. Bot. Soc. Brit. Is. 5, 4: 376 (1964).

Syn: A. odoratum var. alpinum Max. et Uechtr. in Flora 5, 2: 426 (1866); A. alpinum A. et D. Löve in Rep. Dept. Agric. Univ. Inst. Appl. Sci. (Reykjavik) ser. B, 3: 105 (1948).

Fl. 6-8. On peaty grassy banks, granite slopes, marshy area in clearing of Fagus woods, 1000-3000 m.

Typus: "Reg. alp. montis Njullas Laplandiae" Löve et Löve 347.

Mainly N. Anatolia, rarely W. and C. Anatolia.

A3 Bolu d. Ala Da.: Kartal Kaya, 2000 m, Khan et el. 495!

A7 Trabzon: Zigana Pass, 1920 m, E.K. Balls 392!

A8 Rize: between Rize and Ispir, 3000 m, Stn. & Hend. 6270!

Artvin: dist. Murgul, Magara Y., Şavval Tepe, 3000 m, Stn. & Hend. 6052!

B2 Kütahya: Simav, Kicir to Akdag, 1900 m, Coode & Jones 2742!

B3 Eskişehir: Sündiken Da. Atalan tekke, 1000 m, T. Ekim 918!

External distribution: N. and C. Europe, Caucasia, Iran, Transcaspia, Siberia.

2. A. gracile Biv., Stirp. Rar. Sic. Descr. 1: t. 1 fig. 1 (1813).

Ic: Trin. Sp. Gram. 1 (2): 13 (1828);

Fiori, Ic. Ital. 1: 18, f. 154 (1895).

Annual. Stem 10-22 (-34) cm, simple or branched. Leaf blades 1-7.5 cm x 2-7 mm, linear, acute, ciliate; sheaths glabrous, sometimes slightly inflated; ligule 1.2-4 mm, acute. Panicle rather loose, 1.5-3.5 cm x 6-20 mm, ovate-oblong, with 4-9 spikelets; pedicels clearly apparent, ciliate. Spikelets 9-12 mm. Glumes persistent; lower glume 5.5-6.5 mm, ovate, acuminate; upper glume 10-12 mm, lanceolate, acuminate. Lemmas of sterile florets 6.5-9 mm, covered with long hairs in lower part; awn of lowest lemma 20-22 mm, very strongly twisted in lower half, geniculate. Lemma of fertile floret glabrous, shiny, 2.7-3.2 mm, suborbicular. Fl. 4. Dry open habitats, 500-600 m.

Typus: [Sicily] "Hab. in montibus circa Panormum"

Islands.

Is: Rahdos: M. Profeta, 500-600 m, Fiori 35!

External distribution: N.W. Africa, Sardinia, Sicily, Aegean.

So far there has been no record from the Turkish mainland, but this species can probably be found on the W. coast of Anatolia. It has a very characteristic panicle which consists of 4-9 spikelets with rather big florets (9-12 mm).

3. A. aristatum Boiss., Voy. Bot. Espagne 2: 638 (1842).

Ic: Husnot, Grem. t. 1 (1899).

Annual. Stem 4-33 cm, solitary or loosely tufted, erect to spreading, branched in lower part. Leaf blades 1-5 (-6) cm x 0.8-4 (-5) mm, linear, acuminate, glabrous or hairy; sheaths glabrous, smooth,

somewhat inflated; ligule 1-2.5 mm, acute. Panicle 1.5-3.5 cm x 5-13 mm, lanceolate to ovate-oblong. Spikelets 6-7 mm, lanceolate. Lower glume 3.8-4.2 mm, ovate, acuminate; upper glume 6.2-6.7 mm, enfolding the florets. Sterile lemmas 2.7-3 mm, narrowly oblong, with sericeous hairs in lower part. Awn of upper sterile floret 7-7.5 mm, geniculate, twisted dark brown below the middle. Palea absent. Fertile lemma 1.7-2 mm, suborbicular, glabrous.

Syntypes: in Sardinia, Hispania interiori prope Matritum, Carreno Islands.

Gökceada: around Kuzu Limani, E. Leblebici & O. Seçmen 1348 (as A. odoratum)!

External distribution: Mainly S. Europe.

There has been two records of this species from the Istanbul area, but these proved to be wrong.

The specimen cited above is the first correct record for Turkey.

31. HIEROCHLOE R. Br., Prod. Fl. Nov. Holl.: 208 (1810), nom. gen. conserv.

Perennial, smelling of coumarin. Leaf blades flat. Ligule membranous. Inflorescence a ± lax panicle. Spikelets ovate, laterally compressed, with 3 florets, lower 2 florets male, uppermost one hermaphrodite. Glumes persistent, subequal, ovate, acute, about as long as florets, 3-veined. Lemmas of male florets membranous, 3-5-veined, elliptic, obtuse; palea slightly shorter than lemma, 2-veined, membranous. Lemma of hermaphrodite floret 5-veined, rather hard and shiny, hairy towards apex; palea 1-veined, shorter than lemma. Rhachilla disarticulating above glumes. Stamens 3 in male florets, 2 in hermaphrodite ones. Style 2, united in lower part. Caryopsis elliptic; embryo $\frac{1}{2}$ x as long as caryopsis. Hilum linear.

Type: H. odorata (L.) Beauv.

Literature:

Weimarck, G. 1971. Variation and Taxonomy of Hierochloë (Graminae) in the Northern Hemisphere. Bot. Not. 124: 129-175.

H. odorata (L.) Beauv., Ess. Agrost. 62, 164 (1812).

Syn: Zangheri, Fl. Ital. 2: 182, f. 6615-6616 (1812);
Hubbard, Grasses 267 (1968).

Perennial, with long creeping rhizomes. Stem 30-80 cm, smooth. Leaves mainly basal. Leaf blades 18-30 cm x 4-8 (-10) mm, linear, acuminate, glabrous to slightly hairy, scabrous on margins; sheaths glabrous; ligule 1-2 mm, obtuse. Panicle 4-9 cm x 1.5-3 cm, pyramidal; branches 2-4.5 cm, patent, bearing spikelets only in upper half; pedicels 0.5-4 mm, glabrous. Spikelets 4-6 mm. Lemmas of male floret 3.5-4.5 mm, ciliate on margins. Lemma of hermaphrodite one 3 mm,

± appressed hairy towards apex. Anthers 2-2.5 mm. Fl. 7. Grassy mountain steppes, 2160 m.

Described from: In Europae pratis [Hb. Linn. 1212/14.7

E. Anatolia.

A8/B8 Erzurum: Karaca düz, 2160 m, 24 vii 1916, Saposhnikov et Schischkin.

External distribution: C., N. & W. Europe, S. France, Crimea, Caucasia, Afghanistan, S. & C. Russia to E. Asia. Introduced in N. America. Euro-Sib. element.

32. ALOPECURUS L., Sp. Pl. 60 (1753)

Annual, biennial or perennial. Leaf blades flat to convolute. Ligule membranous. Sheaths glabrous or hairy. Inflorescence a spike-like panicle, oblong to cylindrical or ovate, occasionally globose in outline. Spikelets laterally compressed, with 1 floret. Glumes equal to subequal, acute to obtuse or terminating in an aristate point, 3-veined, always connate below, with a wing on keels or not, usually ciliate on keels. Lemma 5-veined, obtuse-truncate, connate below, dorsally awned. Palea 1-veined, keeled, sometimes absent. Rhachilla disarticulating below glumes. Lodicules absent. Stamens 3. Styles connate below. Caryopsis glabrous, laterally compressed, obliquely-obovate in side view. Embryo $\frac{1}{3}$ of the length of caryopsis.

Type: A. pratensis L.

Literature: Paunero, E. 1952. Las especies espanolas del genero Alopecurus in Anal. Inst. Bot. Cavanilles 10 (2): 301-346.

Tzvelev, N.N. 1971. Genus Alopecurus L. in URSS in Novit. Syst. Pl. Vasc. (Leningrad) 8: 12-22.

Key to Species

1. Glumes terminating in an aristate point, longer than lemma (when aristate point included)
   2. Basal sheaths covered with or adpressed hairs
      3. Leaf blades and upper sheaths white-tomentose .... 12. lanatus
      3. Leaf blades and upper sheaths not white-tomentose
         4. Basal sheaths ± covered with adpressed silky hairs; stem with dead sheath remains at base; palea present ..... 7. textilis
         4. Basal sheaths ± tomentose; stem with a thickened rootstock at base; palea absent ..... 11. davisii

2. Basal sheaths glabrous

5. Awns of lemmas not exserted or occasionally exserted by 0.5-1.5 mm

6. Aristate points of glumes up to 0.5 mm; spikelets dark-purplish; rootstock not thickened at base ..... 8. glacialis

6. Aristate points of glumes 1-1.6 mm; spikelets usually whitish grey; rootstock thickened at base ..... 9. gerardii

5. Awns of lemmas exserted by 2-8 mm

7. Rhizomes long-creeping; lowest sheaths disintegrating into reticulate fibres; spikelets whitish grey ..... 10. aucheri

7. Rhizomes not creeping; lowest sheaths not disintegrating into reticulate fibres; spikelets purplish

8. Aristate points of glumes covered with silky hairs all over; lemma 2.4-3 mm; anthers 1-1.4 (-1.7) mm ..... 13. laguroides

8. Aristate points of glumes glabrous; lemma 3-4 mm; anthers 2-3.3 mm ..... 6. vaginatus

1. Glumes acute to obtuse at apex, equalling lemma

9. Glumes connate for $\frac{1}{4}$ or less of their length

10. Panicle narrowly cylindrical, 3-6 mm broad; spikelets 1.9-3.4 mm

11. Glumes acute; stem bulbous at base ..... 2. bulbosus

11. Glumes obtuse; stem rhizomatous at base

12. Awns of lemmas exserted by 1.5-3 mm; anthers 1.4-1.7 mm, yellow to purplish ..... 5. geniculatus

12. Awns of lemmas not exserted or occasionally exserted by 1mm; anthers 0.6-1 mm, orange ..... 1. aequalis

10. Panicle usually oblong, 6-15 mm broad; spikelets 3.5-7 mm

13. Lemma acute; glumes parallel or convergent at apex, shortly hairy on keel ..... 3. pratensis

13. Lemma obliquely-truncate; glumes divergent at apex, long hairy on keel ..... 4. arundinaceus

9. Glumes connate for 1/3 to 4/5 of their length

14. Glumes with a wing on keel

15. Panicle ovoid, 6-15 mm broad ..... 16. utriculatus

15. Panicle narrowly cylindrical, 3-6 mm broad

16. Spikelets 4-6 mm; glumes connate for $\frac{1}{3}$ to $\frac{1}{2}$, acute ..... 15. myosuroides

16. Spikelets 3-4 mm; glumes connate for 1/2 to 4/5 of their length, obtuse ..... 14. creticus

14. Glumes without wing on keel

17. Spikelets 3.2-4.5 mm; glumes gradually narrowed above middle; anthers 1.5-2 mm ..... 18. setarioides

17. Spikelets 5-8.5 mm; glumes abruptly narrowed above the middle, triangular; anthers 3.2-4.9 mm ..... 17. rendleii

Sect. ALOPECURUS

1. A. aequalis Sobol., Fl. Petrop. 16 (1799).

Syn: A. fulvus Smith in Smith et Sowerby, Engl. Bot. 21, t. 1467 (1805).

Ic: Hubbard, Grasses 328 (1968);

Zangheri, Fl. Ital. 2: 183, f. 6671 (1976).

Annual or biennial. Stem 10-60 cm, ascending from a geniculate or prostrate base, sometimes rooting at nodes. Leaf blades 2-11 cm x 1-4 mm, linear, acuminate, rough on veins, glabrous beneath; sheaths smooth, uppermost one sometimes inflated; ligule up to 5.5 mm, obtuse.

Panicle 1.5-5 cm x 3-6 mm, narrowly cylindrical. Spikelets 1.9-2.7 mm, elliptic, obtuse. Glumes narrowly oblong, obtuse or rounded, with hyaline band on margins, ciliate. Lemma as long as or slightly longer than glumes, elliptic, obtuse, glabrous, connate for $\frac{1}{3}$ to $\frac{1}{2}$ their length at base, usually with a straight awn; awn 0.7-1.4 mm when present, not exserted or slightly exserted. Palea absent. Anthers 0.6-1 mm, yellow in early stage, orange at maturity. Fl. 6-8. Damp places, marshy edge of water, 800-2650 m.

Typus: [U.S.S.R] "Habitat in locis uliginosis", Sobolewski [Iso LE!]

Scattered.

A1(E) Kirklareli: 6 km from Kirklareli to Kofçay, A. Baytop (ISTE 3246)!

A3 Ankara d. Beypazari: Egriova, 1600 m, Y. Akman 5!

A4 Ankara d. Kizilcahamam: Işik Da., Khan et al. 734!

A5 Samsun: Ladik (large lake near Ladik), 800 m, Tobey 774!

A9 Kars: Yalnizçam, 1900 m, D.29653!

B2 Uşak: Murat Da., 1700 m, 1 vi 1964, Regel!

B8 Bitlis: 36 km E. of Muş, D.24768!

C4 Konya: Konya-Adana road, 1000 m, T. Kesercioglu 15498!

External distribution: N., C. & S. Europe, eastwards to C. Asia. Introduced into E. Asia and N. America. Euro-Siberian element.

This species resembles A. geniculatis, but differs in a number of characters, such as annual to biennial habit; spikelet 1.9-2.7 mm; awns of lemmas 0.7-1.4 mm; anthers 0.6-1 mm, orange in colour. In N.E. Anatolia the awn on the lemmas gets relatively long and exserted, but towards its western distribution range in Anatolia awn length gradually gets shorter. This clinal variation in awn length does not enable me to recognise further taxonomic divisions in this species.

2. A. bulbosus Gouan, Hort. Monsp. 37 (1762).

Ic: Trin. Sp. Gram. 1 (4): 40 (1828);

Hubbard, Grasses 330 (1968).

Caespitose perennial. Stem 3-40 cm, erect or ascending from base, smooth and glabrous, 2-3-noded, not rooting at nodes, bulboses at base. Leaf blades 1.5-10 cm x 1-3 mm, linear, acuminate, flat to convolute, slightly rough on margins; sheaths smooth, uppermost sometimes inflated; ligule 1.8-3.5 (-6) mm, obtuse. Paniole 1.3-5.5 cm x 3-6 mm, narrowly cylindrical. Spikelets 2.5-3.4 (-4) mm, oblong. Glumes narrowly oblong, acute, shortly ciliate on keel and on sides below the middle, slightly connate at base. Lemma shorter than glumes, narrowly oblong, obtuse, margins slightly connate at base, glabrous except for minutely hairy apex, awned above the base; awn 2-4 mm. Palea absent. Anthers 1.3-1.8 mm. Fl. 5-6. Salt marsh on sea shore, sea level.

Typus: [France] "Habitat Monspelii: frequens in pratis", Gouan

N.W. Anatolia.

A2(A) Istanbul: Maltepe, 2 v 1897, Azn.!

A2(A) Istanbul: between Kartal and Cevizli, A. Baytop (ISTE 10210)!

A2(A) Kocaeli: Pendik, 21 v 1893, Azn.!

External distribution: W. Europe and Mediterranean. Mediterranean element.

3. A. pratensis L., Sp. Pl. 60 (1753).

Ic: Trin., Sp. Gram. 1 (4): 44 (1828);

Lowe, Nat. Hist. Brit. Grasses t. 3 (1891).

Caespitose perennial. Stem 40-62 cm, erect to geniculately ascending from base, glabrous and smooth, 2-noded. Leaf blades 1.5-8 cm x 2-4 mm, linear, acuminate, slightly scabrid on margins; sheaths smooth, uppermost sometimes scarcely inflated; ligule 0.5-1.5 mm, truncate.

Panicle 3.3-5.7 cm x 6-7 mm, cylindrical to ovoid, green to purplish. Spikelets 4.5-6 mm, lanceolate-oblong to elliptic. Glumes narrowly lanceolate, acute, parallel to convergent at apex, connate for ¼ of their length, with fine hairs on sides and ciliate on keels. Lemma as long as glumes or slightly shorter, ovate to elliptic, acute, connate for ¼ of their length, awned below middle; awn 7-8 mm. Palea absent. Anthers 3.5 mm. Fl. 6. Moist places in lowlands.

Described from: "Habitat in Europae pratis", [Hb. Linn. 82/1!]

Turkey-in-Europe.

A1(E) Edirne: Sarayiçi, A. Baytop (ISTE 18343)!

External distribution: Eurasia, E. to Afghanistan. Introduced into E. Asia and N. America. Euro-Siberian element.

4. A. arundinaceus Poiret in Lam., Encycl. Meth. Bot. 8: 776 (1808).

Syn: A. ventricosus Pers., Syn. Pl. 1: 80 (1805), non Hudson (1778);
A. nigricans Hornem., Hort. Hofn. 1: 68 (1813)!;
A. pratensis var. armenus C. Koch in Linnaea 21: 381 (1848);
A. armenus (C. Koch) Grossh., Fl. Cauc. ed. 2, 1: 173 (1939);
A. arundinaceus subsp. armenus (C. Koch) Tzvel. in Novit. Syst. Pl. Vasc. (Leningrad) 56, 18 (1971).

Ic: Zangheri, Fl. Ital. 2: 183, f. 6670 (1976).

Perennial, with creeping rhizomes. Stem 23-105 cm, usually erect, sometimes geniculately ascending from base, 2-noded. Leaf blades 2.5-4.5 cm x 3-10 mm, linear, acuminate, scabrid on margins and somewhat on upper surface; sheaths glabrous to slightly hairy, inflated; ligule 1.5-5 mm, obtuse-truncate. Panicle 1.7-7 cm x 6-14 mm, broadly cylindrical, green to purplish. Spikelets 3.5-7 mm, urceolate. Glumes lanceolate, acute, diverging at apex, connate for ¼ of their length, ciliate on keels. Lemma 3.5-5.8 mm, ovate, obliquely truncate,

with a subdorsal awn; awn 1.5-7.5 mm, somewhat geniculate and twisted below but usually rather slender and variously curved. Anthers 3-3.6 mm. Fl. 4-8. Marshy ground, water meadows, cultivated land, banks, roadsides, ditches, sea level-2800 m.

Typus: "Cultivee au Jardin des Plantes de Paris", Poiret [P]

Widespread, rare in S. Anatolia.

A2(E) Istanbul: Topkapi to Maltepe, 28 v 1913, Azn.!

A3 Bolu: Köroglu Da., 1800 m, Y. Akman 6381!

A4 Cankiri: Eldivan Da., 1200 m, A. Baytop (ISTE 35225)!

A5 Amasya: between Merzifon and Çorum, 10 km from Merzifon, A. Baytop (ISTE 9121)!

A7 Gümüşhane: Aktas, Sint. 1894: 6161!

A9 Kars: Kagizman, N. side of pass between Akçay and Cumaçay, 2350 m, D.46773!

B1 Manisa: Manisa Da., A. Baytop (ISTE 9923)!

B3 Eskişehir: Sundiken Da., Kuzuoulu Göl, 1500 m, T. Ekim 526!

B6 Sivas: Sivas, 1200 m, Stn. & Hend. 5364!

B8 Erzurum: 29 km from Hinis to Pasinler, 1800 m, D.46417!

B9 Agri: 2 km S.W. of Hamur (Murat valley), 1680 m, D.44087!

C2 Denizli: Honaz Da., Atalan Y., 1550 m, E. Tuzlaci (ISTE 26605)!

C3 Konya: Konya Kara Çayiri, H. Birand 133!

C6 Maraş d. Göksun: Hobek Da., 1700 m, D.20198!

C10 Hakkari: Yüksekova, 1950 m, D.45854!

External distribution: Eurasian.

Its closest relative is A. pratensis, from which it differs in several characters, such as long creeping rhizomes, obliquely truncate lemma apex and divergent glumes with long hairs on their keels.

It seems quite variable in its sparsely to densely hairy glumes variation related to its widespread distribution and much collecting in Turkey.

In this species the lemma does not usually have a palea, but in one specimen collected from B6 Sivas (Tobey: 1679) I have found lemmas with a palea which requires further investigation.

5. A. geniculatus L., Sp. Pl. 60 (1753).

Ic: Trin. Sp. Gram. 1 (4): 42 (1828);

Hubbard, Grasses 332 (1968).

Perennial. Stem 7-60 cm, geniculately ascending or decumbent, especially in lower part, glabrous and smooth, usually 1-5-noded, rooting at lower nodes. Leaf blades 1-8 (-12) cm x 1.5-5.5 (-7) mm, linear, acuminate, slightly rough veins on upper surface, glabrous beneath; sheaths whitish green, glabrous, uppermost sometimes inflated; ligule 2-5 mm, obtuse. Panicle (0.8-) 1-6 (-7) cm x 3-6 mm, narrowly cylindrical. Spikelets 2.5-3.5 mm, oblong, green to purplish. Glumes narrowly oblong, obtuse, connate at base, ciliate on keel and with adpressed hairs on margins. Lemma as long as glumes or slightly shorter, oblong-ovate, truncate, margins connate at base, awned just above base; awn 3.5-5 mm, exceeding glumes by 1.5-3 mm. Palea absent. Anthers 1.4-1.7 mm, yellow to purplish. Wet places.

Described from: "In Europa uliginosis", Fb. Linn. 82/317

Turkey-in-Europe.

A1(E) Çanakkale: Gelibolu, Sirjaev 133

External distribution: Mainly Europe, eastwards to Afghanistan. Introduced into N. America.

As it has only once been found in Turkey, it might have been introduced by chance. A. geniculatus is certainly closely related to A. aequalis but differs in a few characters such as perennial habit, awns exserted by 1.5-3 mm, anthers 1.4-1.7 mm, yellow to purplish.

Sect. COLOBACHNE (Beauv.) Trin

6. A. vaginatus (Willd.) Boiss., Fl. Or. 5: 488 (1884).

Syn: Polypogon vaginatus Willd. in Neue Schrift. Ges. Berlin 3: 44 (1801);

A. angustifolius Sm. in Sibth & Sm., Fl. Graeca 1: 64 (1808)!;

Colobachne vaginata (Willd.) Beauv., Ess Agrost. 22 (1812);

A. dasyanthus Trautv., Acta Horti Petrop. 5: 486 (1878)!;

A. vaginatus var. unipaleaceus Boiss., Fl. Or. 5: 489 (1884)! p.p.

Ic: Fl. Crusii 1: t. 10 (1941);

Bor, Fl. Iraq 9: 295, t. 105 (1968).

Caespitose perennial, rhizomatus. Stem 18-30 cm, slender, usually erect, slightly bent at base, smooth and glabrous, 1-2-noded in lower part but nodes covered by sheaths. Leaves almost all basal, except 1-2 cauline ones. Leaf blades 1-15 cm x (0.4-) 1-2 mm, linear, acuminate, convolute to flat, glabrous, slightly scabrid on margins; sheaths always glabrous, uppermost usually inflated; ligule 0.5-2 mm, obliquely-truncate. Panicle 1.4-2.5 cm x 7-13 mm, ovate to oblong. Spikelets 4.5-6.3 mm (incl. aristate point), urceolate. Glumes ciliate on keel, terminating in a slightly divergent aristate point (0.6-1.8 mm), connate at base. Lemma 3.2-4 mm, obtuse; awn 5-10.5 mm, attached to lower ⅓ of lemma, geniculate and twisted below. Palea present. Anthers 2.3-3.3 mm. Fl. 4-6. Rocky alpine mountain slopes, 700-3100 m.

Typus: [Crimea] "Wachst in Taurien at trockenen stellen und bluht im Mai", Pall [B!]

Mainly N. Anatolia

A2(A) Bursa: Ulu Da., A. Bayton (ISTE 2556)!

A5 Amasya: Amasya, 700 m, 10 iv 1889, Bornm.!

A7 Gümüşhane: Karagöl Da., Sint. 1894: 7387!

A8 Rize: d. Ikizdere, Cermanin Tepe above Cimil, 3100 m, D.21091!

A9 Kars: Arpaçay, Grossheim I: Map 157

B7 Erzincan: Egin, Sint. 1890: 2236!

B10 Agri: Dogubayazit, Grossheim I: Map 157

C5 Adana: Karaisali, 24 vi 1970, A. Pamukçuoglu (HUB)!

Is: Samos: Izirka, 1400 m, Rech. 4112!

External distribution: Crimea, E. Mediterranean, Caucasia, Iran, W. Pakistan.

The type specimen of A. dasyanthus, borrowed from Leningrad has been investigated and placed under A. vaginatus, though in the latter the glumes are sometimes slightly divergent in the later stage of development. According to Komarov (Engl. Transl. 1963), A. dasyanthus has infundibular spikelets and divergent aristate points at tip of glumes, whereas A. vaginatus was thought to have urceolate spikelets and slender aristate point at tip of glumes. As far as Turkish material is concerned, these two species seem to refer only to one species as accepted in Fl. Orientalis (1884). Boissier's treatment of this species is not satisfactory at all, because of the acceptance of A. laguroides, A. cassius, etc., under A. vaginatus. In fact the two former species are quite distinct species from A. vaginatus.

7. A. textilis Boiss., Diagn. Ser. 1 (13): 40 (1853).

Densely caespitose perennial, rhizomes fibrous. Stem 5-70 cm, erect to geniculate, smooth and glabrous, rather thickened at base, covered by dead leaf sheaths, 1-2-noded in lower half. Leaf blades mainly basal, up to 30 cm x 1-3 mm, linear, acuminate, convolute to filiform or flat; sheaths (especially the lower ones) covered by adpressed silky hairs, uppermost ones inflated; ligule 0.5-1 mm, truncate, slightly hairy at apex. Panicle 1-3 cm x 0.6-1.5 cm, elliptic in outline. Spikelets 4.5-8 mm, elliptic. Glumes lanceolate, terminating in an aristate point (c. 1-2 mm) or mucro, hirsute on keels,

connate to lower ¼ of their length. Lemma 4-5.5 mm, truncate-subtridentate, ciliate at top, margins connate at base; awn 8-14 (-17) mm, attached to lower ⅓ of lemma. Palea 2.5-4 mm, linear, acuminate, slightly hairy at apex. Anthers 3.5-4 mm.

Key to subspecies

1. spikelets 4.5-6.5 mm (incl. aristate point); leaves convolute ..... subsp. textilis

1. Spikelets 7-8 mm (incl. aristate point), basal leaves flat ..... subsp. tiflisiensis

1. subsp. textilis

Syn: A. textilis Boiss., Diagn. Ser. I (13): 40 (1853);
A. vaginatus subsp. pubescens var. textilis (Boiss.) Westb. in Trudy Bot. Sada Jur'ev. 5: 23 (1905).

Fl. 5-8. Stony mountain slopes, 1676-3353 m.

Typus: [N. Iran] "In glareosis vulcanicis jugi Besmitschal in m. Demawend, 2743 m", [21 vi 1843], Th. Kotschy: 351 [Iso. E! K!]

Widespread but mainly Inner Anatolia.

A7 Giresun: Balaban Da. (Kilic Tepe) above Tamdere, 2900 m, D.20619!

B5 Nigde: Hasan Da., above Taşpinar Y., 2800 m, D.18968!

B7 Erzincan: Keşiş Da., above Cimin, 2800-2900 m, D.31795!

B8 Bingöl: Bingöl Da., 2438 m, Kotschy 540!

B9 Van d. Gevaş: Artos Da., 3353 m, D.22892!

C5 Nigde: Aladag, on Demir kazik, Findlay 175!

C6 Maraş d. Çardak: Berit Da., above Arpa Çukuru Y., 2700 m, D.20289!

C9 Hakkari: Kara Da., 3353 m, D.24416 p.p!

C10 Hakkari: Sat Da. between Veregöz and Sat G., 2900-3000 m, D.45588!

External distribution: Lebanon, N. Iraq, Iran.

subsp. tiflisiensis (Westb.) Tzvel. in Novit. Syst. Plant. Vasc. (Leningrad) 5: 15 (1971).

Syn: A. vaginatus subsp. pubescens var. tiflisiensis Westb. in Trudy Bot. Sada Jur'ev. 5: 23 (1905)!;

A. tiflisiensis (Westb.) Grossh. in Grossh. et Schischk., Sched. Herb. Pl. Or. Exs. 3: 15 (1924)!

Ic: Fl. Grusii 1: t. 12 (1941).

Fl. 5. Mountain slopes, 2300-2500 m.

Typus: "Tiflis", Westberg /Iso. LE!/

E. Anatolia.

B8 Erzurum: Palandöken Da., 2300 m, T. Baytop (ISTE 34885)!

B9 Bitlis: Nemrut Da., S. of Büyük göl, 2500 m, A. Tatli (ISTE 27156)!

External distribution: N. Iraq, Caucasia, Transcaspia.

8. A. glacialis C. Koch in Linnaea 21: 382 (1848).

Syn: A. ponticus C. Koch in Linnaea 21: 382 (1848)!;

Colobachne pontica (C. Koch) Nyu. in Bot. Not. 69 (1851);

A. sericeus Albov in Bull. Herb. Boiss. 1: 251 (1893)!;

A. caucasicus Sered. in Not. Syst. (Leningrad) 21: 55 (1961)!

Ic: Fl. Grusii 1: t. 9 (1941);

Fl. U.S.S.R (transl.) 2: 120, t. 11 f. 10 (1963).

Caespitose perennial. Stem 36-67 cm, erect to slightly geniculate at nodes, usually branched at base, 2-noded, with fibrous roots. Leaf blades 2-15 cm x 1-2.7 mm, linear, acuminate, slightly scaberulous on upper surface, margins scabrid, glabrous beneath; sheaths glabrous, uppermost one slightly inflated; ligule 1-1.5 mm, obtuse. Panicle 0.9-2.5 cm x 0.6-0.9 cm, ovate-elliptic to oblong, often dark purple. Spikelets 3.5-5.5 mm, oblong-urceolate. Glumes lanceolate, slightly connate at base, terminating in a divergent aristate point, dorsally

densely ciliate. Lemma 3-4 mm, glabrous, denticulate at apex and with a mucro, dorsally awned, margins connate at base; awn 3-4.4 mm, slightly exserted or not, sometimes geniculate, attached in lower $\frac{1}{2}$-$\frac{1}{3}$ of lemma. Palea 2-2.6 mm, linear, acuminate, sometimes lacking. Anthers 2-3.5 mm. Fl. 7-8. Rocky places in alpine steppe, 2200-3200 m.

Typus [Turkey A8 Rize] "Auf dem Rücken des pontischen Gebirges, im Gaue Hemschin, auf Granitboden, 2652 m", [viii 1866], C. Koch [G!]

N.E. Anatolia (Colchis).

A8 Rize: d. Ikizdere, Cermanin Tepe above Cimil, 3100-3200 m, D.21094!;
Ikizdere, Baltaş Tepe, 3200 m, D.21106!;
Cimil, 2600 m, viii 1866, Bal.!;
Camlihemsin, Amlahit Y., 2200-2720 m, A. Guner (ISTE 34111)!

A9 Kars: Ardahan, Grossheim 1: Map 161

External distribution: Caucasia, Iran, Afghanistan. Euro-Siberian (mt.) element.

As can be seen from the synonymy of A. glacialis, so far four specimens have been described on the basis of rather inconsistent palea characters. Presence and absence of palea is a variable character in Alopecurus as a whole. I have examined types of all four taxa and decided to put them together under A. glacialis.

9. A. gerardii Vill. in L., Syst. Pl. Eur. 1, Fl. Delph. 5 (1786).

Caespitose Perennial. Stem 7-40 cm, erect to geniculate, especially at nodes, glabrous and smooth, 2-noded, rather thickened at base, rhizomatus. Leaf blades 1-7 cm x 1-4.2 mm, linear, acuminate, glabrous, slightly scabrid on margins, dark green; sheaths glabrous, uppermost usually inflated; ligule 1-2 mm, truncate. Panicle 1-2 cm x 0.7-1 cm, ovoid. Spikelets 4-6.3 mm, whitish grey. Glumes lanceolate, with aristate point up to 1.5 mm, slightly connate at base, covered by

long ciliae on dorsal surface especially on keel. Lemma 3-4 mm, obliquely truncate at apex, with a fringe of hairs at apex, dorsally awned; awn 0.8-6 mm, sometimes almost missing. Palea 2.5-3.5 mm, linear, acuminate, ciliate in upper half of keel. Anthers 2-2.5 mm. Fl. 5-7. Open rocky slopes, with Juniperus, 1700-2180 m.

Key to varieties

1. Awn of lemma not exserted, up to 2 mm ..... var. gerardii

1. Awn of lemma exserted, up to 6 mm ..... var. cassius

1. var. gerardii

Syn: Colobachne gerardi (Vill.) Link, Enum. Hort. Berol. Alt. 1: 74 (1821).

Ic: Trin., Sp. Gram. 1 (1): 1 (1928);
Zangheri, Fl. Ital. 2: 183, f. 6665 (1976).

Typus: [France] Je l'ai cueilli au fond du Valgaudemar, a Orcieres, fur le Mont-Genevre Vivace

N.W., C. & S. Anatolia.

A2(A) Bursa: Uludag, near Büyük Hotel, 1780 m, A. Baytop (ISTE 36866)!

B2 Kütahya d. Simav: Kiçir to Akdag, 1900-2100 m, Coode & Jones 2714!

B5 Kayseri: Bakir Da., nr. Akoluk Y. above Kisge, 2000 m, D.19520!;
Erciyas Da., 2100 m, 9 vii 1856, Bal. 850!

C4 Konya: Bozkir, Üçpinar-Üçyazi, 2000 m, R. Çetik & E. Yurdakulol (ANK. 472)!

C5 Adana: Karsanti, Torosan Da., 2090 m, E. Yurdakulol 10788!

C6 Maraş: Berit Da., 2438 m, 10 viii 1865, Haussk.n.!

External distribution: S. Europe.

A. gerardii is a well known species in Europe, but in Turkey particularly around Hatay (C6) area it becomes slightly different

from its usual appearance, seeming to have longer exserting awns. Even Boissier did not know what to do with it: first he described it as a new species, A. cassius, and later placed it under A. vaginatus var. unipaleaceus Boiss. along with a number of other quite distinct species. It certainly seems to qualify for varietal rank, on the basis of its exserted awn.

2. var. cassius (Boiss.) M. Dogan, comb. et stat. nov.

Syn: A. cassius Boiss., Diagn. Ser. 1 (13): 41 (1853).

Typus: [Turkey, C6 Hatay] "Hab. in regione alpina montis Cassii", [Junio 1846], Boissier [Holo G!]

Amanus.

C6 Hatay: Amanos Mt., v-viii 1846, Boissier!

10. A. aucheri Boiss., Diagn. Ser. 1 (13): 41 (1853).

Syn: A. vaginatus subsp. aucheri (Boiss.) Westb. in Tr. Yurbevsk. Bot. Sada 5: 23 (1905)!

Caespitose perennial, with creeping rhizomes. Stem 20-60 cm, erect or slightly geniculate at nodes. Leaf blades 3-15 cm x 2-5 (-6) mm, linear, acuminate, glabrous and smooth; sheaths glabrous, uppermost inflated, lower sheath fibres reticulately arranged; ligule about 2 mm, obtuse at apex. Panicle 1.3-2.5 cm x 1-1.5 cm, elliptic-oblong. Spikelets 4.5-6.2 mm (incl. aristate point), urceolate, whitish grey. Glumes lanceolate, terminating in a divergent or straight aristate point c. 1-2 mm, ciliate on keel and margins, shortly connate at base. Lemma 3-4 mm, oblong, truncate, glabrous, dorsally awned; awn 6.5-9 (-10) mm, attached to lower $\frac{1}{3}$ of lemma, geniculate or not, somewhat twisted below. Palea absent. Anthers 1.8-2.7 mm. Fl. 5-8. Rocky volcanic slopes near permanent snow beds, alpine mountain meadows, 2000-3353 m.

Syntypes: [Iran] "Hab. in monte Elbrus, Aucher 5457, ad nives deliquescentes ejusdem jugi supra pagum asadbar, Kotschy, loc. cit. No: 464 [9 vii 1843] [G!]

E. Anatolia.

B6 Sivas: Bey Da., S. of Zara, 2000 m, Stn. & Hend. 5285!

B8 Erzurum: Palandöken Da., Dadaş, A. Tatli (ISTE 27889)!

B9 Bitlis: Nemrut Da., W. of Büyük lake, 2500 m, A. Tatli (ISTE 27155)!

B10 Kars: Agri Da., 2438 m. B. Post 2161!

B10 Hakkari: Sat Da. (above Yüksekova), 2900 m, Duncan & Tait 81!

External distribution: Caucasia, Transcaspia, Iran. Irano-Turanian element.

This species seems very close to A. vaginatus when only the floral characters are examined, as was done by Westberg (1905) where he treated it as a subspecies of A. vaginatus. However, when a taxonomic conclusion is to be reached, all characters must be carefully studied. A. aucheri differs from A. vaginatus in a number of features, such as rhizomes long-creeping, spikelets whitish grey and densely pilose, lowest sheaths disintegrating into reticulate fibrous.

11. A. davisii Bor in Notes R.B.G. Edinb. 25: 63 (1963).

Caespitose perennial. Stem 7.5-38 cm, erect, slender, glabrous and smooth, 1-noded (in lower part), with a gradually thickened root-stock at base. Leaf blades 1-5 cm x 1-3 mm, linear-convolute, obtuse or mucronate at apex, margins ciliate; uppermost sheath glabrous and inflated, covered by villous on basal sheath; ligule 0.5-2 mm, acute. Panicle 0.9-2 cm x 0.7-1 cm, ovate, rather dense. Spikelets 4-6 mm (incl. aristate point), cup-shaped. Glumes connate at base, terminating in an aristate point up to 1.5 mm, densely pilose. Lemma 3.5-4 mm, obliquely truncate at apex, awned above base, connate for $\frac{1}{3}$ of its

length in lower part; awn 7-10 mm, geniculate, twisted in lower half. Palea absent. Anthers 2.5-3 mm. Fl. 5. Open places and stony mountain slopes, 1219-1524 m.

Typus: Samos: Mount. Kerkis, on Vigla, 1219-1524 m, 2 v 1940, Davis 1688 /Holo E!/

W. Anatolia and Islands.

B1 Izmir: Kemalpaşa, Nif Da., near peak, 1500 m, H. Peşmen & O. Seçmen (EGE 16357)!

Endemic. E. Mediterranean (Mt.) element. Related to A. lanatus.

12. A. lanatus Sm. in Sibth. & Sm., Fl. Graec. Prod. 1: 43 (1806).

Syn: A. phalaroides C. Koch in Linnaea 19: 5 (1858);

A. lanatus subsp. elongatus Quezel & Pamukçuoglu in Candollea 25: 346 (1970).

Ic: Trin., Sp. Gram. 1 (4): 43 (1828).

Caespitose perennial. Stem 3.5-30 cm, erect or slightly curved, somewhat geniculate at node, rather slender, glabrous and smooth in upper part, white tomentose in lower part, 1-noded, with a black rather thick cylindrical stock at base. Leaf blades mostly basal, 1-5.5 cm x 2-3 mm, linear, obtuse or mucronate, usually convolute, densely white-tomentose all over; sheaths very close to base of stem, inflated, tomentose like leaf blades; ligule 1.5-2.5 mm, acute. Panicle 0.8-1.5 cm x 0.8-1.3 cm, ovate-globose. Spikelets 4.5-6.2 mm. Glumes lanceolate, terminating in an aristate point c. 1-1.5 mm, covered by dense hispid hairs, slightly connate at base. Lemma 2.4-3.5 mm, obliquely truncate at apex, slightly ciliate, especially at apex, with an awn, margins slightly connate at base; awn 6.5-11 mm, attached to lower 1/5-1/7 of lemma, geniculate and twisted in lower half. Palea absent.

Anthers 1.8-2.7 mm, cream. Fl. 5-8. Scree and rock crevices on high mountain slopes, 2000-3450 m.

Typus: [Turkey] "In summitate montis Olympi Bithyni nive peracta", Sibthorp [Holo OXF; Iso BM!]

N.W. and S. Anatolia (Anti-Taurus).

A2(A) Bursa: Uludag, Karagöller road, A. Baytop ISTE 20902)!

B3 Eskişehir: d. Sivrihisar, Arayit Da., 1500-1800 m, 8 iv 1941, H.J. Romieux!

B6 Maraş: d. Göksun, Binboga Da., on Işik Da. above Karli Y., 2800 m, D. 19995!

C3 Antalya: Perge, 10 vii 1970, A. Pamukçuoglu (HUB)!

C5 Nigde: Aladag, above Alaca, 3000-3450 m, E. Parry: 194!

Endemic. E. Mediterranean (mt.) element.

A photograph of type material of A. phalaroides has been seen from Missouri Botanical Garden Herbarium. The recently published subspecies, A. lanatus subsp. elongatus Quezel & Pamukçuoglu, does not seem to have any taxonomic significance. The endemic A. lanatus is closer to A. davisii than to any other one species, its leaves and sheaths being characteristically covered by a very dense tomentose indumentum.

13. A. laguroides Bal. in Bull. Soc. Bot. France 21: 11 (1874).

Syn: A. vaginatus var. unipaleaceus Boiss., Fl. Or. 5: 488 (1884) p.p!

Dense caespitose perennial, with creeping fibrous rhizomes. Stem 5-20 cm, glabrous, erect, slightly ascending from base, 1-2-noded in lower half. Leaf blades 1-8 cm x 0.5-2.5 mm, linear, obtuse to acuminate, later convolute, glabrous and smooth, occasionally slightly scabrid only on margins. Cauline leaves 1 or 2, mostly from base; sheaths glabrous, scarious, usually uppermost inflated; ligule 0.3-1 mm, truncate, denticulate. Panicle 0.8-2 cm x 0.8-1.4 cm, ovoid-

elliptic, ± purplish. Spikelets 4.5-6 mm (incl. aristate point), urceolate-oblong. Glumes linear, covered all over by long silky hairs, scarcely connate at base, terminating into an aristate point; aristate points slightly divergent, 0.8-2 mm, covered by long silky hairs. Lemma 2.4-3 mm, obtuse, with a row of short hairs at apex; awn 7-9 mm, attached in lower ¼ of lemma, geniculate and twisted below. Palea absent. Anthers (0.7-) 1-1.4 (-1.7) mm, yellow to purplish. Fl. 8. Rocky mountain slopes near snow bed, 3000-4267 m.

Typus: [Turkey A8 Rize] "Region alpine superieure du Lazistan, vers 3000 metres d' altitude", [15 viii 1866], Balansa: 1552 [Iso E!]

N.E. and E. Anatolia.

A8 Rize: d. Ikizdere: Vercinin Tepe, 3400 m, D.21137!

B9 Bitlis: Süphan Da., above Adilceviz, 4054 m, D.24664!

B10 Agri: Agri Da., 3685-3962 m, B.V. Post 2147!

External distribution: According to the literature, it seems endemic to Turkey, but might well be found in N.W. Iran or Caucasia. Euro-Siberian (mt.) element.

This species has often been confused with A. vaginatus, due either to wrong treatment in various Floras, or its resemblance to A. vaginatus. It differs from A. vaginatus in a few characters, such as having the aristate points of the glumes covered by silky hairs all over, lemma less than 3 mm (2.4-3 mm), and anthers 1-1.7 mm.

Sect. PSEUDOPHALARIS Tzvelev

14. A. creticus Trin. in Sprengel, Neue Entdeck. 2: 45 (1820).

Syn: A. thracicus Penev & Kozuharov in Notes R.B.G. Edinb. 28: 187 (1968).

Ic: Trin., Sp. Gram. 1 (4): 41 (1828);

Reichb., Ic. Fl. Germ. 1: t. 178 f. 475 (1850).

Tufted annual. Stem 7-22 cm, ascending from base, usually branched, 2-3-noded, rooting at lower nodes, glabrous and smooth. Leaf blades 1-7 cm x 1-3.5 mm, linear, acuminate, glabrous; sheaths glabrous, the uppermost usuallu inflated; ligule 2-3 mm, obtuse at apex. Panicle 2-3.5 cm x 4-5.5 mm, oblong to oblong-cylindrical. Spikelets 3-4 mm, oblong, pale in lower half, purple in upper half. Glumes obtuse at apex, divergent and mucronate, connate for ½ to 4/5 of their length in lower part, ciliate in the upper half, especially on wing. Lemma slightly shorter than glumes, truncate at apex, connate for ½ to ⅔ of their length in lower part, awned above base; awn 3-6 mm, exserted by 1-4 mm. Palea absent. Anthers 1.2-2.5 mm. Fl. 4-5. Marshy and wet places, Nr. sea level.

Typus: "Hab. in Creta", Sieber [Iso LE!]

N.W. Turkey.

A2(E) Istanbul: Soguksu, Küçükçekmece G., H. Demiriz (ISTE 7185)!

A2(E) Istanbul: Bebek, 18 iv 1909, Azn.!

A2(A) Istanbul: Kadiköy, 1 v 1918, Azn.!

C1 Aydin: Milet, Ak Bogaz, 1842, Boiss. 619!

External distribution: Jugoslavia, Greece, Aegean. E. Mediterranean element.

A. creticus resembles A. geniculatus, but is an annual species, with glumes connate for ½ to 4/5 of their length in lower part, and with a winged keel. A. thracicus Penev & Kozuhanov has been described from Bulgaria and an isotype at Edinburgh Herbarium has also been studied: no major differance was found to justify separation from A. creticus.

15. A. myosuroides Hudson, Fl. Angl. 1: 23 (1762).

Annual. Rhizomes fibrous. Stem 10-98 cm, erect, somewhat geniculately ascending from base, densely or loosely tufted, somewhat solitary. Leaf blades 1.5-23 cm x 2-8 mm, linear, acuminate, glabrous; sheaths smooth and glabrous, uppermost one somewhat inflated; ligule 2-5 mm, obtuse. Panicle 2-10 cm x 3-6 mm, narrowly cylindrical, tapering towards apex. Spikelets 4-6 mm, oblong to lanceolate-oblong, green to purplish. Glumes narrowly oblong, acute, connate for $\frac{1}{3}$ to $\frac{1}{2}$ of their length, shortly hairy at base. Lemma equaling glumes or somewhat slightly longer, elliptical, ovate, obtuse, margins connate for $\frac{1}{3}$ to $\frac{1}{2}$ of their length, awned just above the base, or sometimes awn nearly absent; awn up to 12 mm when present. Palea absent. Anthers 2.5-4 mm. Fl. 3-8. Cultivated fields, road banks, water meadows, roadside ditches, salty and sandy soil, deciduous forest. Nr. sea level to 1850 m.

Key to varieties

1. Awn 8-12 mm, exserted from glumes by 5-6 mm
..... 1. var. myosuroides

1. Awn either not present or not exserted
  2. Wing of glumes almost as long as glumes, covering entire keel, 1 mm or more in width ..... 2. var. latialatus
  2. Wing of glumes very short, only in upper part of glumes, up to 0.5 mm in width ..... 3. var. breviaristatus

1. var. myosuroides

Syn: A. agrestis L., Sp. Pl., ed. 2: 89 (1762).

Ic: Hubbard, Grasses 326 (1968);
Bor, Fl. Iraq 9: 289, t. 102 (1968).

Typus: "Hab. in arvis, et ad vias, Anglia", Hudson.

Widespread.

A1(E) Kirklareli: 5 km S. of Kirklareli, 100 m, D.41977!

A2(E) Istanbul: Büyükdere, 6 v 1900, Azn.!

A3 Bolu: Büyük Melen, A. Baytop (ISTE 15500)!

A4 Ankara: Mithat Plain on road to Istanbul, A. Baytop (ISTE 9189)!

A5 Yozgat: 25 km from Çekerek to Alaca, 900 m, Coode & Jones 1637!

A6 Tokat: Yeşilirmak valley, R. Çetik 46!

A8 Gümüşhane: Çoruh valley, N. of Bayburt, 1500 m, D.31994!

B1 Balikesir: 10 km from Balikesir to Bigadiç, nr. Mecidiyeköy, A. Baytop (ISTE 9868)!

B3 Bilecik: Inönü, A. Baytop (ISTE 9337)!

B4 Ankara: Polatli, nr. Temelli Köy, B. Kasapligil (ANK. 478)!

B5 Kayseri: betw. Soysalli and Incesu, 26 km to Incesu, A. Baytop (ISTE 20321a)!

B6 Sivas: Yildizeli, 1370 m, A. Baytop (ISTE 40904)!

B7 Malatya: Hekimhan, 1300 m, Stn. & Hend. 5445!

B8 Erzurum: betw. Ilica and Tercan nr. the turning to Aşkale, 1850 m, D.30885!

B9 Van: Erciş, 1700 m, D.44132!

C3 Burdur: Gölhisar, W. of Gölhisar Lake, 1000 m, Ö. Seçmen & E. Leblebici (EDE 16362)!

C5 Adana: 9 km S. of Adana, betw. Adana and Karataş, Coode & Jones 236!

C6 Maras d. Göksun: Hobek Da., 1700 m, D. 20199!

C7 Urfa: 8 km from Diyarbakir to Çinar, 650 m, D.28767!

C9 Siirt: above Sirnak, 1450 m, D.42612!

External distribution: Eurasia & N. Africa.

2. var. latialatus M. Dogan (in ed.)

Typus: /Turkey C5 Adana/ Adana to Karataş, 5 km S. of Adana, 1 v 1965, Coode & Jones 258! /Holo E!/

Only known from the type locality. A robust gathering with exceptionally broad-winged glumes.

3. var. breviaristatus Marchesetti ex Ascherson & Graebner, Syn: Mitteleur. Fl. 2: 130 (1899).

Typus: "Adriaküste von Istrien", Marchesetti

Outer Anatolia, Islands.

A2(A) Bursa: betw. Gemlik and Armutlu, nr. Gemlik, A. Baytop (ISTE 24217)!

A6 Ordu: betw. Terme and Ünye, 8 km from Ünye, A. Baytop (ISTE 15253)!

B1 Izmir: Germencik, 50 m, D.25226!

C3 Antalya: Alanya, 2 m, D.25912!

C5 Mersin: Kuyuluk, 10 km W. of Mersin, 2 m, D. 26523!

C6 Maraş: Andiran, 11 km S. of Çatak, 800 m, Coode & Jones 1123B!

Is: Lesvos: S. side of mt. Bourounia 3 km E. of Keramia, 20 m, Edmondson 2360!

External distribution: Europe, Mediterranean, Iraq, Iran, Afghanistan, Pakistan, Russia. Introduced into N. America and New Zealand.

16. A. utriculatus Banks & Sol. in Russell, Nat. Hist. Aleppo 2: 243 (1794).

Annual. Rhizome fibrous. Stem 4-38 cm, usually geniculately ascending from base, tufted, occasionally solitary, glabrous and smooth, 3-4-noded. Leaf blades 0.7-12 cm x 0.8-8 mm, linear, acuminate; sheaths glabrous, uppermost one strongly inflated; ligule 2-4 mm, obtuse, denticulate. Panicle 0.8-3.3 (-4) cm x 0.6-1.5 cm, ovoid to oblong,

pale-green to purplish, loose or dense; branches with 1-4 spikelets. Spikelets 5-8.5 mm, laterally compressed. Glumes acute, connate for ⅓ to ½ of their length in lower part, lanceolate, with a very narrow or rather broad wing on ciliate keel. Lemma as long as glumes or slightly shorter, acute to apex, awned from just above the base, connate margins in lower half; awn 6-15 mm, geniculate and twisted below. Palea absent. Anthers 3.2-4.2 mm.

Key to subspecies

1. Panicle rather loose; glumes almost wingles or with a rather narrow wing on upper half of keel ..... subsp. utriculatus
1. Panicle very dense; glumes with a broad long wing on keel ..... subsp. anthoxanthoides

1. ,subsp. utriculatus

Ic: Bor, Fl. Iraq 9: 293, t. 104 (1968).

Fl. 3-4. Waste places, grassy banks, on limestone rock, 30-1400 m.

Typus: [Syria] "Prope Aleppo", Russell [Holo BM!]

Mainly S.W. and S. Anatolia.

B6 Malatya: 40 km from Malatya to Maraş, 1400 m, Stn. & Hend. 5462!

C2 Mugla: d. Fethiye, Xanthus valley, nr. Kalkan, 10 m, D.25452!

C5 Mersin: 10 km S. of Mersin (Viranşehir), 5 iv 1855, Bal.!

Adana d. Bahçe: Haruniye, 450 m, D.26930!

C6 Gaziantep: Gaziantep, 853 m, 19 iv 1935, E.K. Balls (ANK. 449)!

Malatya: d. Doganşehir 30 km S. of Doganşehir on Malatya-Gaziantep road, 1380 m, H. Birand (ANK. 448)!

External distribution: Cyprus, Syria, Palestine, Iran.

Observation: A. utriculatus has been much confused with A. rendlei because of its rather complicated literature which is fully explained by Eig (1937).

subsp. anthoxanthoides (Boiss.) M. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: A. anthoxanthoides Boiss., Diagn. Ser. 1 (13): 42 (1853).

Fl. 4. Terra rossa hills, oak scrub and grazed rocky limestone slopes, 550 m.

Typus: [Turkey/Syrie] "Hab. in monte Cassio Syriae borealis", [v-vii 1846], Boissier [Iso G!]

S. Anatolia (Anti-Taurus).

C6 Maraş: Maraş, 550 m, D. 27298 p.p.!

External distribution: Latakia, Lebanon. E. Mediterranean element.

Sect. TOZZETTIA (Savi) Endl.

17. A. rendlei Eig in J. Bot. (London) 75: 187 (1937).

Syn: Phalaris utriculatus L., Syst. ed. 10, 2: 869 (1767);
non A. utriculatus Banks & Sol. (1794).

Ic: Trin., Sp. Gram. 1 (4): 46 (1828) (as A. utriculatus Sol.);
Zangheri, Fl. Ital. 2: 183 , f. 6673 (1976) (as A. utriculatus Sol.).

Annual. Rhizomes fibrous. Stem 8-40 cm, erect or geniculately ascending from base, loosely tufted, 3-4-noded. Leaf blades 0.7-16 cm x 1-3 mm, linear, acuminate, slightly rough on upper surface, glabrous beneath; sheaths glabrous, uppermost one strongly inflated; ligule 1-3 mm, obtuse. Panicle 1.1-3.2 cm x 9-11 mm, ovate-oblong, tapering towards apex, branches with 1-2 spikelets. Spikelets 5-8 mm. Glumes subcoriaceous, strongly flattened, connate for $\frac{1}{3}$ to $\frac{1}{2}$ of their length, gibbous at sides, abruptly triangular-cuspidate above middle, acute, slightly divergent at apex, ciliate on keel. Lemma as long a glumes or slightly longer, lanceolate, subobtuse to acute, awned above base, margins connate for $\frac{1}{2}$ of their length; awn 7-18 mm. Palea absent. Anthers 3.4-4.9 mm. Fl. 3-5. Moist water meadows nr. sea, 0-100 m.

Typus: [S. France] Ic. of 'Gramen pratense' in Dalechamps, Historia Generalis Plantarum 1: 425 (1587).

N.W. Turkey.

A1(E) Tekirdag: Tekirdag-Hayranbolu road, 10 km from Tekirdag, A. Baytop (ISTE 19794)!

A1(E) Çanakkale, v. 1864, Schmidt 2568

A2(E) Istanbul: Florya, 1 iv 1894, Azn.!

A2(A) Istanbul: Maltepe, 2 v 1894, Azn.!

A2(A) Izmit: Izmit, 1 m, D.26250!

A6 Samsun: Samsun, 1858, Tchihatchef!

A3 Bolu: Düzce, Kühne 2508 p.p.!

External distribution: W. & S. Europe. In Turkey it has its eastern limit. Mediterranean element.

18. A. setarioides Gren., Fl. Massil. Adv. 43 (1857).

Syn: A. neglectus Azn. in Mag. Bot. Lap. 8: 11 (1911).

Annual. Stem 12-35 cm, erect or geniculate at nodes, tufted or solitary, simple or branched, rather slender, 2-3-noded. Leaf blades 1.2-10 cm x 0.8-3.5 mm, linear, acuminate, slightly scabrid on upper surface, glabrous beneath; sheaths glabrous, uppermost one strongly inflated; ligule 1-2.5 mm, broadly acute to obtuse, denticulate. Panicle 0.8-3.2 cm x 6-11 mm, ovate to broadly cylindrical. Spikelets 3.2-4.5 mm, elliptic-urceolate, solitary on branches. Glumes with long-ciliate keel, acute at apex, connate for $\frac{1}{3}$ of their length. Lemma 3-3.6 mm, acute at apex, slightly shorter than glumes, margins connate for $\frac{1}{3}$ of their length; awn 6.5-10.5 mm, geniculate and twisted in lower half. Palea absent. Anthers 1.5-2 mm. Fl. 4-6. Seaside, dried up ditches, wet places, Nr. sea level.

Described from Marseille (France).

N.W. Turkey, W. Anatolia.

A1(E) Edirne: betw. Havza and Edirne, A. Baytop (ISTE 6549)!

A1(E) Edirne: betw. Kesan and Enez, A. Baytop (ISTE 17824)!

A2(E) Istanbul: Arnavutköy, 8 vi 1913, Azn.!

A2(A) Istanbul: Haydarpaşa, 11 vi 1911, Azn.!

A2(A) Bursa: Karacabey stud farm, 11 vi 1938, Krause (ANK 480)!

B1 Izmir: Bornova, H. Peşmen (EGE 5044)!

C2 Mugla: Köycegiz, 11 iv 1962, C. Regel (ISTE 18969)!

External native distribution: Jugoslavia, Greece. E. Meditteranean element.

33. CORNUCOPIAE L., Sp. Pl. 54 (1753)

Annual. Leaf blades flat. Ligule membranous. Inflorescence a dense head-like panicle, seated in a cup-shaped toothed involucre. Spikelets with 1 floret, laterally compressed. Glumes membranous, equal, connate in lower $\frac{1}{3}$ of their length, 3-veined. Lemma equaling glumes, connate in lower $\frac{1}{2}$-$\frac{2}{3}$, 5-veined, with a dorsal awn. Palea absent. Lodicules absent. Stamens 3. Styles 2, connate below. Caryopsis laterally compressed, obliquely obovate in side view.

Type: C. cucullatum L.

C. cucullatum L., Sp. Pl. 54 (1753).

Ic: Sibth. & Sm., Fl. Graeca 1: t. 51 (1808);

Bor, Fl. Iraq 9: 303, t. 109 (1968).

Annual. Stem 8-47 cm, simple or branched, numerous, erect to geniculately ascending from base, 2-5-noded. Leaf blades 0.6-12 cm x 1-6 mm, linear, acuminate, glabrous to scabrid or ciliate on upper surface; sheaths glabrous, strongly inflated; ligule 0.7-3 mm, obtuse. Panicle 0.5-1.2 cm x 2-9 mm, ovate; peduncles curved, retrorsely scabrid hairy. Involucre 3.5-6.5 mm long, enveloping nearly half of the panicle, glabrous to scabrid, dentate at apex; each tooth 1-1.6 mm, acute. Spikelets 6-7.5 mm, oblong, truncate. Glumes as long as lemma, narrowly elliptic-oblong, usually ciliate on keels. Lemma ovate, truncate at apex; awn very short or absent. Anthers 4-6 mm. Caryopsis 2-2.6 mm, obovate, laterally compressed. Fl. 3-5. Moist banks, marshy fields, inside cultivated land, 0-500 m.

Described from Smyrna D. Hasselquist [Hb. Linn. 76/1!]

S. Anatolia, Islands.

B1 Izmir: iv 1827, Fleischer!

B7 Diyarbakir: Ergani, T. Ekim 1081!

C2 Mugla: Marmaris to Emercik, 10 m, D.25357!

C4 Antalya: Alanya iv 1845, Heldrich.!

C6 Gaziantep: Gaziantep to Maraş, 1219 m, E.K. Balls 883!

C7 Urfa: Siverek, Karaca Da., Sint. 1888: 697!

Is. Kos: Kos to Asclepieion, 50 m, D.40438!

External distribution: Italy, Sicily, Greece, Aegean, W. Syria, Syrian Desert, N. Iraq. E. Mediterranean element.

54. BECKMANNIA Host, Gram. Austr. 3: 5 (1805)

Perennial. Leaf blades flat. Ligule hyaline. Inflorescence a panicle. Spikelets arranged in 2 rows along one side of branches, laterally compressed, obovate in outline, with 2 florets. Glumes equal, shorter than lemma, navicular, ± inflated. Lemma lanceolate, 5-veined, rounded dorsally. Palea 2-keeled. Rhachilla disarticulating below glumes. Lodicules 2, acuminate. Stamens 3. Caryopsis glabrous, elliptic-oblong.

Type: B.eruciformis (L.) Host.

B. eruciformis (L.) Host, Gram. Austr. 3: 5 (1805).

Syn: Phalaris eruciformis L., Sp. Pl. 55 (1753).

Ic: Reichb., Ic. Fl. Germ. 1: t. 171 f. 452 (1850);
Kulczynski, Atlas Fl. Polsk. 4 (1): 382 (1931).

Rhizomes creeping. Stem 50-150 cm, usually with a swollen tuberous base, erect. Leaf blades 10.5-30 cm x 4-10 mm, linear, scabrid; sheaths ribbed; ligule 5-8 mm, acute. Panicle 18-25 cm x 0.5-4 cm, cylindrical, interrupted; branches 1-3 cm, erect to erecto-patent. Spikelets 2.5-5 mm, suborbicular. Glumes 2-3.7 mm, green or rarely purplish, with whitish coriaceous sides and scarious margins, puberulent on inner surface. Lemma puberulent on back, shortly mucronate at apex. Anthers 1.8 mm. Fl. 6-9. Shallow water, wet places, plains, 0-1950 m.

Described from Siberia, Russia, Europa australi [Hb. Linn. 78/9!]

Widespread, but rare in Inner Anatolia and Mediterranean area.

A1(E) Edirne: between Edirne and Havza, A. Baytop (ISTE 6550)!

A2(E) Istanbul: between Yedikule and Bakirköy, 21 vi 1894, Azn.!

A3 Bolu: Aladag, 1300 m, O. Alpay 182!

A4 Ankara: Kizilcahamam, Kurumcu Köyü, 1500 m, Khan et al. 751!

A9 Kars: Cildir Göl, 29 vii 1970, T. Baytop!

B3 Eskisehir: Türkmen Da., Yörük hirka cayi, 900 m, T. Ekim 2216!

B8 Erzurum: Airport, near airstrip, 11 vii 1969, J.G. Ross!

B9 Bitlis: Tatvan, on road to Hizankere, 24 vii 1969, T. Gözler!

C3 Konya: d. Beyşehir, Kurucuova nr. Beyşehir lake, 1200 m,
H. Peşmen & A. Güner 2310!

C7 Adiyaman: 3 km from Gölbasi, on road to Malatya, R. Alava 7024!

C10 Hakkari: 19 km from Yüksekova to Semdinle, 1950 m, D.45127!

External distribution: Europe, Caucasia, Crimea, N.W. Iran, Transcaspia, S. Russia, E. Asia. Introduced in N. America.

In Flora Iranica Beckmannia has been left out completely as a result of little collecting, but I have detected B. eruciformis from S.W. Iran for the first time (Azerbaijan: Shahpur to Rezaiyeh, south of Shahpur, 1350 m, J. Lamond 4058).

35. PHLEUM L., Sp. Pl. 59 (1753)

Annual or perennial. Leaf blades flat. Ligule hyaline, obtuse to truncate. Inflorescence a spike-like panicle. Spikelets with 1 floret, hermaphrodite, laterally compressed. Glumes equal, 3-veined, longer than the lemma, sometimes with a narrow wing on keel, gradually or abruptly terminating in an aristate point or with a small mucro. Lemma 5-7-veined, rounded dorsally, obtuse or truncate at apex. Palea equalling lemma or slightly shorter, 2-veined. Rhachilla disarticulating above the glumes. Lodicules 2. Stamens 3 (-2). Ovary glabrous. Caryopsis elliptic to oval.

Type: P. pratense L.

Literature: Nordenskiöld, H. 1941. Cytological studies in triploid Phleum. In Bot. Not. 1941: 12-32. Nordenskiöld, H. 1945. Cyto-Genetic studies in the genus Phleum. In Acta Agric. Suec. 1: 1-138. Horn af Rantzien, H. 1946. Taxonomical and Phytogeographical Studies in Phleum arenarium L. In Bot. Not. 1946: 364-386.

Key to Species

1. Perennial, with non-flowering shoots at anthesis
   2. Panicle branches free from main axis
      3. Spikelets 2-3 mm; glumea abruptly terminating in an aristate point (c. 03-0.5 mm), glabrous on keel ..... 9. phleoides
      3. Spikelets 3-4.8 mm; glumes gradually terminating in an aristate point (c. 0.5-1.2 mm), ciliate on keel ..... 8. montanum
   2. Panicle branches adnate to main axis
      4. Aristate points of glumes 1.5-3.5 mm; panicle not more than 4 cm long, ovoid-oblong or shortly cylindrical ..... 1. alpinum

4. Aristate points of glumes 0.2-1.7 mm; panicle longer than 4 cm, cylindrical

5. Panicle 6-10 mm wide; spikelets 3.5-4 mm; aristate points of glumes 1-1.7 mm ..... 3. pratense

5. Panicle 3-5 mm wide; spikelets 2-2.7 mm; aristate points of glumes 0.2-0.5 mm ..... 4. bertolonii

1. Annual, without non-flowering shoots at anthesis

6. Glumes with a narrow wing on keel; stamens 2 ..... 5. crypsoides

6. Glumes without a wing on keel; stamens 3

7. Spikelets 4-8 (-10) mm (incl. aristate point); aristate points 4-7 mm ..... 2. echinatum

7. Spikelets 1.5-5 mm (incl. aristate points); aristate points up to 1.2 mm, sometimes almost absent

8. Glumes semi-elliptical; aristate points almost missing ..... 6. subulatum

8. Glumes not semi-elliptical; aristate points 0.2-1.5 mm

9. Spikelets cuneate; glumes swollen in upper third ..... 7. paniculatum

9. Spikelets not cuneate; glumes flat in upper third

10. Panicle tapered at base; spikelets lanceolate; anthers 0.3-0.5 (-0.8) mm; lemma hairs tapering to a fine point ..... 10. arenarium

10. Panicle usually rounded at base; spikelets oblong to ovate; anthers 1.2-2 mm; lemma hairs clavate

11. Spikelets 2.7-3.4 mm; aristate points 0.2-0.4 mm ..... 12. boissieri

11. Spikelets 3-5 mm; aristate points 0.5-0.8 mm ..... 11. exeratum

Sect. PHLEUM

1. P. alpinum L., Sp. Pl. 59 (1753).

Syn: P. commutatum Gaud., Alpina 3: 4 (1808);

P. alpinum var. commutatum Boiss., Fl. Or. 5: 484 (1884)!

Ic: Bor, Fl. Iraq 9: 307, t. 111 (1968);

Hubbard, Grasses 324 (1968).

Laxly ceaspitose perennial, shortly rhizomatus. Stem 10-54 (-61) cm, erect to geniculately ascending, smooth and glabrous, 2-3-noded. Leaf blades 2.5-15.5 cm x 2.5-6 mm, linear, acuminate, glabrous but scabrous on margins; sheaths glabrous, uppermost one sometimes inflated; ligule up to 2 mm, truncate. Panicle 1-4 cm x 0.5-1.2 cm, ovoid-oblong to short-cylindrical, usually purplish. Spikelets 3-7 mm (incl. aristate point), oblong, truncate. Glumes 2.5-4 mm (excl. aristate points), ciliate on keels, slightly hispid on margins, abruptly terminating in an aristate point; aristate points (1.5-) 2-3.5 mm. Lemma ovate, obtuse, c. $\frac{2}{3}$ as long as glumes, hyaline, minutely hairy on veins, mid-vein sometimes minutely exserted. Palea slightly shorter than lemma. Anthers 1.2-1.8 mm. Caryopsis c. 1.5-1.6 mm. Fl. 6-8.

Wet alpine and subalpine meadows, open slopes, by stream and in Picea-Fagus forest, 1525-3174 m.

Typus: "Habitat in Alpibus" /Hb. Linn. 81/4!/

Mainly N. & E. Anatolia.

A2(A) Bursa: Uludag, 1842, Boiss.!

A3 Bolu: Ala Da., Kartalkaya, 1700 m, O. Alpay 391!

A7 Giresun: Balaban Da., above Tamdere, Avşar Y., 2400 m, D.20566!

A8 Rize: Çamlihemşin, Amlahit Y., 1900-2000 m, A. Güner 1158!

A9 Coruh: Kordevan Da. near Küttül Y., 2100 m, D.30187!

B1 Balikesir: Kaz Da., Sint. 528!

B7 Tunceli: Munzur Da. above Ovacik, 2400 m, D.31343!

B8 Mus: W. side of Bingöl Da., 2530 m, D.46167!

B10 Kars: Büyük Agri Da., 2438 m, B.V. Post 2162!

C5 Nigde: Bulghar Maden, viii 1855, Bal.!

C10 Hakkari: Sat Sa. betw. Varegöz and Sat G., 2600 m, D.45673!

External distribution: W., N. and C. Europe, C. and S. Russia, Meriterranean (except N. Africa), Caucasia, Siberia, Afghanistan, E. Asia.

This species is often mixed with another high mountain species, P. pratense, but differs in a number of characters, vis. panicle not more than 4 cm long, ovoid-oblong or cylindrical; spikelets 3-7 mm (incl. aristate point); aristate points of glumes 1.5-3.5 mm.

Here, P. alpinum L. var. commutatum Boiss. is not recognized as a variety, because as far as the examined material either from Boissier's herbarium or other herbaria allows it seems difficult to accept this variety. I have examined a specimen which was collected from A2(A) Bursa: Uludag by Boissier in 1842 and treated as var. commutatum by Boissier in his Fl. Or. 5: 484 (1884). This specimen grows in the same habitat but is a slightly dwarf form of this species. However, it does not require any taxonomic rank.

2. P. echinatum Host, Gram. Austr. 3: 8 (1805).

Ic: Trin., Sp. Gram. 1 (1): 7 (1828);

Reichb., Ic. Fl. Germ. 1: t. 179, f. 485 (1850).

Annual. Stem 11-20 cm, erect or geniculately ascending from base, simple or branched, smooth and glabrous, 1-4-noded. Leaf blades (1-) 2-6 cm x 1.2-2.5 mm, linear, acuminate; sheaths glabrous, uppermost one sometimes inflated; ligule 2.5-4 mm, obtuse. Panicle 1.6-2.2 (-3.5) cm x (0.7-) 1.1-1.5 cm, ovoid to oblong, lower spikelets reflexed. Spikelets 4-8 (-10) mm (incl. aristate points) oblong, truncate, pale

to whitish green. Glumes oblong, obtuse, margins largely membranous, ciliate on keel, abruptly terminating in a divergent aristate point; lower glume slightly puberulent on margins; aristate points 4-7 mm. Lemma c. 2 mm, hyaline, ovate, slightly hairy on veins. Palea slightly shorter than lemma. Anthers 1.8-2.4 mm. Fl. 4-6. Calcicole, near sea level.

Typus: "In Dalmatia inter Breviaqua & Anono" I. Host.

Localised.

A2(E) Istanbul: Istanbul, 1845, Noë 2!

External distribution: Sicily, Italy, Jugoslavia, Albania, Greece, Aegean. E. Mediterranean element.

At first it may seem to be rather suspicious to have only one record from the Flora of Turkey area, but this species can easily be transported long distances because of its relatively long aristate points. However, it is not surprising to come across this species in Istanbul.

3. P. pratense L., Sp. Pl. 59 (1753).

Ic: Lowe, Nat. Hist. Brit. Grasses t. 18 (1891);

Hubbard, Grasses 322 (1968).

Laxly to densely caespitose perennial. Stem 9-85 (-130) cm, erect, or geniculately ascending from base, smooth and glabrous, 3-4-noded, lowest node sometimes rather thickened. Leaf blades 4-20 cm x 3-9 mm, linear, acuminate, glabrous, scabridulous on margins and towards the apex; sheaths glabrous; ligule 1-6 mm, obtuse. Panicle 1-6.2 (-11) cm x 6-8 (-10) mm, cylindrical. Spikelets 3.5-4 mm (incl. aristate points), oblong, truncate. Glumes oblong, largely hyaline on margins, ciliate on keel; lower glume softly hairy on margins; aristate point 1-1.6 mm. Lemma 1.4-2.1 mm, minutely hairy. Palea nearly equalling lemma.

Anthers 1.5-2 mm. Fl. 6-8. Inside mixed deciduous woodland, wet water meadows, open mountain slopes, cultivated land, 1300-2500 m.

Typus: "Hab. in Europae versuris et pratis" /Hb. Linn. 81/17

Widespread, but not present in S. Anatolia.

A2(A) Istanbul: Göksu, 22 vi 1894, Azn.!

A4 Bolu: Gerede to Aktaş Ormani, 1500 m, O. Ketenoğlu 343!

A6 Sivas: Yildiz Da., Sariyer, 1700 m, Tobey 2349!

A8 Trabzon: N. slope of Soganli Da. above Çaykara, 1300 m, D.32081!

A9 Kars: 5 km N. of Kars, 1810 m, D. Spencer 101!

B1 Izmir: Bornova to Manisa, 420 m, Hub.-Mor. 2437!

B3 Eskisehir: Cifteler harasi, H. Birand & M. Zohary 3281!

B6 Yozgat d. Akdagmadeni: Malbant Da., 2000-2200 m, T. Ekim & A. Duzenli 3756!

B8 Erzurum: 29 km from Hinis to Pasinler, 1800 m, D.46375!

B9 Agri d. Suluçam (Musun): 5 km E. of Balik G., 2250 m, D.47079!

C10 Hakkari: Gevar Ovasi betw. Yuksekova and Sat Da., 1900 m, D.45795!

External distribution: W., N and C. Europe, Mediterranean east to Aegean, Caucasia, Siberia, Syrian Desert, Iran, E. Asia. Introduced into N. America.

4. P. bertolonii Dc., Cat. Horti Monsp. 132 (1813).

Syn: P. nodosum auct. non L., Syst. Nat., ed. 10: 871 (1759);
P. pratense L. var. nodosum Boiss., Fl. Or. 5: 484 (1884)!;
P. pratense L. subsp. bertolonii (DC.) Bornm. in Bot. Jahrb. 61, 140: 157 (1928).

Ic: Trin., Sp. Gram. 1 (1): 6 (1828);
Hubbard, Grasses 320 (1968).

Caespitose perennial. Stem 15-68 cm, erect or geniculately ascending from base, glabrous and smooth, 3-5-noded, the lowest node rather thickened. Leaf blades 2-16 cm x 1.5-2.5 mm, linear, acuminate, glabrous, slightly scabridulous on margins; sheaths smooth; ligule 1.5-2.5 mm, obtuse. Panicle 1-6 cm x 3-5 mm, cylindrical. Spikelets 1.9-2.5 (-2.7) mm (incl. aristate points), oblong, truncate. Glumes oblong, largely hyaline on margins, ciliate on keel; aristate points 0.2-0.5 mm; lower glume softly hairy on margins; upper glume glabrous on margins. Lemma 0.7-1.8 mm, truncate-denticulate. Palea ± equaling lemma. Anthers 1-2 mm. Fl. 5-7. Sandy soil, roadside, protected fields, 30-1500 m.

Typus: "Hab. in collibus circa Sarzanam", Bertoloni

Turkey-in-Europe, N.W. Anatolia, Inner Anatolia and Islands.

A1(E) Edirne: 25 km S.E. of Keşan, 500 m, F. Sorger 77-1-19!

A2(E) Istanbul: Kemerburgaz, A. Baytop (ISTE 5986)!

A2(A) Istanbul: Çamlica, 28 vi 1891, Azn.!

A3 Ankara: Beypazari above Karaşar, Narli Kaş, 1500 m, Y. Akman 17!

A4 Çankiri: 1 km S. of Dogu gendarme station, 1430 m, K.P. Buttler 1559B!

B3 Eskişehir: Türkmen Da., 1000 m, T. Ekim 2223!

Is. Bozcaada: Göztepe to Merkez, 30 m, Ö. Seçmen & E. Leblebici 1640a

External distribution: W. and C. Europe, Mediterranean, S. Russia, Crimea, Caucasia, N. Iran.

Sect. MAILLEA (Parl.) Horn af Rantzien.

5. P. crypsoides (D'Urv.) Hackel ex Franchet in Bull. Soc. Bot. Fr. 39: 274 (1892).

Syn: Phalaris crypsoides d'Urv., Enum. Pl. Ins. Pont. Eux. 7 (1822); Maillea crypsoides (d'Urv.) Boiss., Fl. Or. 5: 478-479 (1884).

Annual. Stem (1-) 2-2.5 (-4) cm, usually tufted, erect, glabrous and smooth. Leaf blades 0.4-2.5 cm x 1-2.5 mm, linear, acute, green, slightly scabrid on margins and upper surface (on the veins), channeled deeply; sheaths glabrous and smooth, membranous, uppermost one usually inflated and enveloping the panicle; ligule up to 2 mm. Panicle 0.7-1 mm x 5-10 mm, ovoid to elliptical, rounded at base, whitish. Spikelets 3-3.8 mm, ovate to broadly elliptical. Glumes hyaline on margins, slightly hairy, with a dorsal wing, pectinate; aristate point c. 0.2-0.3 mm. Lemma 0.8-1 mm, 1-veined, ovate, obtuse at apex, glabrous. Palea $\frac{2}{3}$ as long as lemma, bifid at apex. Anthers 0.7-0.9 mm. Stamens 2. Caryopsis 0.9-1 mm, ovoid, terete. Fl. 5-6. Sandy soil on the coast, sea level.

Typus: /Greece/ "In scopulo Raphi ad littus Atticum", D'Urville Islands.

Rhodos: sea coast, 22 vi 1870, Bourgeau!

External distribution: Sardinia, Greece, Aegean. Mediterranean element.

Sect. ACHNODON Griseb.

6. P. subulatum (Savi) Aschers. & Graebn., Syn. Mitteleur. Fl. 2 (1): 154 (1899).

Annual. Stem 7-42 cm, erect to geniculately ascending from base, smooth and glabrous, usually simple, solitary to tufted, 1-6-noded. Leaf blades 1-15 cm x 1-5 mm, linear, acuminate, usually glabrous, slightly scabrous only on margins, sometimes covered with long hairs; sheaths glabrous, uppermost one slightly inflated; ligule 2.5-5 mm, acute. Panicle 1-12 cm x 3-9 mm, cylindrical, whitish green. Spikelets (1.5-) 2-4 mm, elliptic, rather firm. Glumes semi-elliptical, with a minute aristate point, largely hyaline on margins and between veins,

glabrous or ciliate on keel. Lemma about $\frac{1}{3}$-$\frac{1}{2}$ as long as glumes, hyaline ovate, dentate-truncate at apex, covered with clavate hairs. Palea nearly equalling lemma, with short clavate hairs on keels. Anthers 1.3-2 mm.

Key to subspecies

1. Glumes glabrous on keel ..... subsp. subulatum

1. Glumes ciliate on keel ..... subsp. ciliatum

. subsp. subulatum

Syn: Phalaris subulata Savi, Fl. Pis. 1: 57 (1798);

Phalaris tenuis Host, Gram. Austr. 2: 36 (1802);

Phleum tenue (Host) Schrad., Fl. Germ. 191 (1806).

Ic: Reichb., Ic. Fl. Germ. I: t. 179, f. 480 (1850);

Fiori, Ic. Fl. Ital. 1: 21, f. 175 (1895) as P. tenue.

Fl. 5-7. Sandy clay cliff on coastline, on limestone, mountain slopes, meadows, in Quercus, Paliurus and Pinus brutia forest, 3-914 m.

Typus: "Nel monte Pisano fiorisce vel Maggio", Savi

Widespread but not present in Inner and E. Anatolia.

A1(E) Tekirdag: 5.5 km W. of Tekirdag, 100 m, Ccode & Jones 2836!

A2(E) Istanbul: Kiyyos, 27 km N. of Istanbul, 20 m, J.R. Edmondson 403!

A3 Adapazari: Arifiye, 30 m, D.36258!

A4 Zonguldak: Zonguldak to Çaycuma, 450 m, D.37658!

A5 Sinop: Sinop, West beach, Tobey 1012!

A7 Trabzon: Trabzon, 33 m, Balls & Gourlay 1596!

B1 Izmir: 11 km S. of Aliaga, 200 m, F. Sorger 66-5-15!

B2 Manisa/Izmir: 13.5 km from Salihli to Ödemiş, 440 m, K.P. Buttler 17286!

C2 Denizli: Pamukkale, 400 m, F. Sorger 66-6-7!

C3 Antalya: Manavgat, N. Birand & K. Karamanoglu (ANK. 1060)!

C4 Içel: Mut, 9 km from Mut to Karaman, 300 m, Coode & Jones 926!

C5 Adana: Sultanhisar, Toros Da., Keserciogiu (EGE 15508)!

C8 Siirt, Botan Çay Gorge, 11 km from Siirt, 450 m, D.43262!

Is. Gökceada: near Todori fountain, 200 m, Ö. Segmen & E. Leblebici 1962!

External distribution: W. and C. Europe, Crimea, Mediterranean, Syrian Desert, N. Iraq, Arabia, Pakistan.

subsp. ciliatum (Boiss.) C.J. Humphries in Bot. J. Linn. Soc. 76: 339 (1978).

Syn: Phleum tenue var. ciliatum Boiss., Fl. Or. 5: 480 (1884)!

Fl. 5-7. Grassy slopes and lawns, stony ground near sea, on limestone, 20-700 m.

Typus: "Hab. Pelouses du Cimetiere Turc pres Rhodes", 8 v 1870, Bourgeau [G!]

W. Anatolia and Islands.

B1 Izmir: Yamanlar Da., Karagöl, 700 m, Regel & Leblebici (EGE 16365)!

C1 Mugla: d. Marmaris: Datça to Knidas, 150 m, Khan et al. 111!

C2 Mugla: 13 km S. of Fethiye, O. Polunin 13964!

Is. Psara: Ahladhokambos, 20 m, W. Greuter 10849!

Rhodos: Rhodos, Bal. 2454!

External distribution: Jugoslava, Greece, Crete, Aegean.

Sect. CHILOCHLOA (Beauv.) Griseb.

7. P. paniculatum Hudson, Fl. Angl. ed. 1: 23 (1762).

subsp. ciliatum (Boiss.) M. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: P. annuum M. Bieb., Fl. Taur.-Cauc. 1: 46 (1808)!;

P. asperum Vill. var. ciliatum Boiss., Fl. Or. 5: 482 (1884)!

Annual. Stem 7-24 (-40) cm, fasciculate, erect or geniculately ascending, smooth and glabrous, usually 3-5-noded. Leaf blades 2-7 (-14) cm x 2-5 mm, linear, acute, glabrous, scabrid on margins; sheaths slightly inflated; ligule 2-4 mm, obtuse. Panicle 1-7 cm x 4-6 mm, cylindrical. Spikelets 1.6-3.5 mm, cuneate. Glumes ± truncate, swollen in upper third and terminating in an aristate point, rather coarse, shortly ciliate on keel; aristate point 0.4-0.6 mm. Lemma about $\frac{2}{3}$ as long as glumes, subobtuse, slightly hairy. Palea as long as lemma. Anthers 0.4-0.7 mm. Caryopsis 1-1.1 mm. Fl. 6. Irrigated fields, dry rocky slopes and open places, 680-2440 m.

Typus: [Crimea] "Hab. in Tauria meridionalis et Caucaso septentrionali", Marschall Bieberstein.

E. Anatolia.

A8 Çoruh: Atila Da., Sarter Da., 680 m, R. Angin 2368!

C9 Hakkari: Zap gorge near turning to Hakkari, 1220 m, J. Trelawny 1103!

C10 Hakkari: S. of Cilo Da., N.W. slope of Talana, 2440 m, J. Trelawny 1604!

C10 Hakkari: 45 km S. of Yüksekova, Piskasir road to Oramar, 1830 m, J. Trelawny 1407!

External distribution: Crimea, Caucasia, Iran, Afghanistan.

8. P. montanum C. Koch in Linnaea 11: 383 (1848).

Densely caespitose perennial. Stem 12-83 (-90) cm, usually erect, only geniculate at base and lower nodes, glabrous, smooth, robust, often purplish, 2-3-noded. Leaf blades 2-21 cm x 1-4 mm, linear, rather firm, flat to convolute, scabrous on margins, ± glaucous; sheaths glabrous; ligule 1-3.5 mm, obtuse. Panicle 1.4-19.5 cm x 6-12 mm,

cylindrical, tapering towards apex. Spikelets 3-4.8 mm (incl. aristate points). Glumes gradually terminating in an aristate point, cectinate-ciliate on keels; aristate point 0.5-1.2 mm. Lemma c. 2 mm, slightly hairy, rounded on dorsal, ovate, obtuse when opened up, rather firm. Palea equaling lemma. Anthers 1-2 mm.

Key to subspecies

1. Spikelets 3-4 mm; glumes hairy but hairs very short
..... subsp. montanum

1. Spikelets 3-4.8 mm; glumes covered by long aculeolate-ciliate on dorsal side ..... subsp. serrulatum

1. subsp. montanum

Ic: Reichb., Ic. Fl. Germ. I: t. 180 f. 487 (1850);
Kulczynski, Atlas Fl. Polsk. 4 (2): 401 (1932).

Fl. 6-7. Grassy igneous slopes, edge of Betula forest, Oak scrub, on sand stones, banks, 265-2300 m.

Typus: [Turkey A8 Çoruh] "Auf alk im Gaue Artamudsch östlich von Artvin", C. Koch

N., E. and Inner Anatolia.

A2(A) Bilecik: Bilecik to Pazaryeri, 500 m, D.36462!

A3 Bolu: Abant G., 9 vii 1940, Azn.!

A4 Ankara: Cubuk, Karagöl, S. Erik 463!

A5 Corum: 40 km E. of Corum on road to Samsun, Jardine 378!

A7 Trabzon: Bestas köy, 10 km S. of citadel, 265 m, Dent 70B!

A9 Kars: Susuz, 8 km from Kars, 1800 m, D.30610!

B5 Nigde: Hasan Da., N. slope, 1500 m, A. Düzenli 409!

B6 Sivas d. Sarikişla: Güldede Da., 2000-2150 m, T. Ekim & A. Düzenli 3755!

B7 Erzincan: 48 km from Erzincan to Sivas, M. Tanker (ISTE 5617)!

B10 Kars d. Aralik: Kucuk Agri Da., near Serdar Bulak 2300 m, D.46891!

C4 Konya: Ermenek to Karaman, 53 km from Ermenek, 1480-1580 m, Hub.-Mor. 10339!

C6 Hatay: Amanus Mountains, 1500-2000 m, Samuelsson 3797!

External distribution: C. Europe, Bulgaria, Jugoslavia, Albania, Greece, Crimea, Egypt, Lebanon, Caucasia, W. Iran, Afghanistan.

2. subsp. serrulatum (Boiss.) N. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: P. boehmeri var. ciliatum Griseb. in Ledeb., Fl. Ross. 4: 457 (1852);

P. serrulatum Boiss., Diagn. Ser. 2 (4): 125 (1859)!

Fl. 5-7. Mountain slopes, tree plantation fields, 750-1150 m.

Typus: [Turkey C5 Adana] "Hab. in collibus incultis Ciliciae supra Gülek Boghas", [1 vii 1855], Balansa 12 [G!]

Mainly S. Anatolia.

C2 Antalya d. Kemer: Teke Da. near Ovacik, 1100-1200 m, D.15203!

C2 Denizli: Honas Da., 750 m, E. Tuzlaci (ISTE 24969)!

C3 Antalya: around Side, 5 vi 1970, A. Pamukcuoglu & Quezel (HUB)!

C5 Adana: Karaisali, 24 vi 1970, A. Pamukcuoglu (HUB)!

C5 Adana: Karsanti, 1150 m, E. Yurdakulol (ISTE 23852)!

External distribution: Lebanon, Latakia.

9 P. phleoides (L.) Karsten, Deutsche Fl. 374 (1881).

Syn: Phalaris phleoides L., Sp. Pl. 55 (1753)!;

Phleum boehmeri Wibel, Prim. Fl. Werth. 125 (1799).

Ic: Hubbard, Grasses 318 (1968).

Densely caespitose perennial. Stem 14-83 cm, erect but often geniculate at base, smooth, glabrous, often purplish, 2-3-noded.

Leaf blades (0.7-) 2-21 cm x 1-4 mm, linear, acuminate, flat to convolute, scabrous on margins, greyish green; sheaths smooth; ligule 0.7-2 mm, obtuse. Panicle 1.5-5.5 cm x 4-7 mm, cylindrical, tapering towards apex, greenish-grey. Spikelets 2-3.5 mm (incl. aristate point), oblong. Glumes abruptly terminating in an aristate point, glabrous on keel, obtuse at apex; aristate point c. 0.3-0.5 mm, usually divergent. Lemma $\frac{2}{3}$-$\frac{3}{4}$ as long as glumes, rounded on dorsal surface, ovate-obtuse when opened up, rather firm, usually minutely hairy on the back. Palea equaling lemma. Anthers c. 0.9-1.2 mm. Caryopsis c. 1.3 mm.

Fl. 6-8. Dry pastures and hillsides, 800-2000 m.

Typus: "Hab. in Europae versuris", /Hb. Linn. 78/5!/

N., W. and Inner Anatolia.

A1(E) Kirklareli: 17 km N. of Kirklareli, Kadiköy, N. Ulucak (ISTE 23871)!

A2(A) Istanbul: Kayiş Da., 7.5 km E. of Erenköy, 9 vi 1895, Azn.!

A4 Ankara: Çubuk, 500 m E. of Karagöl, 1200-1400 m, S. Erik 187!

A8 Rize: Cimil, 2000 m, Bal. 1558!

A9 Kars: Cildir, Grossheim I: Map 152

B2 Izmir: Bozdag, 1500 m, K.P. Buttler 17427!

B3 Eskişehir: Türkmen Da., Kuyucuk alani, 1400 m, T. Ekim 2227!

External distribution: W., N. and C. Europe, Mediterranean area, Crimea, N. Iraq, Iran, C. and S. Russia, Siberia.

10. P. arenarium L., Sp. Pl. 60 (1753).

Syn: P. arenarium L. subsp. eu-arenarium Hayek, Prodr. Fl. Balc. 3: 345 (1933).

Ic: Kulczynski, Atlas Fl. Polsk. 4 (2): 401a (1932); Hubbard, Grasses 316 (1968).

Annual. Stem 2-24 cm, tufted to solitary, erect to geniculately ascending from base, rather slender, 2-3-noded. Leaf baldes 0.5-4 cm x 2-4 mm, linear, acute, rough on margins; sheaths smooth, scarious, sometimes uppermost one inflated; ligule 2-7 mm, acute. Panicle 1-3.5 cm x 5-8 mm, ovoid to oblong, tapered at base but rounded at apex, usually pale green, occasionally ± purplish. Spikelets 3-4 mm, lanceolate to oblong. Glumes lanceolate, hyaline on margins and between veins, gradually narrowed in an aristate point, densely ciliate on keel; aristate point 0.3-0.5 mm. Lemma ⅓ as long as glumes, obtuse to dentate-truncate at apex, hairy on dorsal surface. Palea as long as lemma. Anthers 0.3-0.5 (0.8) mm. Sandy soil on coast, sea level. Typus: "Hab. in Europae locis arenosis" /Hort. Cliff. BM!/

Islands.

Samos: Mittlere Region, Forsyth-Major: 396

Lesvos: Malea; Nerutsika, Candargy

External distribution: N.W. Africa, Cyrenaica, Aegean, W. Syria.

The presence of P. arenarium L. has long been accepted from Turkish Thrace but no major investigation has been done on this species. I have investigated a number of specimens and found that neither Boissier's nor Aznavour's Turkish records are correct. The most distinctive feature of this species is the length of its anthers which are never longer than 0.8 mm. This is not made clear even in Flora Europaea in which these wrong Turkish records are accepted.

11. P. exeratum Griseb., Spicil. Fl. Rumel. 2: 463 (1844).

Annual. Stem 5-49 cm, erect or geniculately ascending from base, tufted or solitary, slender, smooth and glabrous, 4-5-noded. Leaf blades 1-11.5 cm x 2-6 mm, linear, acute, glabrous, minutely rough on margins; sheaths glabrous, sometimes uppermost one ± inflated;

ligule 2-5 mm, obtuse. Panicle 1-9 (-10) cm x 5-12 mm, cylindrical, usually rounded at base. Spikelets 3-5 mm, oblong-lanceolate. Glumes largely hyaline on margins, ciliate on keel, two lateral veins visible; aristate points 0.5-0.8 mm, usually straight. Lemma 1.2-1.5 mm, hyaline, ovate, obtuse, covered with clavate hairs on dorsal surface. Anthers 1.2-2 mm. Caryopsis 0.9-1.1 mm, elliptic, ± terete.

Key to subspecies

1. Spikelets 3-5 mm; cilia about as long as width of glumes and rather dense ..... subsp. exeratum

1. Spikelets 2-2.5 (-3) mm; cilia less than ½ x as long as width of glumes and not dense ..... subsp. aegaeum

subsp. exeratum

Syn: P. graecum Boiss., Heldr. ex Boiss., Diagn. Ser. 1 (13): 42 (1853)!;

P. arenarium L. var. breviglume Bornm., in Verh. Zool.-Bot. Ges. Wien 48: 643 (1898)!;

P. cormutum Mez in Feddes Rep. 17: 293 (1921).

Ic: Bor, Fl. Iraq 9: 309, t. 112 (1968);

Zangheri, Fl. Ital. 2: 183, f. 6650 (1976) as P. graecum.

Fl. 5-7. Open places, inside Pinus forest, on chalky soil, 600-2300 m.

Typus: [Bulgaria] "Prope Rusköi, et prope Banjo, Thracia", Frivaldsky.

Widespread.

A1(E) Edirne: 3 km from Süloglu to Kovankaya, A. Baytop (ISTE 31804)!

A2(E) Istanbul: Belgrad forest near Topuzlu Bent, 20 v 1959, Yalt.!

A3 Ankara: Beypazari, Inözü De., 1200 m, Y. Akman 1018!

A4 Ankara: 15 km N. of Ankara on Çankiri road, Coode & Jones 2133!

A5 Çorum: Osmancik to Kargi, 600 m, Tobey 2671!

A6 Samsun: Gelemen, sea level, H. Birand (ANK 1061)!

A9 Kars: Sarikamis, 2300 m, G. Oguz & B. Yildiz (EGE 16358)!

B1 Manisa: Manisa Da., A. Baytop (ISTE 9921)!

B2 Kutahya: Gediz to Çavdarhisar, 1100 m, D.36994!

B3 Afyon: Bayat, Erdenalani Tepe, 1520 m, M. Vural: 91!

B4 Ankara: Tuz G. N.E. side of lake, A. Bayton (ISTE 7113)!

B5 Kayseri: 19 km from Kayseri to Sivas, 1020 m, H. Birand & M.Zohary 66!

C2 Denizli: Cankurtaran to Acipayam, 34 km from Denizli, 1250 m, A. Baytop & E. Tuzlaci (ISTE 25548)!

C3 Isparta: Egridir, Anamas, Yakaavşar köy, 1400 m, H. Peşmen & A. Güner 1428!

C4 Konya: Meram, Regel (EGE 4588)!

C7 Urfa: 32 km from Urfa to Hilvan, 700 m, D.28251!

External distribution: Italy, Balkans, W. Syria, N, Iraq, Iran, Transcaspia.

. subsp. aegaeum (Vierh.) M. Dogan in Notes R.B.G. Edinb.

Syn: P. arenarium L. subsp. aegaeum Vierh. in Verh. Zool.-Bot. Ges. Wien 69: 304 (1919);

P. graecum subsp. aegaeum (Vierh.) W. Greuter in Boissiera 13: 180 (1967).

Sandy soil on coast, sea level.

Syntypes: Delos, Naxos, Kythnos und Cerigo, Vieshapper.

Islands.

Kos: Tigaki, A. Hansen et al. 360;

Troulos, A. Hansen et al. 1098;

M. Limanaki, A. Hansen et al. 1146a.

External distribution: Aegean.

12. P. boissieri Bornm. in Mag. Bot. Lap. 11: 20 (1912).

Syn: P. exeratum Hochst. ex Boiss., Fl. Or. 5: 480 (1884).

Annual. Stem 8-60 cm, usually erect, somewhat geniculately ascending from base, tufted or solitary, simple, very occasionally branched, smooth and glabrous, slightly purplish, 3-4-noded. Leaf blades 1.5-7 (-8) cm x 2-4.2 mm, linear, acuminate, rather soft, glabrous. Panicle 1.5-14 cm x 3-6 mm, cylindrical to oblong, tapering at both ends. Spikelets 2.7-3.4 mm, elliptic to lanceolate-elliptic. Glumes ± coriaceous, ciliate on keel; aristate point 0.2-0.4 mm, always divergent. Lemma 1.2-1.5 mm, ovate, obtuse, covered with clavate hairs on dorsal surface. Palea equalling lemma. Anthers 1.5-1.5 mm. Caryopsis 0.8-1 mm, rounded, terete. Fl. 5-8. Rocky limestone slopes, sand dunes, fallow fields, 0-1300 m.

Typus: [Syria] "In collibus siccis Syriae borealis ad Aleppo" [1842], Kotschy: 197.

Inner and S. Anatolia.

B5 Nevşehir: 5 km from Gulşehir to Nevşehir, 450 m, McNeill 385!

B6 Malatya: Derende to Kavakagaç, 14 vii 1906, G. & B. Post!

C5 Adana: near Tuzla, sea level, Coode & Jones 335!

C6 Maraş: 24 km from Maraş to Goksun, 1300 m, Stn. & Hend. 5516!

C8 Mardin: 56 km N. of Mardin to Diyarbakir, 600 m, H. Birand!

C9 Hakkari: Çukurca, 1200 m, D.44763!

External distribution: Palestine, Latakia, Syrian Desert, N. Iraq, N., N.W. and C. Iran, Afghanistan. Introduced into N. America.

36. PSEUDOPHLEUM M. Dogan in Notes R.B.G. Edinb. 40(1): 75-76 (1982)

Annual. Leaf blades convolute. Ligule membranous. Inflorescence a spike-like panicle. Spikelets with 1 floret, laterally compressed, hermaphrodite. Glumes shorter than lemma, 3-veined, unequal, navicular, slightly connate at base. Lemma oblong, terminating in a short awn, keeled in upper half but dorsally rounded, 5-veined, densely hairy on dorsal surface. Palea 2-veined, equaling lemma. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Ovary glabrous. Caryopsis ovate. Monotypic.

Type: P. gibbum (Boiss.) M. Dogan

P. gibbum (Boiss.) M. Dogan in Notes R.B.G. Edinb. 40(1): 77 (1982)

Syn: Phleum gibbum (Boiss., Diagn. ser. 1 (5): 69 (1844).

Annual. Stem 5-20 cm, often solitary, sometimes tufted, erect, occasionally geniculate in lower part, reddish, slender, glabrous and smooth, 3-4-noded. Leaf blades 0.8-5 cm x 0.8-1.5 mm, linear, acuminate, ± convolute, rigid, scabrid on margin; sheaths glabrous; ligule 2.5-4 mm, acute. Panicle 0.7-4.3 cm x 0.4-0.6 mm, cylindrical. Spikelets 2.5-3 mm, cuneate-obovate, pale green. Glumes navicular, narrow at base, coarse, coriaceous; lower glume 1.8-2.2 mm; upper glume 2.4-2.6 mm. Lemma 2.7-3 mm (incl. awn), oblong, coriaceous, hairy; terminal awn up to 0.6 mm. Palea c. 2.6 mm. Caryopsis c. 1.3 mm. Fl. 6-7. Meadows, dry hilly places on mountains, 900-1250 m.

Typus: [Turkey A2 Aydin] "Hab. in arenosis regionis superioris Mesogis supra Tralles in consortio Saponariae Mesogitanae etc." [vi 1842], Boissier [Holo G!]

W. Anatolia.

B2 Manisa: Boz Da. Y., 22 vii 1854, Bal.!

B2 Uşak: Kaya Agil Köy, S.W. of Uşak, 7 vii 1857, Bal.!

B2 Usak: Karagöl Köy, 7 vii 1857, Bal.!

B2/C2 Burdur: Beysehir to Sarkikaraagac, 11 km E. of the latter, 1250 m, R. Çetik (ISTE 33840)!

B2 Denizli: Yayla Gölü near Buldan, G. Regel (ISTE 12329)!

Endemic to Turkey. E. Mediterranean element.

37. RHIZOCEPHALUS Boiss. Diagn. ser. 1, 5: 68 (1844)

Annual. Leaf blades flat. Ligule membranous. Inflorescence a dense head-like panicle, surrounded by sheaths. Spikelets with 1 floret, laterally compressed, hermaphrodite. Glumes equal, shorter than lemma, 3-veined, coriaceous, very shortly connate at base. Lemma 5-veined, coriaceous, with hyaline margins, enclosing palea, with an apical mucro. Palea 2-veined, keeled, nearly equaling lemma. Rhachilla disarticulating above glumes. Lodicules absent. Stamens 2. Ovary glabrous. Caryopsis ovate, with a short beak. Monotypic.

Type: R. orientalis Boiss.

R. orientalis Boiss., Diagn. ser. 1 (5): 68 (1844).

Syn: Crypsis pygmaea Jaub. et Spach, Ill. Pl. Orient. 4: 8, t. 307 (1850);

Heleochloa orientalis (Boiss.) Dinsm. in Post, Fl. Pal. ed. 2, 2: 717 (1933).

Ic: Bor, Fl. Iraq 9: 321, t. 117 (1968).

Annual. Stem 0.5-2 cm, tufted. Leaf blades 0.8-4 cm x 1-4 mm, linear, acuminate, green, scaberulous on upper surface, glabrous on lower; sheaths scarious, inflated; ligule up to 1 mm, lacerate. Panicle 0.8-1.5 cm x 4-8 mm. Spikelets 3.5-6.5 mm (incl. mucro), Glumes 2.5-4 mm, urceolate, when flattened oblong, lanceolate. Lemma 5-6.5 mm (incl. mucro), lanceolate to oblong, scabrid on veins, covered with clavate hairs in lower half; terminal mucro 0.5-1 mm. Palea 4-5.5 mm, lanceolate, hyaline. Anthers 0.5-0.7 mm.

Fl. 3-4. Roadside, grazed and salty steppe, 950-1200 m.

Typus: "In Mesopotamia" Aucher-Eloy: 3066 /Holo G!/

Inner Anatolia.

B4 Ankara: Tuz Gölü, 10 km S. of Sereflikoçhisar, 950 m, Coode & Jones 136!

B5 Yozgat: 10 km N. of Bogazlayan, on road to Yozgat, 1200 m,

Coode & Jones 1497!

C5 Nigde: Aksaray to Ulukişla, S. of junction with Nigde road, 1200 m,

Coode & Jones 183!

External distribution: W. Syria, N. Iraq, N.W. and W. Iran, Transcaspia. Ir.-Tur. element.

Chapter VIII

8. Phytogeography, Dispersal Mechanisms and Endemism

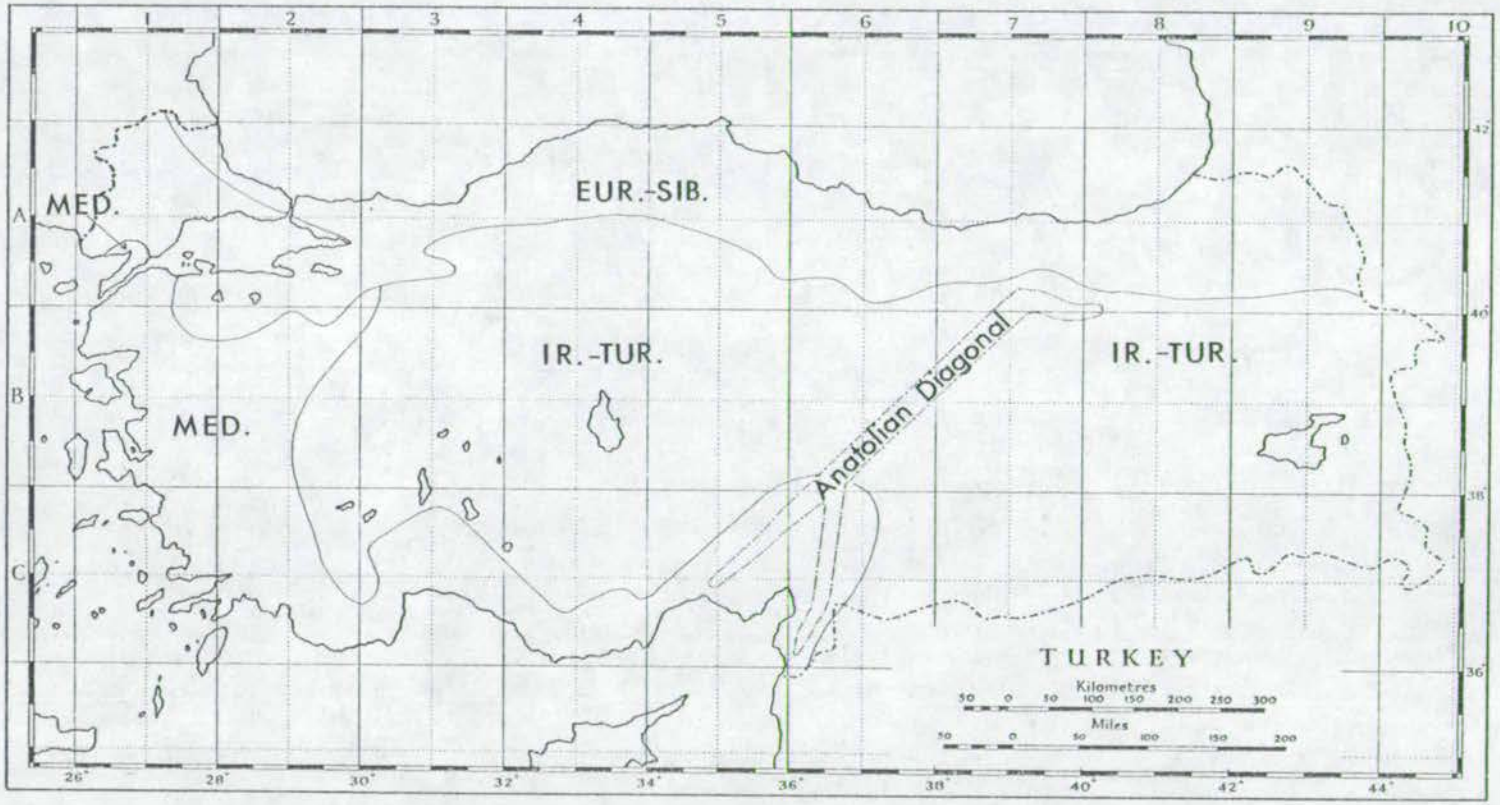
8.1. Introduction

Turkey occupies an area of almost 300,000 square miles and forms a bridge between S.W. Asia and S.E. Europe. It is bounded on the east by Russia and Iran; on the west of Greece, Bulgaria and the Aegean Sea; on the north by the Black Sea; on the south by the Mediterranean, Iraq and Syria. A brief summary regarding the climatic types, topographic features and also phytogeographical regions of Turkey, is given by Walter (1956) and later Davis (1965, vol. 1) in his Flora of Turkey. M. Zohary (1973) mentioned phytogeographical regions of Turkey and listed some of the indicator species growing in them. This is the only work which covers the whole of S.W. Asia and mainly deals with the different vegetation types, climate, topography and soil.

8.2. Phytogeographical regions

According to Davis (op. cit.) Turkey is the contact area of three phytogeographical regions: Euro-Siberian (represented by the Euxine province); Mediterranean (represented by the East Mediterranean provinces of West Anatolia, Taurus and Amanus [i.e. West and South Anatolia respectively]); and Irano-Turanian (represented by Inner Anatolia [i.e. Central and Eastern Anatolia]). These three phytogeographical regions differ from one another on the basis of their different floristic composition and in vegetational aspects. Methods for the recognition of such regions are given by Braun-Blanquet (1932) and Zohary (1962, 1963). The most pragmatic method, adopted by Davis (1965, 1971) for the delimitation of the Turkish phytogeographic regions, takes account of the distribution of only the present day flora, not considering floras or vegetation which no longer exist

Map I



Phytogeographical Regions in Turkey

EUR.-SIB. Euro-Siberian Region; MED. Mediterranean Region; IR.-TUR. Irano-Turanian Region.

in the area. The present three phytogeographical regions in Turkey are shown on Map I after Davis (1971), though he (personal communication) considers that some modification of the regional boundaries will be required, especially in N.E. Anatolia, where most of the province of Kars (except the Aras valley) is Euro-Siberian, not Irano-Turanian.

8.3. Climate

Climate is certainly one of the most important factors determining the distribution of plants in general. This is the reason why these three phytogeographical regions have been dominated by different plant communities. In Turkey the three phytogeographical regions, Euro-Siberian, Mediterranean and Irano-Turanian, experience different types of climate.

In the Euro-Siberian phytogeographical region, confined to North Anatolia, the most striking climatic feature is the heavy rainfall which is greatest in the east around Rize where it continues all the year round. As a result of relatively high evaporation, the hills are covered by thick mist, but above the tree level the sky is quite clear and the meadows exposed to long daily sunlight. Towards the west, rainfall drops after Fatsa (Ordu) and increases again after Cape Sinop. In N. Anatolia there is a narrow coastal Mediterranean vegetation, particularly between Sinop and Alaçam (Samsun). In Rize, Perşembe (Ordu), Çarşamba and Bafra (Samsun), Citrus and Zea mays crops grow very well because of relatively mild winters. However, in the Euro-Siberian phytogeographical region summers are warm and relatively wet; winters (at least in the lower regions) are mild and also wet.

In the Mediterranean phytogeographical region, confined to the South and West Anatolia, summers are hot and arid but the winters (except in the mountains) are mild and wet. Even during the hottest summer days,

in spite of having not very much rain, humidity is not as low as it is on the plateau of Inner Anatolia. During winter, snow lies above 1000 m, so increased cold, low temperature and drier air partly explain the penetration of steppic elements from Inner Anatolia into the high mountains, especially in the N. side of the Taurus range.

In the Irano-Turanian phytogeographical region (represented by Central and East Anatolia), a typical steppic climate occurs - cold winters, hot dry summers. Main water supply is the winter snowfall. During summer, diurnal temperature variation is considerable. Humidity is lower than in the Mediterranean area, causing ones lips to crack. This is the area which provides the most favourable conditions for cultivating cereals. In fact, the cultivation of grasses is very long established in this part of Turkey, not so much because ancient civilizations existed here but because of the favourable climatic conditions.

The differentiating factors between the climates of the Euro-Siberian and Mediterranean regions are thus precipitation and temperature; between the Mediterranean and Irano-Turanian regions they are the lower precipitation and especially very low summer humidity and extremely cold winters of the Irano-Turanian region. Water supply is therefore often vital in controlling the distribution of Euro-Siberian, Mediterranean and Irano-Turanian elements. Both the Mediterranean and Irano-Turanian regions have a predominantly therophytic climate.

Some plants are characteristic of central Anatolian steppe, forming low xeromorphic communities. Among these the more important genera are spiny Astragalus, Artemisia, Festuca and Stipa spp. Birand (1960) fully investigated the halophytic vegetation around Tuzgölü, dominated by Chenopodiaceae.

In the highest mountains of Turkey, above 3000 m, snow lies throughout the summer. Small glaciers still exist on the top of some

of these mountains, such as Cilo Da., Agri Da. and Erciyas Da.

Dam construction works have been going on in Turkey for two decades and in recent years the completion of the Keban (Elazig) dam demonstrated its vital importance from a climatic point of view. Probably after the next decade there will be two more big dams in S.E. Anatolia. One called "Atatürk Baraji" (Gaziantep-Urfa) will be the third biggest dam in the world. This means there will be several big lakes. One can predict that, in the long term, after the completion of these construction works, a considerable climatic change will take place in S.E. Anatolia ameliorating the climate. Eventually more Mediterranean elements may penetrate into these areas and the Irano-Turanian elements may decline.

8.4. Topography

Most of the Anatolian peninsula consists of a plateau, rising steadily towards the east and bounded on the north and south by high mountain ranges. The Balkan and Anatolian ranges help to connect the Alps to the Himalayan mountain chain. This link is continued by the Aegean Islands which are the relicts of long submerged land that in the Pliocene connected Greece to Turkey. In W. Anatolia, mountain chains run from east to west, and between them a few rivers (Gediz, Menderes), provide the most fertile plains. Mountain orientation is important from a climatic point of view. The W. Anatolian mountains diverge into two big chains; one is the N. Anatolian mountain chain, and the other one is Taurus mountain chain. Each of these chains lies parallel to the sea and forms a strong barrier between steppic Central Anatolia and the relatively wet coastal areas.

In Turkish Thrace, the topography is rather heterogeneous. This part forms the eastern part of the Balkan peninsula and consists of low plains

in most areas. Turkish Thrace is drained by the Ergene river. A low mountain chain, Istranca daglari, lies along the Black Sea coast, and is a continuation of the N. Anatolian mountains into Thrace; it is composed of schists.

In North Anatolia the mountains are extremely steep on the side facing the Black Sea, but are occasionally interrupted by rivers, such as the Sakarya, Kizilirmak, Yeşilirmak, Mertirmagi, Kelkit and Çoruh. Along these rivers some of the Mediterranean elements from the coast line penetrate more deeply into N. Anatolia. These rivers provide deep valleys and along these roads connect N. Anatolian towns to C. Anatolian ones. In eastern North Anatolia the mountain range is high, continuous and close to the sea, rising at many points to over 3000 m. Most of the area consists of basic igneous rocks and flysch but the summit of some of the highest mountain peaks are made of granite or of crystalline limestone or marble.

In South Anatolia a massive mountain range consists of the Lycian and Cilician Taurus, Ala Dag, Anti-Taurus and Amanus. These ranges lie parallel to the shore and, as in the N. Anatolia, make communications extremely difficult, though there are a few deep gorges cut by the Göksu, Seyhan and Ceyhan rivers. Most of the area consists of hard limestone but considerable areas of basic igneous rocks, shale and slates occur from the Isaurian Taurus eastwards. Around Mut (Içel) and Ermenek (Konya), there are extensive areas of soft chalky rocks. Diorite is found above Bulghar Maden in the Cilician Taurus. In the Amanus Mountains, limestone is rare (Düldül Dag), most of the area consisting of igneous rocks.

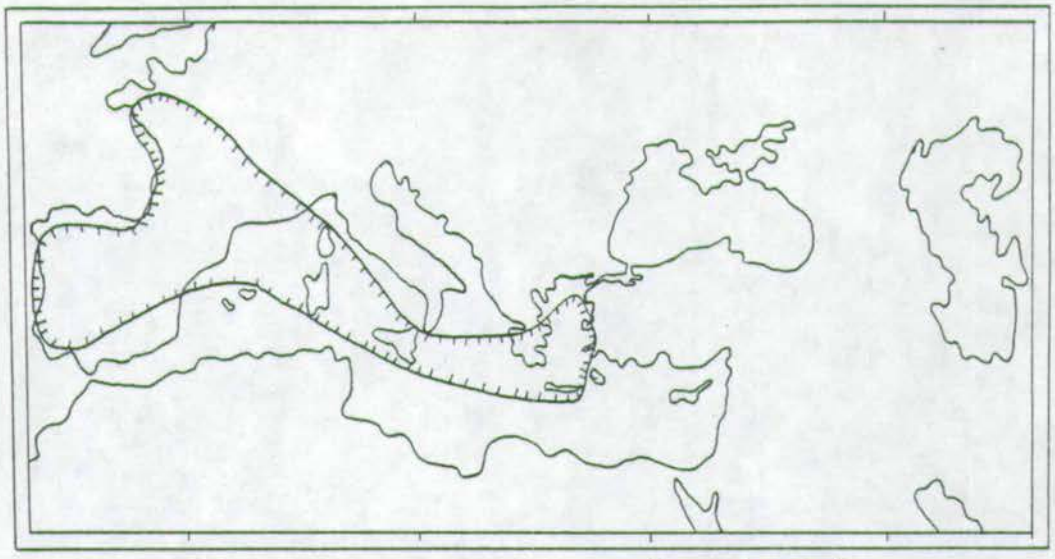
In Central Anatolia the average altitude approximates to 800-1000 m. In a depression in the middle of the plateau lies the salt lake, Tuz Gölü. Much of the Central Anatolian plateau is covered by very soft

rocks - chalk, clay and marl. There are a few extinct volcanoes, such as Erciyas Da., Hasan Da. and Kara Da. A large area of volcanic tuff is present near Nevşehir.

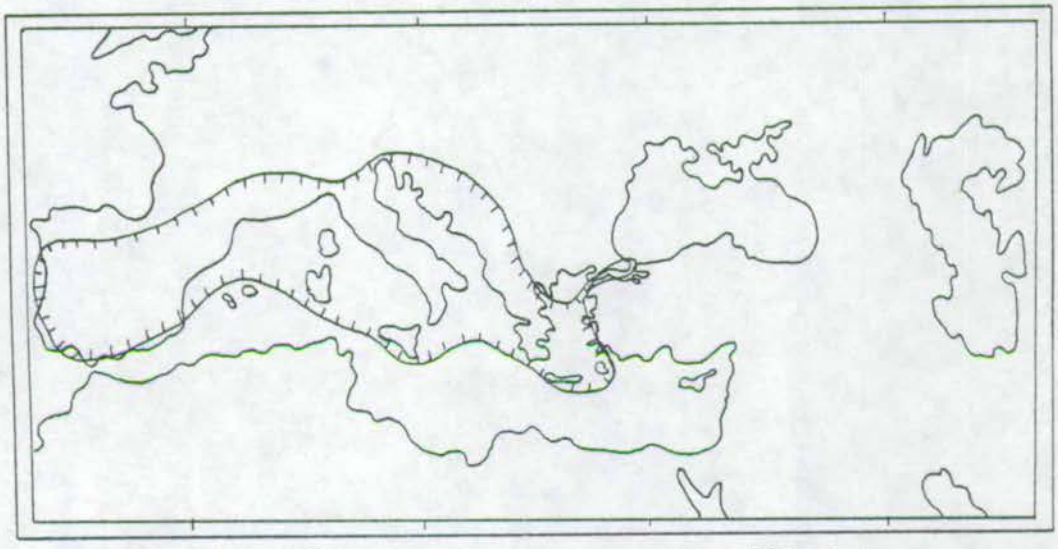
In East Anatolia the average altitude is nearly 1700 m. A mountain belt called by Davis (1965-) "The Anatolian Diagonal" extends from the Amanus and Bulghar Da. north-eastwards to Suşehri (Sivas). Much of E. Anatolia is covered with basic igneous rocks of various kinds, but Munzur Daglari is of hard limestone, and Cilo Dag dolomitic. Extinct Quaternary volcanoes are Süphan Da. (4434 m), Nemrut Da. (3050 m) and Agri Da. (5165 m). The area between Van Gölü and Ardahan is covered by basaltic lava flows. The southern part of E. Anatolia is relatively low (average altitude 400-800 m) compared to other places, and is also relatively flat, the only conspicuous relief in this area being the basaltic Karaca Da. (1919 m). This lowland area is watered by the two rivers, Tigris and Euphrates, and its native steppic vegetation is now much depleted by cereal cultivation.

8.5. Geographical distribution outside Turkey

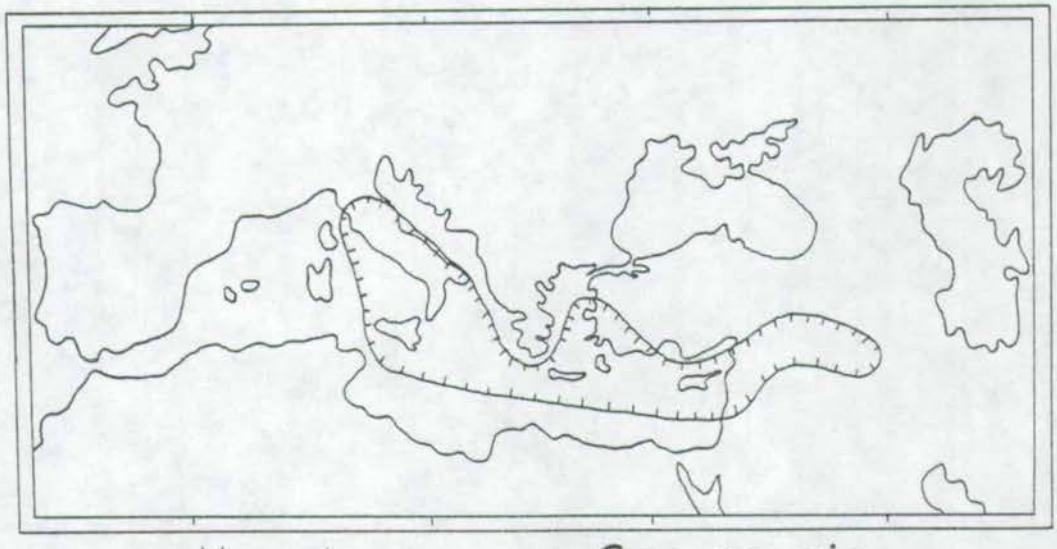
Appendix I shows the general distribution of all the revised species throughout their distribution range. During the preparation of this table, a number of floristic works have been carefully combed in order to assess species distribution throughout its entire range. I have tried to see herbarium specimens instead of relying on literature records, but in certain cases this was found to be almost impossible due to poor representation in the herbaria I visited. The Floras consulted are mainly those of S.W. Asia, N. Africa and Europe. As far as European Floras are concerned, there seemed to be no need to go over them all since these have been broadly synthesised by Tutin et al. 1980 (Europe). The South-West Asian Floras etc. include: Boissier 1884



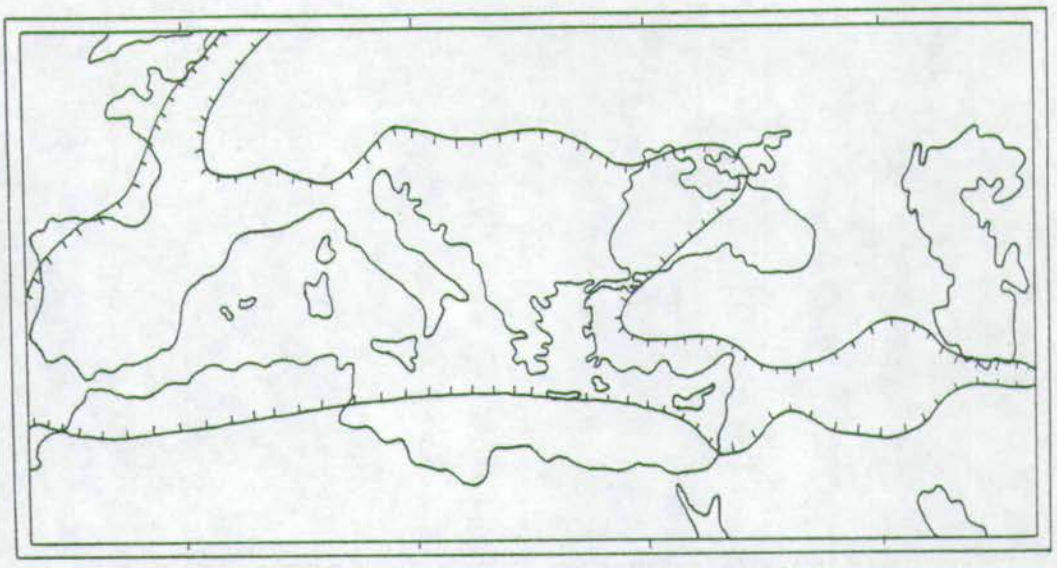
Map 2 Antinoria



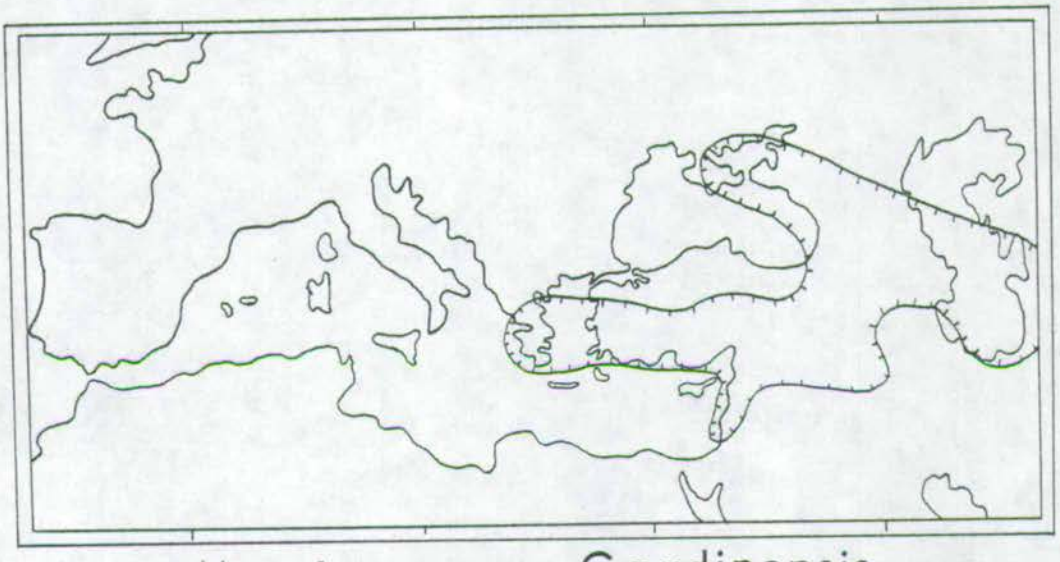
Map 3 Avellinia



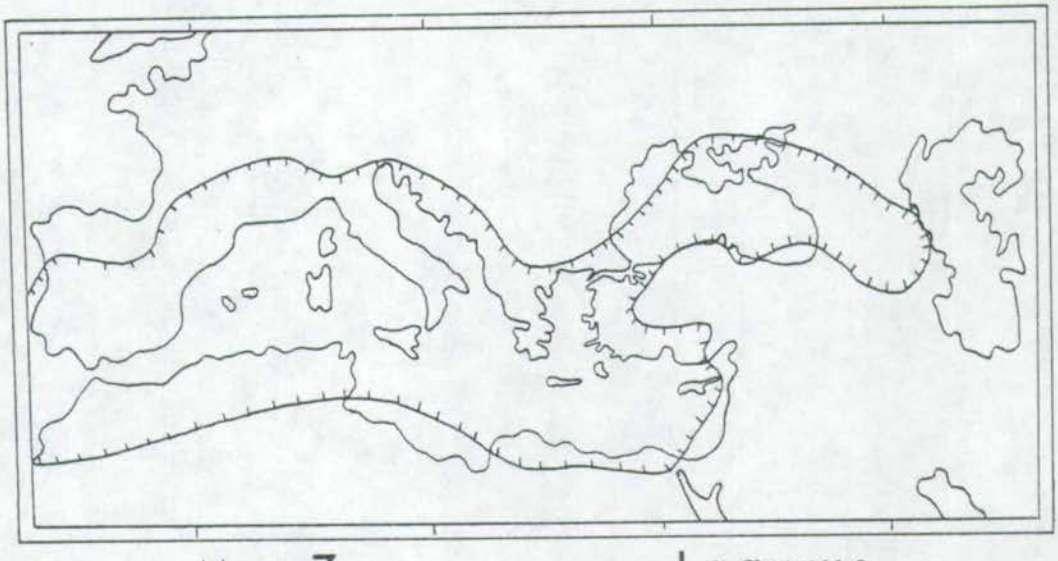
Map 4 Cornucopiae



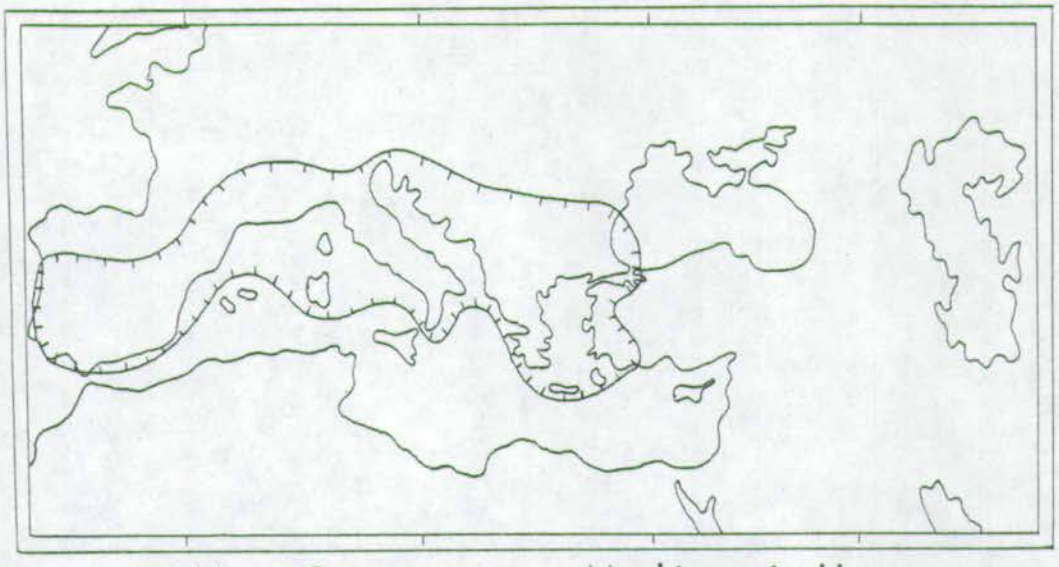
Map 5 Gastridium



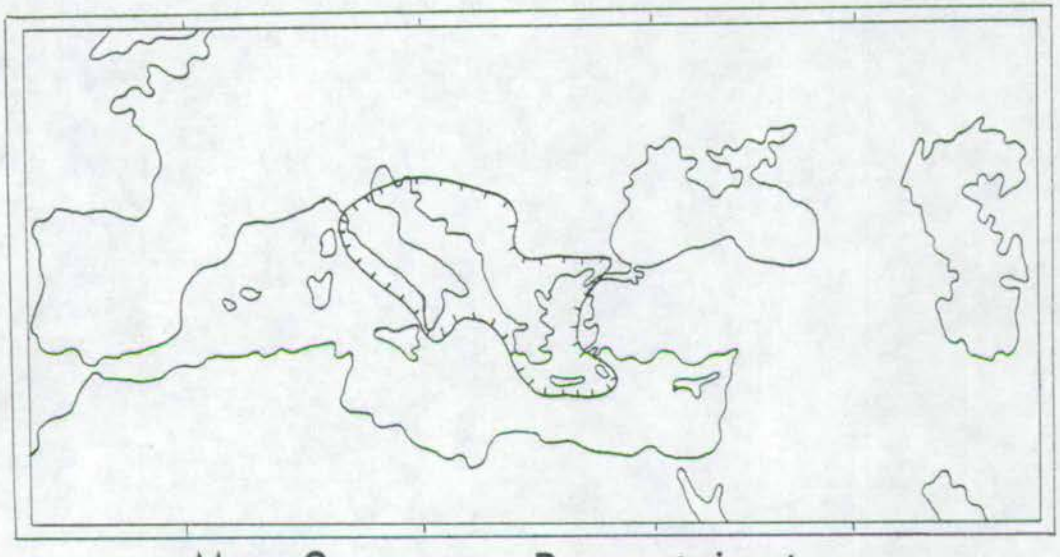
Map 6 Gaudinopsis



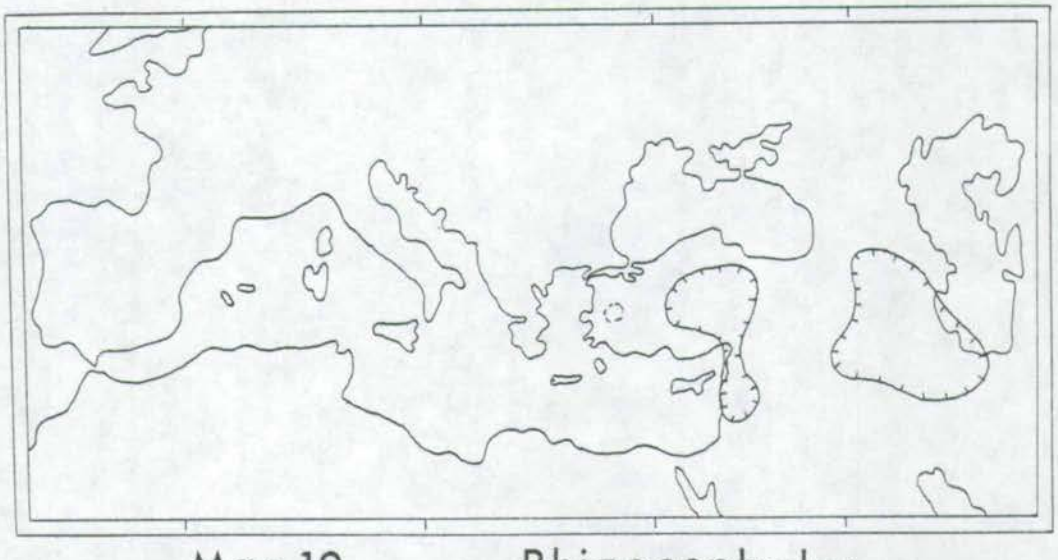
Map 7 Lagurus



Map 8 Molineriella

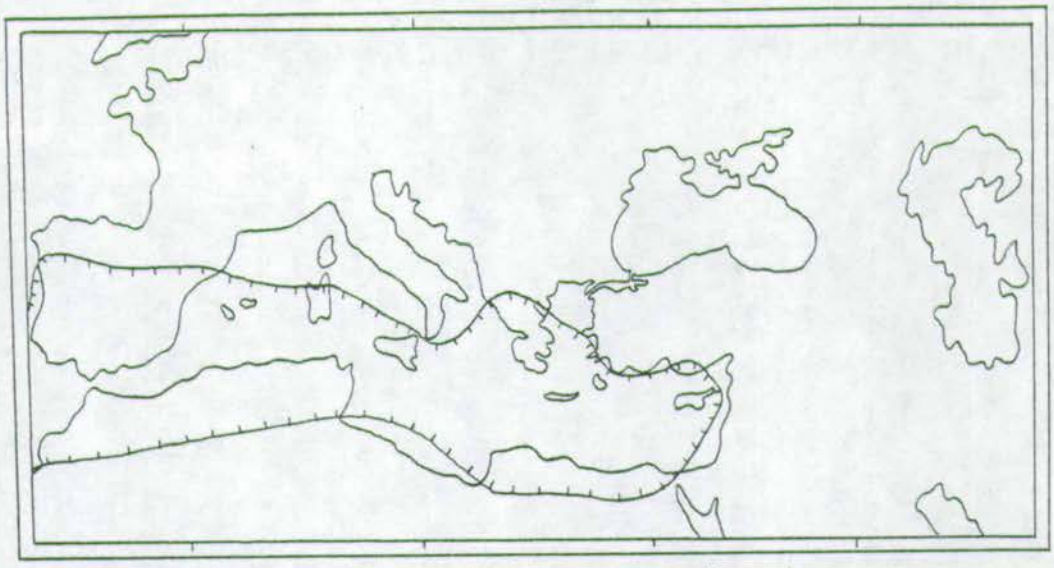


Map 9 Parvotrisetum

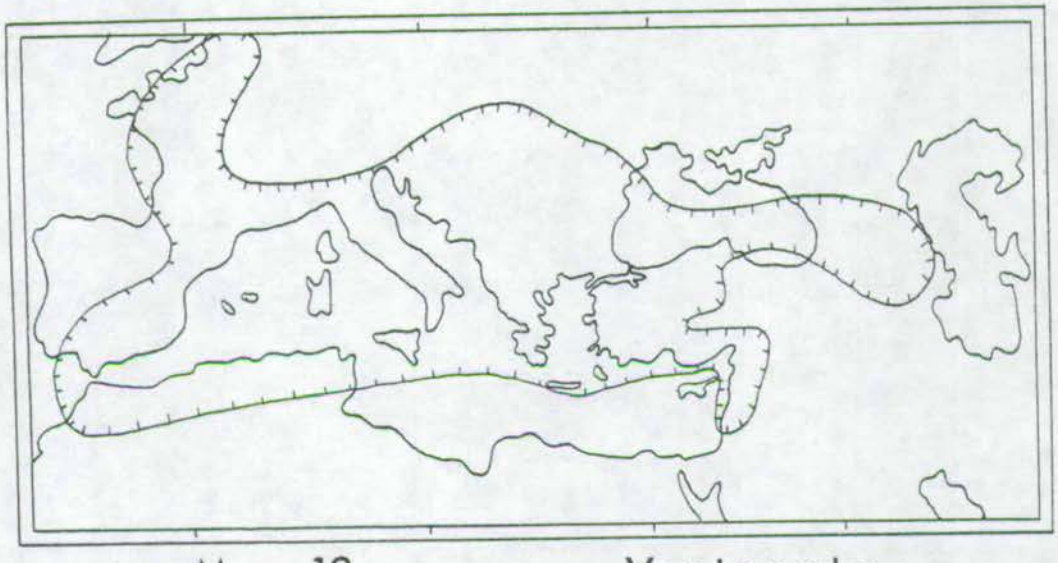


Map 10 ____ Rhizocephalus

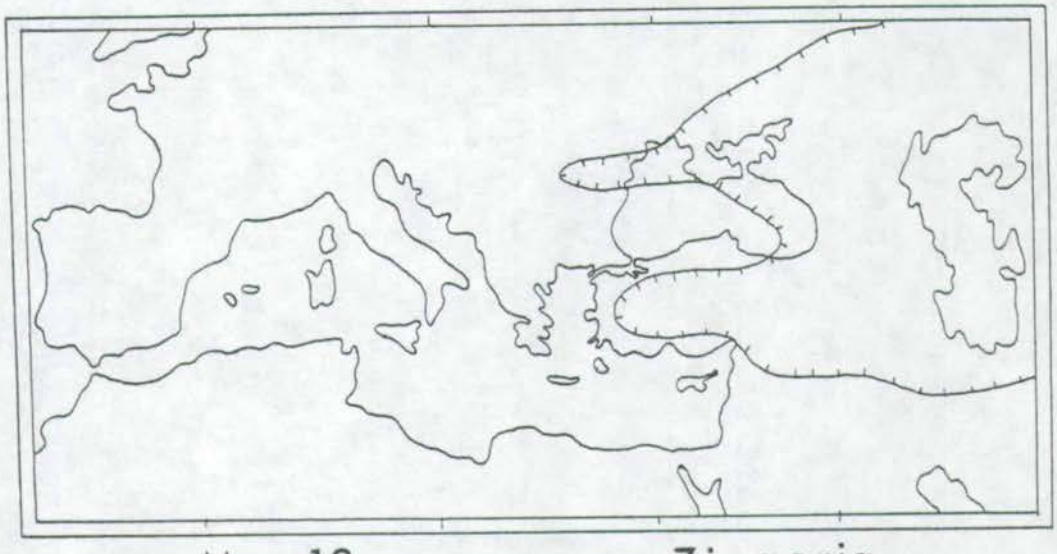
..... Pseudophleum



Map 11 Triplachne



Map 12 Ventenata



Map 13 Zingeria

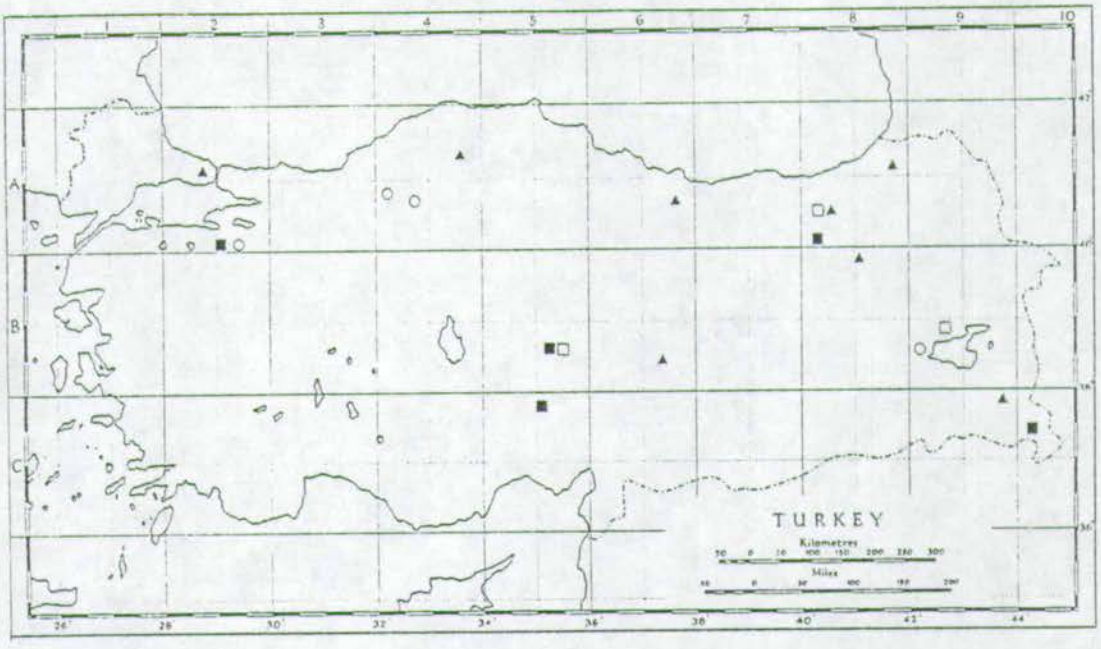
(Fl. Orientalis vol. 5), Grossheim 1939 (Caucasia), Komarov ed., English translation 1963 (U.R.S.S.), Tzvelev 1976 (Poaceae, S.S.S.R), Rechinger 1943 (Aegean Islands), Mouterde 1966 (Lebanon and Syria), Bor 1968, 1970 (Iraq, Iran) and Holmboe 1914 (Cyprus), Osorio-Tafall and Seraphim 1973 (Cyprus). North African Floras include those of Tackholm and Drar 1941 (Egypt), Maire 1953 (the whole of North Africa excluding Egypt) and Quezel and Santa 1962 (Algeria). Domin's (1907) Monograph of Koeleria s.l. Baum's (1977) Oats: Wild and Cultivated, Bews's (1929) The World's Grasses, Holm's (1979) A Geographical Atlas of World Weeds and Meusel's (1965) Vergleichende Chorologie Der Zentraleuropaischen Flora, were also used.

Some of the revised genera have rather restricted geographical distribution areas. This must be due to a number of factors, such as their age, past climatic and vegetational changes, dispersal capabilities, tolerance to other species in the same environment, and a number of other factors which originally restricted the survival and spread of species. The general distribution of the following genera is shown in Maps 2-13 namely Ventenata, Rhizocephalus, Pseudophleum, Lagurus, Molineriella, Zingeria, Antinoria, Parvotrisetum, Gastridium, Triplachne, Avellinia, Cornucopia, Gaudinopsis. The other remaining genera have rather widespread distribution areas.

8.6. Geographical distribution inside Turkey

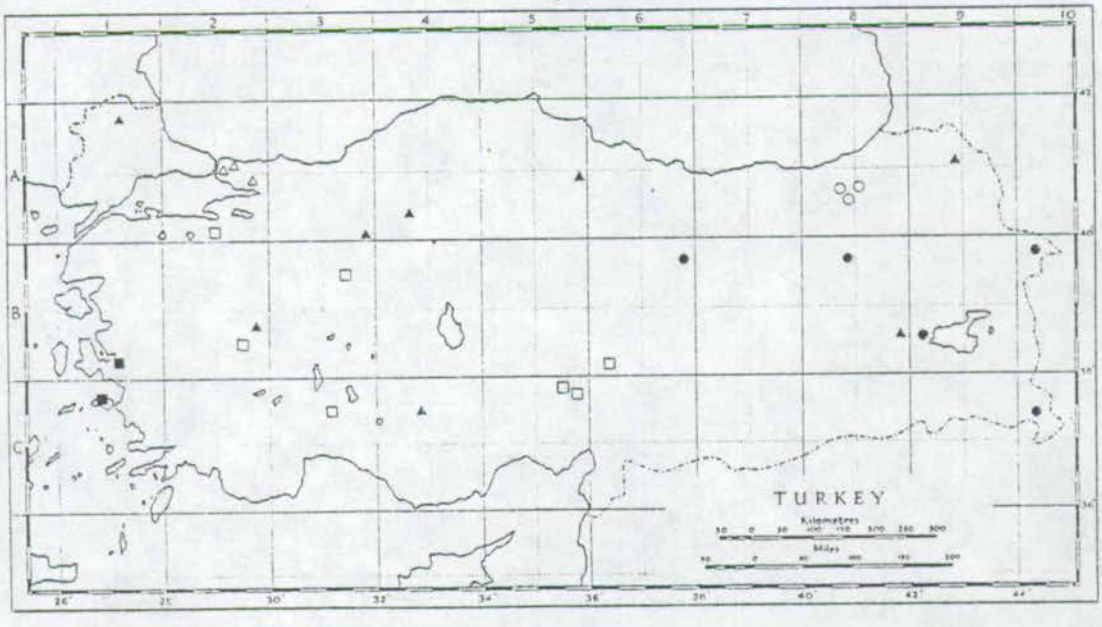
Among the genera I revised, there are a number of species that penetrate into Turkey either from East or West. Some of these species cross Turkey and get into Europe via the Balkan peninsula or vice versa. My main objective here is to explain the distribution of some of the species which present a special distribution pattern and are confined to certain geographical areas in Turkey (see Maps 14-21) I have

Map 14



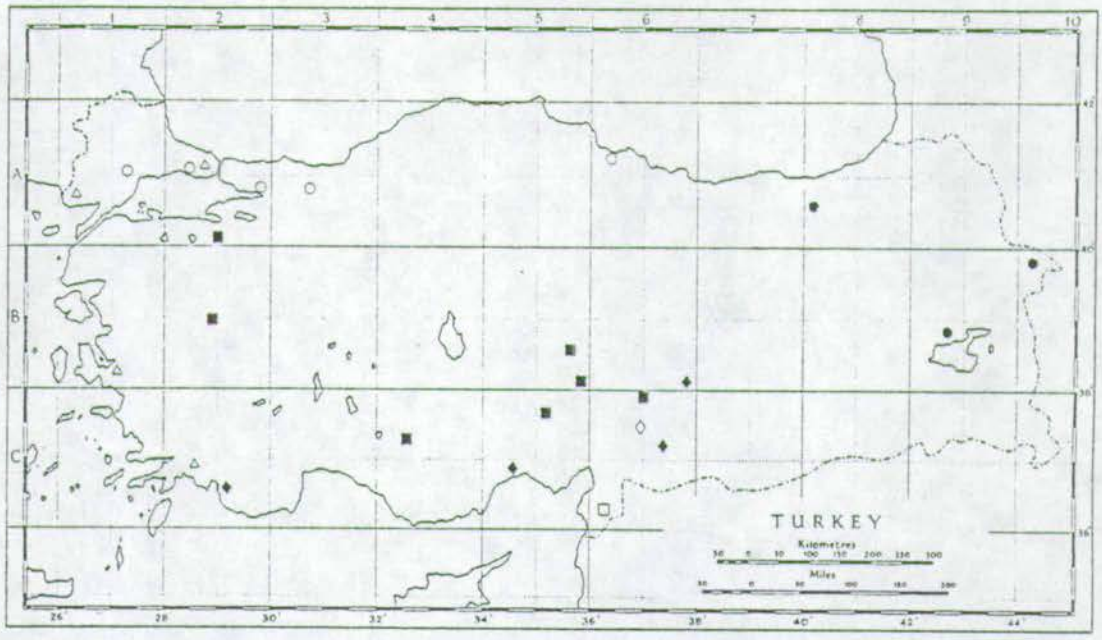
■ Agrostis olympica
□ A. lazica
○ A. canina
▲ A. gigantea

Map 15



□ Alopecurus lanatus
■ A. davisii
▲ A. aequalis
△ A. bulbosus
● A. aucheri
○ A. glacialis

Map 16



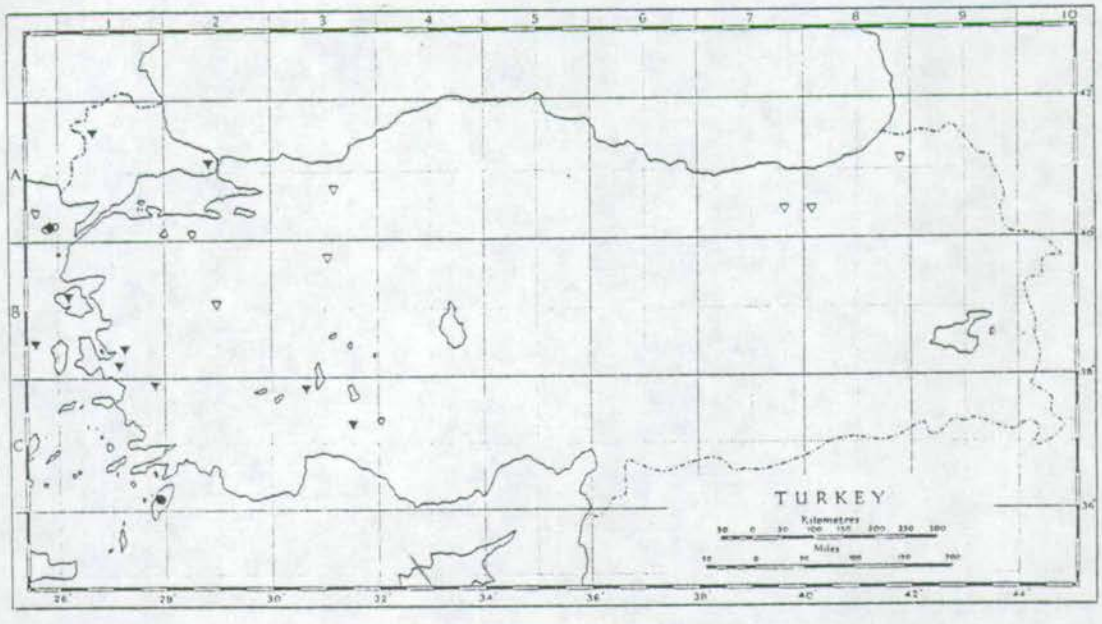
●Alopecurus laguroides △A. setarioides

A. utriculatus: ◆var.utriculatus ◇var.anthoxanthoides

A. gerardii: ■var.gerardii □var.cassius

○A. rendlei

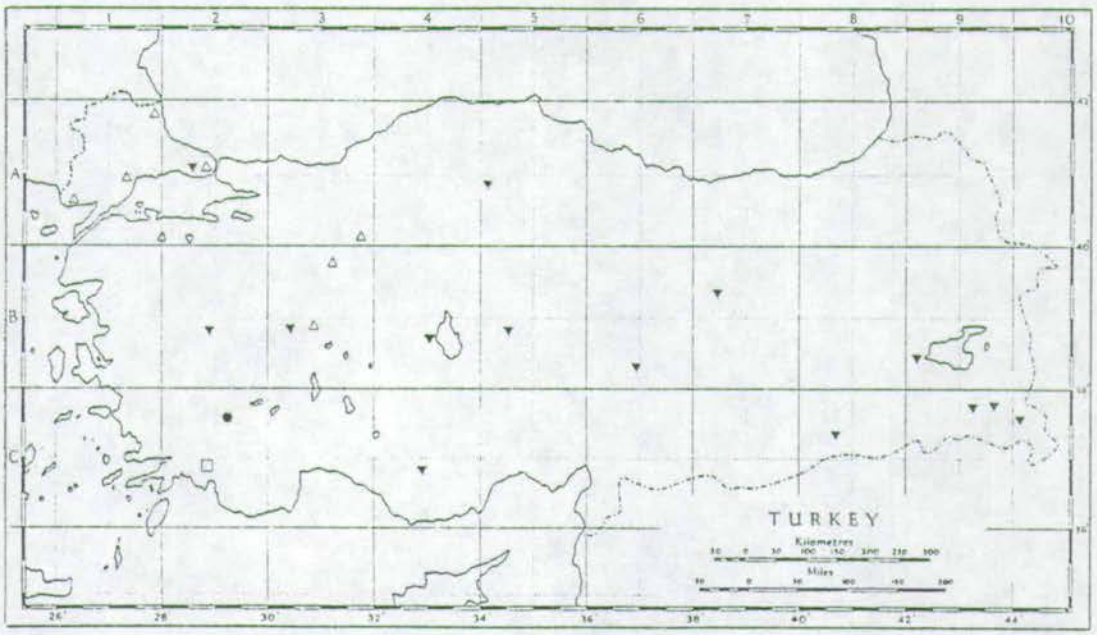
Map 17



◆Anthoxanthum aristatum ●A. gracile

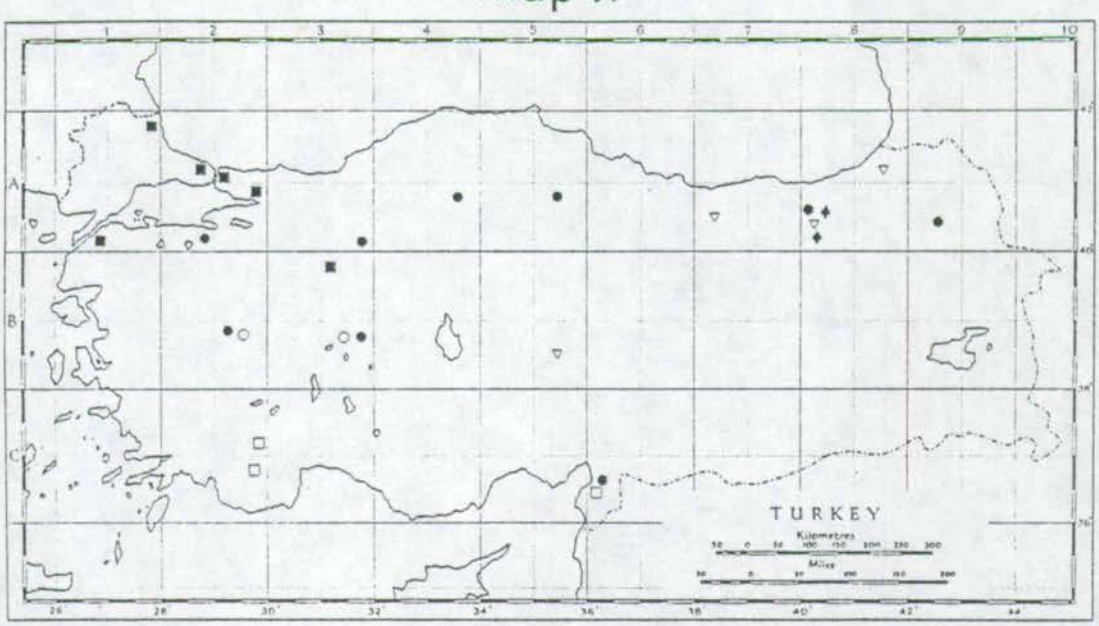
A. odoratum: ▼subsp. odoratum ▽subsp. alpinum

Map 18



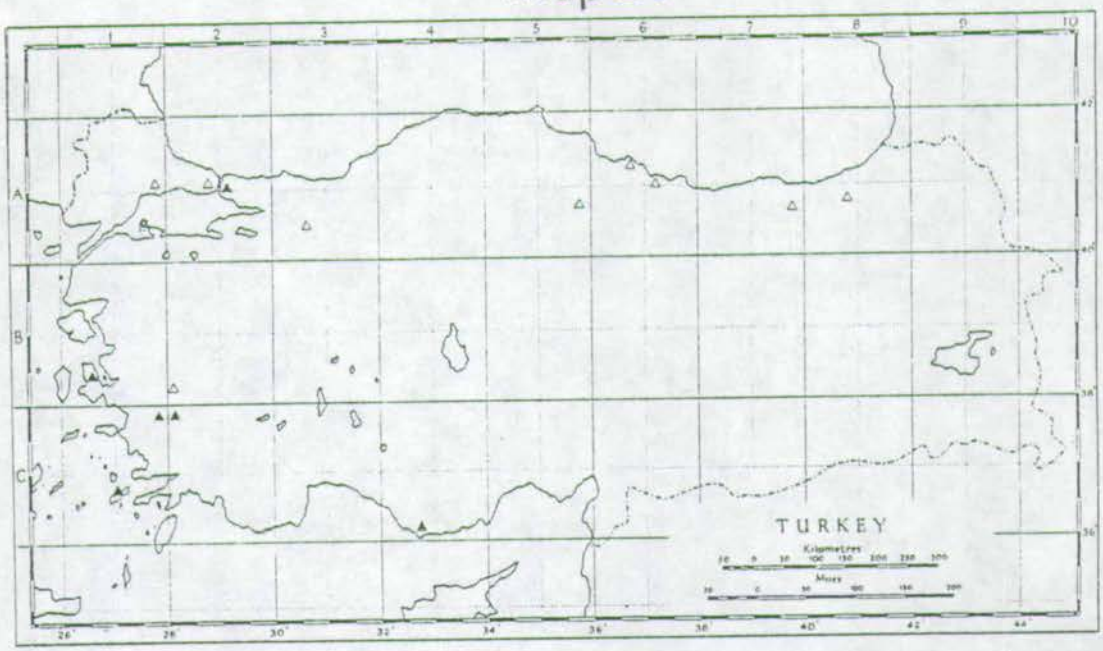
△ Apera spica-venti
▼ A. intermedia
□ A. baytopiana
● A. triaristata

Map 19



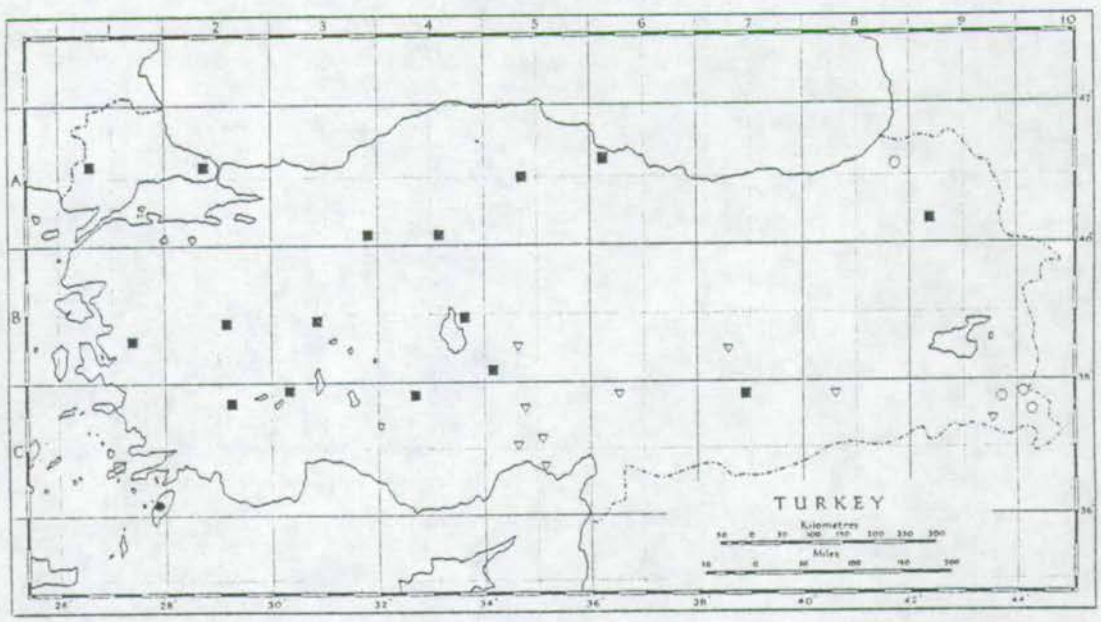
□ Helictotricnon convolutum
▽ H. argaea
◆ H. planiculme
■ H. compressa
H. pubescens: ● suosp. pubescens ○ subsp. longifolia

Map 20



△ Holcus lanatus ▲ H. annuus

Map 21



Phleum exeratum: ■ subsp.exeratum □ subsp.aegaeum

○ P. paniculatum subsp. ciliatum

● P. crypsoides

chosen some species belonging to the genera Alopecurus, Phleum, Helictotrichon, Apera, Anthoxanthum, Agrostis and Holcus in order to show their distinctive distribution patterns. As most of the other remaining species do not have a narrow distribution pattern, there is no need to mention them here.

Among the species whose distribution is confined to W. Anatolia (incl. Turkish Thrace) or the East Aegean Islands are Anthoxanthum gracile, A. aristatum, Phleum crypsoides, P. exeratum subsp. aegaeum and Apera spica-venti. These species are mainly distributed in Europe and often their distribution areas in Turkey are the most eastern extentions of their range. Some other species have their western most limit of distribution in Turkey. As examples of this distribution type, a few species are mapped: Agrostis olympica, Phleum paniculatum subsp. ciliatum, Helictotrichon argaeum, Alopecurus glacialis, A. laguroides.

Some of the species whose distribution is mainly N. Anatolian tend to get into C. Anatolia, occuring on the slopes of Erciyas Da., and very occasionally N. Anatolian species reach as far S. as the Amanus mountains (e.g. Alopecurus vaginatus). Such disjunctions occur sporadically, throughout the Turkish flora and are probably linked to Quaternary climatic changes and perhaps even long-distance dispersal.

8.7. Dispersal Mechanisms

Fairly comprehensive information on the modes of dispersal of plants in general can be found in the works of Ridley (1930), Guppy (1906, 1917), Van der Pijl (1972) and Rabinowitz and Rapp (1981). As far as Gramineae is concerned we can easily say that anemochory (wind dispersal) and zoochory (animal dispersal) are equally common. Especially within the tribe Aveneae, lemmas usually have a more or

less hairy callus and, after the break-up of florets and whenever rhachillas disarticulate between the florets, the diaspores can be transported for long distances by wind. Examples of this type of wind dispersed grasses are Agrostis olympica, A. lazica, Calamagrostis epigejos, C. pseudophragmites, Helictotrichon pubescens and Trisetum rigidum. In some other wind dispersed grasses, spikelets disarticulate below the glumes and the spikelet falls as a unit; this is often the case whenever hairs are attached to the glumes. Almost all wind dispersed grasses have a hairy organ of some kind, but the hairs are often attached to different parts of the spikelet, e.g. on the glumes (Arundo, Imperata), on the awn (Stipa, Stipagrostis), or on the involucral bristles (Pennisetum, etc.). One must not under estimate variation in the mode of dispersal for a genus since there can be zoochorous and anemochorous species within the same genus. In Calamagrostis, some species are apparently zoochorous, such as C. arundinacea, C. parsana, etc., and some others are evidently anemochorous, such as C. epigejos, C. pseudophragmites, etc. Some other wind dispersed grasses have winged glumes, like Phalaris spp., Alopecurus spp., Phleum crypsoides, etc. Whenever spikelets do not disarticulate at all they remain attached to the plant and can be transported as a whole (or in part) by wind, as with Zingeria spp., Panicum spp.

Ammochloa palaestina, growing on sand, is exceptional in many respects, and may be used as a rare example of a naked grains being dispersed by wind; the grains bear terminally expanded, wing-like appendages and are therefore readily transported by wind.

Great variation occurs between the zoochorous grasses. In the commonest case the lemmas have long, twisted, geniculate awns which can easily become attached to the fur of animals. This twist starts unwinding as soon as the diaspore gets wet and helps to bury the caryopsis

(an analogous example is found in the mericarps of Erodium). In Stipa, the callus of the lemma is very sharp and easily gets caught by animal fur. In Tragus, the glumes have prickles and soon get attached to animal fur, thus being transported considerable distances. Occasionally the entire spikelet is surrounded by bristles, as in Setaria, and gets carried away by animals. Whenever there is no disarticulation of the rhachilla, the spikelets (with barbellate awns) remain attached to the main axis, as in Aegilops umbellulata, the whole spike being transported as a unit.

In some of the marsh grasses, such as Glyceria and Scolochloa, the grains are buoyant and can be transported by water in streams or ditches.

In many cultivated grasses there is no natural dispersal mechanism, their distribution being completely dependent on human preferences. This is the explanation for the distribution of some cultivated species which present a worldwide but disjunct distribution.

Since it has been accepted that the origin of the Gramineae was in the Tropics where most of the oldest tribes (e.g. Bambuseae) are centred, it can be ruled out that animal dispersal is more ancient and primitive than wind dispersal because the former is very common among Bambusoid grasses.

8.8. Endemism

The grasses are widespread because they are wind dispersed. Perhaps because of this, in my group endemism is low (c. 9%). Among the genera revised, the only endemic genus is the monotypic Pseudophleum (P. gibbum), but there are a number of endemic species, such as Alopecurus davisii, A. laguroides, A. lanatus, Apera triaristata, A. baytopiana, Gaudinopsis sorgerae, G. quercetorum, G. huber-morathii,

Helictotrichon argaeum, *Trisetum turcicum*, *Zingeria verticillata*, and *Ventenata eigii*.

The following species are endemic to E. Anatolia and Caucasia: *Agrostis lazica*, *A. balansae*, *Trisetum thospiticum*, *Helictotrichon armeniacum*. *Calamagrostis parsana* is endemic to S.E. Anatolia and neighbouring N. Iran.

Chapter IX

9. Tribal Synopsis of Turkish Gramineae

9.1. Introduction

For the preparation of a tribal synopsis of Turkish grasses, almost all 486 species belonging to 138 genera have been investigated using both external and internal morphology. In particular, the anatomical data revealed by other botanists has been used here to support the acceptance and delimitation of the tribes.

In order to summarize various treatments over a hundred year period, Table VI has been prepared. There have been numerous systems adopted by a number of grass taxonomists, but only six of these workers, Dumortier (1868), Hackel (1887), Bews (1929), Bor (1970), Tzvelev (1976), Tutin et al. (1980) have their systems tabulated here.

Some characters of grasses have been found to have significant taxonomic value at the tribal level, such as leaf shape and its internal morphology, types of silica bodies, types of ligules, types of inflorescence, compression of spikelet, number of florets in each spikelet and their sexes, disarticulation of the rhachilla, relative length of the glumes to lemma, number of lodicules and their shape, number of stamens, hilum shape, starch grain type, chromosome length and basic number.

9.2. Accepted tribes and their descriptions

1. Tribe ORYZEAE Dumort., Obs. Gram. Belg. 83, 135 (1823)

Leaf blades linear, with bambusoid anatomy (See Fig.3, a); silica bodies dumb-bell shaped, arranged transversely; 2-celled micro-hairs present; ligule membranous. Inflorescence a panicle. Spikelets all alike, hermaphrodite (rarely unisexual), usually with 1-3 florets, only uppermost floret hermaphrodite, lower two florets empty and

TABLE VI

DUMORTIER (1868)	HACKEL (1887)	BEWS (1929)	BOR (1970)	TZVELEV (1976)	TUTIN et al. (1980)
Tribe Cynodonteae	Tribe Oryzeae	Tribe Oryzeae	Tribe Oryzeae	Tribe Oryzeae	Tribe Oryzeae
Nardus	Oryza	Oryza	Oryza	Oryza	Oryza
Cynodon	Leersia	Leersia	Leersia	Leersia	Leersia
Beckmannia					
Dactyloctenium	Tribe Hordeae	Tribe Hordeae	Tribe Brachypodieae	Tribe Brachypodieae	Tribe Brachypodieae
Eleusine	Nardus	Elymus	Brachypodium	Brachypodium	Brachypodium
	Lolium	Hordeum	Trachynia	Trachynia	
Tribe Ophiureae	Lepturus	Agropyron			Tribe Triticeae
Psilurus	Psilurus	Haynaldia	Tribe Triticeae	Tribe Triticeae	Leymus
Monerma	Agropyrum	Secale	Henrardia	Agropyron	Elymus
Hemarthria	Haynaldia	Triticum	Agropyron	Elymus	Agropyron
Phacelurus	Secale	Heterantelium	Eremopyrum	Eremopyrum	Eremopyrum
Rottboellia	Triticum	Lolium	Aegilops	Heteranthelium	Crithopsis
	Hordeum	Pholiurus	Amblyopyrum	Amblyopyrum	Aegilops
Tribe Triticeae	Elymus	Psilurus	Triticum	Aegilops	Triticum
Elymus		Nardus	Haynaldia	Triticum	Dasypyrum
Hordeum	Tribe Aveneae		Secale	Dasypyrum	Secale
Secale	Holcus	Tribe Aveneae	Heteranthelium	Secale	Hordeum
Triticum	Aira	Danthonia	Crithopsis	Leymus	Hordelymus
Aegilops	Antinoria	Avenastrum	Elymus	Psathyrostachys	Taeniatherum
Agropyron	Molineria	Avena	Taeniatherum	Hordeum	
Brachypodium	Corynephorus	Deschampsia	Psathyrostachys	Hordelymus	Tribe Bromeae
Trachynia	Deschampsia	Corynephorus	Hordeum	Taeniatherum	Bromus
Gaudinia	Trisetum	Ventenata		Henrardia	
Nardurus	Ventenata	Trisetum	Tribe Bromeae		Tribe Aveneae
Dezmazeria	Avena	Gaudinia	Bromus	Tribe Bromeae	Avena
Lolium	Arrhenatherum	Koeleria	Boissiera	Bromus	Helictotrichon
	Gaudinia	Molineria		Boissiera	Avenula
Tribe Bromaceae	Danthonia	Antinoria	Tribe Aveneae	Bromopsis	Arrhenatherum
Diplachne		Aira	Aira		Gaudinia
Festuca	Tribe Agrostideae	Holcus	Corynephorus	Tribe Aveneae	Ventenata
Vulpia	Aristida	Arrhenatherum	Deschampsia	Avena	Koeleria
Bromus	Stipa		Trisetum	Helictotrichon	Lophochloa
Dactylis	Oryzopsis	Tribe Agrostideae	Trisetaria	Arrhenatherum	Trisetum
Aeluropus	Milium	Ammophila	Gaudinopsis	Gaudinia	Trisetaria
Koeleria	Cornucopiae	Triplachne	Avena	Ventenata	Parvotrisetum
Lophochloa	Crypsis	Gastridium	Helictotrichon	Gaudinopsis	Lagurus
	Heleochloa	Lagurus	Arrhenatherum	Trisetum	Deschampsia
Tribe Poaceae	Maillea	Trisetaria	Anthoxanthum	Trisetaria	Aira
Briza	Phleum	Polypogon	Hierochloë	Rostraria	Molineriella
Eragrostis	Alopecurus	Sporobolus	Koeleria	Koeleria	Antinoria
Poa	Sporobolus	Crypsis	Lophochloa	Deschampsia	Hierochloë
Sphenopus	Polypogon	Cornucopiae		Molineriella	Anthoxanthum
Sclerochloa	Agrostis	Heleochloa	Tribe Agrostideae	Aira	Holcus
Scleropoa	Gastridium	Maillea	Calamagrostis	Corynephorus	Corynephorus
Glyceria	Triplachne	Phleum	Deyeuxia	Holcus	Avellinia
Catabrosa	Calamagrostis	Alopecurus	Alopecurus	Milium	Triplachne
Melica	Ammophila	Milium	Phleum	Calamagrostis	Agrostis
Schismus	Apera	Stipa	Agrostis	Ammophila	Gastridium
Airopsis	Trisetaria	Oryzopsis	Apera	Apera	Polypogon
Antinoria	Lagurus		Polypogon	Lagurus	x Agropogon
Molineria			Gastridium	Agrostis	Ammophila

Tribe Avenaceae
Deschampsia
Aira
Corynephorus
Trisetum
Avenula
Avena
Arrhenatherum
Holcus
Hierochloa

Tribe Cynosureae
Cynosurus
Lamarckia

Tribe Sesleriеae
Sesleria
Echinaria

Tribe Arundinaceae
Arundo
Ampelodesmos

Tribe Agrostideae
Deyeuxia
Calamagrostis
Colpodium
Agrostis
Apera
Sporobolus
Gastridium
Anthoxanthum
Ammophila

Tribe Phleaceae
Alopecurus
Colobachne
Crypsis
Cornucopiae
Lagurus
Polypogon
Phalaris
Maillea

Tribe Oryzaceae
Leersia
Oryza

Tribe Stipaceae
Stipa
Aristida
Piptatherum

Tribe Phalarideae
Phalaris
Anthoxanthum
Hierochloë

Tribe Festuceae
Echinaria
Ammochloa
Sesleria
Ampelodesmos
Arundo
Phragmites
Diplachne
Molinia
Eragrostis
Avellinia
Koeleria
Catabrosa
Sphenopus
Cutandia
Melica
Briza
Dezmazeria
Aeluropus
Dactylis
Cynosurus
Lamarckia
Sclerochloa
Schismus
Nephelochloa
Poa
Colpodium
Scolochloa
Glyceria
Atropis
Festuca
Catapodium
Scleropoa
Bromus
Boissiera
Brachypodium

Tribe Chlorideae
Cynodon
Beckmannia
Eleusine
Dactyloctenium

Tribe Zoysieae
Tragus

Tribe Phalarideae
Anthoxanthum
Hierochloë
Phalaris

Tribe Festuceae
Ampelodesma
Arundo
Phragmites
Cortaderia
Glyceria
Puccinellia
Poa
Festuca
Vulpia
Nardurus
Nephelochloa
Sclerochloa
Colpodium
Scleropoa
Catapodium
Bromus
Brachypodium
Briza
Dactylis
Aeluropus
Desmazeria
Lamarckia
Cynosurus
Sesleria
Ammochloa
Melica
Eragrostis
Avellinia
Molinia
Cutandia
Catabrosa
Sphenopus
Boissiera
Echinaria

Tribe Chlorideae
Eleusine
Dactyloctenium
Beckmannia
Cynodon

Tribe Zoysieae
Tragus
Lagurus
Rhizocephalus

Tribe Phalarideae
Phalaris

Tribe Milieae
Milium
Zingeria

Tribe Festuceae
Echinaria
Ammochloa
Sphenopus
Cutandia
Dactylis
Briza
Cynosurus
Lamarckia
Sclerochloa
Poa
Bellardiochloa
Eremopoa
Nardurus
Catapodium
Colpodium
Catabrosa
Puccinellia
Leucopoa
Festuca
Vulpia
Lolium
x Festulolium
Psilurus

Tribe Monermeae
Monerma
Parapholis

Tribe Sesleriеae
Sesleria

Tribe Meliceae
Melica

Tribe Glycerieae
Glyceria

Tribe Stipeae
Stipa
Oryzopsis
Zingeria
Polypogon
Gastridium

Tribe Phalarideae
Anthoxanthum
Hierochloë
Phalaris
Phalaroides

Tribe Phleeae
Beckmannia
Phleum
Rhizocephalus
Alopecurus

Tribe Scolochloeae
Scolochloa

Tribe Poeae
Festuca
Bellardiochloa
Lolium
Vulpia
Nardurus
Loliolum
Scleropoa
Cutandia
Sphenopus
Psilurus
Poa
Eremopoa
Catabrosella
Hyalopoa
Catabrosa
Colpodium
Puccinellia
Sclerochloa
Dactylis
Cynosurus
Briza
Brizochloa

Tribe Monermeae
Pholiurus
Parapholis
Monerma

Tribe Sesleriеae
Sesleria
Echinaria
Ammochloa
Calamagrostis
Phleum
Alopecurus
Cornucopiae

Tribe Phalarideae
Phalaris

Tribe Milieae
Milium
Zingeria

Tribe Scolochloeae
Scolochloa

Tribe Poeae
Festuca
Lolium
Vulpia
Micropyrum
Narduroides
Desmazeria
Cutandia
Sphenopus
Poa
Bellardiochloa
Eremopoa
Puccinellia
Sclerochloa
Dactylis
Beckmannia
Cynosurus
Lamarckia
Catabrosa
Apera
Psilurus
Briza

Tribe Hainardieae
Pholiurus
Parapholis
Hainardia

Tribe Sesleriеae
Sesleria
Ammochloa
Echinaria

Tribe Meliceae
Melica

Tribe Paniceae
Milium
Paspalum
Panicum
Digitaria
Oplismenus
Echinochloa
Setaria

Tribe Cenchreae
Pennisetum
Tragus

Tribe Andropogoneae
Andropogon
Crysopogon
Sorghum

Tribe Saccharineae
Imperata
Saccharum
Erianthus

Tribe Maydeae
Mays
Coix

Tribe Paniceae
Paspalum
Panicum
Oplismenus
Setaria
Pennisetum

Tribe Andropogoneae
Imperata
Saccharum
Spodiopogon
Rottboellia
Arthraxon
Andropogon
Themedia

Tribe Maydeae
Zea
Coix

Tribe Paniceae
Digitaria
Echinochloa
Paspalum
Oplismenus
Brachiaria
Setaria
Pennisetum

Tribe Andropogoneae
Imperata
Spodiopogon
Erianthus
Saccharum
Sorghum
Arthraxon
Dichanthium
Andropogon
Hyparrhenia
Themedia
Hemarthria
Rottboellia
Phacelurus

Tribe Maydeae
Zea
Coix

Tribe Arundineae
Arundo
Phragmites
Cortaderia

Tribe Danthonieae
Schismus

Tribe Aristideae
Aristida
Stipagrostis

Tribe Aeluropodeae
Aeluropus

Tribe Eragrostideae
Eragrostis
Eleusine
Dactyloctenium
Cleistogenes

Tribe Chlorideae
Cynodon

Tribe Sporoboleae
Sporobolus
Crypsis

Tribe Zoisieae
Tragus

Tribe Paniceae
Panicum
Brachiaria
Echinochloa
Oplismenus
Digitaria
Paspalum
Setaria
Pennisetum

Tribe Andropogoneae
Imperata
Saccharum
Spodiopogon
Phacelurus
Hemarthria
Sorghum
Crysopogon
Arthraxon
Bothriochloa
Dichanthium
Themeda

Tribe Meliceae
Glyceria
Melica

Tribe Molinieae
Molinia

Tribe Nardeae
Nardus

Tribe Stipeae
Stipa
Piptatherum

Tribe Arundineae
Arundo
Phragmites

Tribe Cortaderieae
Cortaderia

Tribe Danthonieae
Sieglingia
Schismus

Tribe Aristideae
Aristida
Stipagrostis

Tribe Aeluropodeae
Aeluropus

Tribe Cynodonteae
Cleistogenes
Eragrostis
Eleusine
Cynodon
Sporobolus
Crypsis

Tribe Zoysieae
Tragus

Tribe Paniceae
Oplismenus
Panicum
Echinochloa
Brachiaria
Paspalum
Digitaria
Setaria
Pennisetum

Tribe Glycerieae
Glyceria

Tribe Molinieae
Molinia

Tribe Nardeae
Nardus

Tribe Stipeae
Stipa
Piptatherum

Tribe Ampelodesmeae
Ampelodesmos

Tribe Arundineae
Arundo

Tribe Cortaderieae
Cortaderia

Tribe Danthonieae
Danthonia
Schismus

Tribe Aristideae
Aristida
Stipagrostis

Tribe Aeluropodeae
Aeluropus

Tribe Eragrostideae
Cleistogenes
Eragrostis
Sporobolus
Crypsis
Eleusine
Dactyloctenium

Tribe Chlorideae
Cynodon

Tribe Zoysieae
Tragus

Tribe Paniceae
Panicum
Oplismenus
Echinochloa
Brachiaria
Digitaria

Tribe Maydeae
Coix
Zea

Tribe Andropogoneae
Spodiopogon
Saccharum
Imparata
Sorghum
Crysopogon
Botriochloa
Andropogon
Arthraxon
Hemarthria
Zea
Coix

Paspalum
Setaria
Pennisetum

Tribe Andropogoneae
Imperata
Saccharum
Sorghum
Chrysopogon
Dichanthium
Andropogon
Hyparrhenia
Phacelurus
Hemarthria
Coix
Zea

scale-like. Glumes reduced to 2 scales or completely missing. Rhachilla disarticulating above glumes. Lemma membranous to coriaceous, awnless or terminally awned. Palea like the lemma of fertile floret. Lodicules 2, entire or bilobed. Stamens 6, 3 or 1. Ovary glabrous. Styles 2. Hilum linear, as long as caryopsis. Starch grains compound. Chromosomes small; basic number 12.

Genera

1) Oryza

2) Leersia

2. Tribe BRACHYPODIEAE (Hack.) Hayek in Ost. Bot. Zeitschr. 74, 10: 253 (1925)

Leaf blades linear, with festucoid anatomy (see Fig. 3, b); silica bodies oblong; 2-celled micro-hairs absent; sheaths open or closed; ligule membranous. Inflorescence a raceme. Spikelets terete to laterally compressed, with several florets. Glumes unequal. Rhachilla disarticulating above the glumes and between florets. Lemma rounded on back, awned from apex. Palea 2-keeled, hyaline with pectinate ciliate. Stamens 3. Ovary with a terminal hairy appendage. Styles 2. Lodicules 2, ciliate. Caryopsis adherent to palea and lemma. Hilum linear. Starch grains simple. Chromosomes small, basic number 5, 7, 9.

Genera

3) Brachypodium

4) Trachynia

3. Tribe TRITICEAE Dumort., Obs. Gram. Belg. 82 (1823)

Leaf blades linear, with festucoid anatomy; silica bodies oblong to elliptical; 2-celled micro-hairs absent; ligule membranous. Inflorescence a spike. Spikelets with 1- to many florets, solitary or in groups of 2-3, mostly hermaphrodite, sessile and alike, or lateral spikelets of a triad pedicelled, male or barren or much reduced. Rhachilla disarticulating above glumes. Glumes coriaceous, strongly nerved, reaching $\frac{1}{2}$ to as long as spikelet. Lemma chartaceous to coriaceous, awnless or awned from apex, keeled or rounded on back. Palea 2-keeled. Lodicules 2, entire or $\pm$ toothed, ciliate. Stamens 3. Ovary hairy at apex but not appendaged. Styles 2. Hilum linear, as long as caryopsis. Starch grains simple. Chromosomes large; basic number 7.

Genera

5) Agropyron
6) Elymus
7) Eremopyrum
8) Heteranthelium
9) Amblyopyrum
10) Crithopsis
11) Aegilops
12) Triticum
13) Dasypyrum
14) Secale
15) Leymus
16) Psathyrostachys
17) Hordeum
18) Hordelymus
19) Taeniatherum
20) Henrardia

4. Tribe BROMEAE Dumort., Obs. Gram. Belg. 82, 115 (1823)

Leaf blades linear, with festucoid anatomy; silica bodies oblong; 2-celled micro-hairs absent; sheaths tubular, later splitting; ligules membranous. Inflorescence a panicle. Spikelets all hermaphrodite, laterally compressed, with many florets. Glumes shorter than spikelet. Rhachilla disarticulating above glumes and between florets. Lemma herbaceous to coriaceous, rounded or keeled on back, awned just below sinus. Palea 2-keeled. Stamens 3(-2). Ovary with terminal flashy hairy appendage.

Styles 2. Hilum linear, as long as caryopsis. Starch grains simple. Chromosomes large; basic number 7.

Genera

21) Bromus

5. Tribe AVENEAE Dumort., Obs. Gram. Belg. 82, 120 (1823)

Leaf blades linear, with festucoid anatomy; silica bodies oblong or elliptic; 2-celled micro-hairs absent; ligule membranous. Inflorescence usually a panicle somewhat spike or raceme. Spikelets hermaphrodite, compressed laterally, with 1- to many florets. Glumes often longer than florets, shiny and with silvery hyaline margins. Rhachilla disarticulating above or occasionally below glumes and between florets. Lemma membranous or cartilaginous, often with a dorsal and geniculate awn. Palea 2-keeled, rarely very short or absent. Lodicules 2(-3), 2-dentate or entire. Stamens 3. Ovary hairy all over or glabrous. Styles 2. Grains with linear or ovate hilum. Starch grains compound. Chromosomes large; basic number 7.

Genera

22) Avena
23) Helictotrichon
24) Arrhenatherum
25) Gaudinia
26) Ventenata
27) Gaudinopsis
28) Trisetum
29) Trisetaria
30) Parvotrisetum
31) Avellinia
32) Rostraria
33) Koeleria
34) Deschampsia
35) Molineriella
36) Antinoria
37) Aira
38) Corynephorus
39) Holcus
40) Calamagrostis
41) Ammophila
42) Apera
43) Agrostis
44) x Agropogon
45) Polypogon
46) Lagurus
47) Gastridium
48) Triplachne

6. Tribe MILIEAE Endl., Fl. Poson. 109 (1830)

Leaf blades linear, with festucoid anatomy; silica bodies few or none; 2-celled micro-hairs absent; ligule membranous. Inflorescence a panicle. Spikelets all hermaphrodite, dorsally compressed, with 1 floret. Rhachilla disarticulating above glumes. Glumes longer than floret. Lemma chartaceous to indurate, awnless. Palea similar in texture to lemma, 2-keeled. Lodicules 2, acute at apex, entire. Stamens 3. Ovary glabrous. Styles 2. Hilum linear to oblong, up to $\frac{2}{3}$ of caryopsis. Starch grains compound. Chromosomes large; basic number 2, 7, 9.

Genera

49) Milium

50) Zingeria

7. Tribe PHALARIDEAE Coss. et Germ., Fl. Envir. Paris, 2: 624 s. str. (1945)

Leaf blades linear, with festucoid anatomy; silica bodies oblong; 2-celled micro-hairs absent; ligule membranous. Inflorescence a panicle, usually dense and cylindrical to ovoid. Spikelets strongly compressed laterally, with 1-3 florets, whenever with 3 florets the lower 2 each reduced to a small lemma or both absent. Rhachilla disarticulating above or below glumes, but not between florets. Spikelets sometimes in groups of 5-7, one fertile and sessile, the remainder sterile and pedicellate, the group falling entire. Glumes longer than florets. Fertile lemma indurate at maturity, awned or unawned. Palea 1-keeled. Lodicules 2 or absent. Stamens 3. Ovary glabrous. Styles 2. Hilum short, oblong. Starch grains compound. Chromosomes large; basic number 5, 6, 7.

Genera

51) Phalaris
52) Anthoxanthum
53) Hierochloe
54) Alopecurus
55) Cornucopia

8. Tribe PHLEEAE Dumort., Obs. Gram. Belg. 82, 91, s. str. (1823)

Leaf blades linear, with festucoid anatomy; silica bodies oblong to elliptical; 2-celled micro-hairs absent; ligule membranous. Inflorescence a spike-like panicle. Spikelets with 1(-2) florets, hermaphrodite, laterally compressed. Glumes longer or shorter than florets. Rhachilla disarticulating above glumes. Lemma membranous or chartilaginous, dorsally or terminally awned or awnless, usually connate at base. Palea 2-keeled. Lodicules 2. Stamens 3(-2). Ovary glabrous. Styles 2. Starch grains compound. Chromosomes large; basic number 7.

Genera

56) Beckmannia
57) Phleum
58) Pseudophleum
59) Rhizocephalus

9. Tribe SCOLOCHLOEAE Tzvel. in Bot. Zhurn. 53, 3: 309 (1968)

Leaf blades linear, with festucoid anatomy; silica bodies rectangular; 2-celled micro-hairs absent; ligule membranous. Inflorescence a panicle. Spikelet hermaphrodite, laterally compressed, with 2-5 florets. Glumes shorter than spikelet. Rhachilla disarticulating above glumes and between florets. Lemma coriaceous, lacerate at apex, dorsally rounded, somewhat mucronate to shortly awned. Palea 2-keeled. Lodicules 2, entire or with a lateral tooth. Stamens 3. Ovary densely hairy at apex. Styles 2. Hilum linear, $\frac{2}{3}$ as long as caryopsis. Starch grains compound. Chromosomes large; basic number 7.

Genera

60) Scolochloa

10. Tribe POEAE R. Br. in Flinders, Voy. Terra Austral. 2: 583, s. str. (1814)

Leaf blades linear to filiform or setaceous, with festucoid anatomy; silica bodies rounded or oblong; 2-celled micro-hairs absent; sheaths sometimes tubular; ligule membranous. Inflorescence usually a panicle, rarely a spike or raceme. Spikelets all hermaphrodite or some hermaphrodite and others sterile, laterally compressed or terete, with 2- to many florets. Glumes shorter than spikelets. Rhachilla disarticulating above glumes and between florets. Lemma awnless or with a terminal awn, usually keeled. Palea 2-keeled. Lodicules 2, lanceolate-acute, entire or lobed. Stamens 3. Hilum punctiform or linear. Starch grains compound. Chromosomes large; basic number 7.

Genera

61) Festuca
62) Bellardiochloa
63) x Festulolium
64) Lolium
65) Vulpia
66) Micropyrum
67) Narduroides
68) Loliolum
69) Catapodium
70) Cutandia
71) Sphenopus
72) Psilurus
73) Poa
74) Eremopoa
75) Nephelochloa
76) Catabrosella
77) Hyalopoa
78) Catabrosa
79) Paracolpodium
80) Colpodium
81) Puccinellia
82) Sclerochloa
83) Dactylis
84) Cynosurus
85) Lamarckia
86) Briza

11. Tribe HAINARDIEAE W. Greuter in Boissiera 13: 177 (1967)

Leaf blades linear to linear-lanceolate, with festucoid anatomy; silica bodies orbicular, oblong or elliptic; 2-celled micro-hairs absent; ligule membranous. Inflorescence a cylindrical spike. Spikelets with 1(-2) florets, all hermaphrodite, rather sunk into cavities of rhachis, sessile. Glumes 1-2; lower glume suppressed at

least in lateral spikelets. Spikelets edge-on or side-on to rhachis. Lemma hyaline, awnless, nearly equaling glumes. Palea 2-keeled. Lodicules 2, lanceolate, entire. Stamens 3. Ovary usually with a glabrous apical appendage. Styles 2. Hilum linear to elliptic. Starch grains compound. Chromosomes large; basic number 7.

Genera

87) Pholiurus

88) Parapholis

89) Hainardia

12. Tribe SESLERIEAE W. Koch, Syn. Fl. Germ. 1: 788 (1837)

Leaf blades linear, sometimes filiform, with festucoid anatomy; silica bodies elliptic or saddle shaped; ligule membranous. Inflorescence a dense, cylindrical or globose panicle, subtended by glume-like bracts. Spikelets with 2-6 hermaphrodite florets. Lemma hyaline, 4-5-dentate or often awned from apex. Palea 2-keeled. Lodicules 2, with 2-5 incisions at tip or absent. Ovary hairy or glabrous at apex. Styles 2. Hilum punctiform. Chromosomes large; basic number 7.

Genera

90) Sesleria

91) Echinaria

92) Ammochloa

13. Tribe MELICEAE Reichenb., Consp. Regni Veget. 53 (1828)

Leaf blades linear, with festucoid anatomy; silica bodies elongate, with rounded ends; sheaths tubular; ligule membranous. Inflorescence a panicle. Spikelets compressed laterally, with 1- to several hermaphrodite florets and 2-3 sterile lemmas forming a terminal clavate

structure (elaiosome). Glumes ± unequal, firmly membranous. Rhachilla disarticulating above glumes and between florets. Lemma ± coriaceous, rounded on dorsal side. Palea 2-keeled. Lodicules 2, truncate, connate laterally. Styles 2. Hilum linear. Chromosomes small or medium sized; basic number 9.

Genera

93) Melica

14. Tribe GLYCERIEAE Endl., Fl. Poson:117 (1830)

Leaf blades linear, with festucoid anatomy; silica bodies oblong, with sinuate outlines; 2-celled micro-hairs absent; ligule membranous; sheaths tubular. Inflorescence a panicle. Spikelets laterally compressed or terete, with a few to many hermaphrodite florets. Glumes shorter than spikelets, unequal. Rhachilla disarticulating above glumes and between florets. Lemma rounded on back, scarious at apex, unawned. Palea 2-keeled. Lodicules 2, truncate, connate. Stamens 3(-2). Ovary glabrous. Styles 2. Hilum linear, as long as caryopsis. Starch grains compound. Chromosomes small; basic number 5.

Genera

94) Glyceria

15. Tribe MOLINIEAE Jiras. in Preslia 38, 1: 33 (1966)

Leaf blades linear, with festucoid anatomy; silica bodies dumb-bell shaped; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence a panicle. Spikelets hermaphrodite, laterally compressed, with 1-4 florets. Glumes shorter than spikelet. Rhachilla disarticulating above glumes and between florets. Lemma membranous, rounded on back, unawned. Palea 2-keeled. Lodicules 2, obovate. Stamens 3. Ovary glabrous. Styles 2. Hilum linear, as long as caryopsis.

Starch grains compound. Chromosomes small; basic number 9.

Genera

95) Molinia

16. Tribe NARDEAE Anderss., Gram. Scand.:112 (1852)

Leaf blades setaceous, with festucoid anatomy; silica bodies saddle-shaped or rounded; 2-celled micro-hairs present; ligule membranous. Inflorescence a spike. Spikelets with 1 hermaphrodite floret, triangular in cross-section, secund. Lower glume very small, upper glume absent. Rhachilla disarticulating above glumes. Lemma chartaceous, with terminal awn. Palea 2-keeled. Lodicules absent. Stamens 3. Ovary glabrous. Style 1. Hilum linear. Starch grains compound. Chromosomes large; basic number 13.

Genera

96) Nardus

17. Tribe STIPEAE Dumort., Obs. Gram. Belg. 83, 134 (1823)

Leaf blades setaceous to linear, usually convolute or folded, with bambusoid anatomy; silica bodies elliptic or slightly crescent, oblong, cross or dumb-bell shaped; 2-celled micro-hairs present; ligule membranous. Inflorescence a panicle. Spikelets with 1 hermaphrodite floret, laterally compressed or terete. Glumes longer than floret. Rhachilla disarticulating above glumes. Lemma terete, becoming indurated at maturity, with a dorsal or terminal awn. Palea 2-veined. Lodicules 3(-2). Stamens 3. Ovary glabrous. Styles 2. Hilum linear, as long as caryopsis. Starch grains compound. Chromosomes small; basic number 9, 11, 12, 13-17.

Genera

97) Stipa

98) Piptatherum

18. Tribe AMPELODESMEAE (Conert) Tutin, Fl. Europ. 5: 252 (1980)

Leaf blades linear, with festucoid anatomy; silica bodies transversely elliptic; 2-celled micro-hairs absent; ligule membranous, becoming ciliate at apex in later stages. Inflorescence a panicle. Spikelets all laterally compressed, with 2- to many hermaphrodite florets. Glumes shorter than spikelet. Rhachilla disarticulating above glumes and between florets. Lemma coriaceous, with membranous margins. Palea 2-keeled. Lodicules 2-3, narrowly lanceolate. Stamens 3. Ovary with densely hairy appendage. Styles 2. Hilum linear. Starch grains simple. Chromosomes small; basic number 12.

Genera

99) Ampelodesmos

19. Tribe ARUNDINEAE Dumort., Obs. Gram. Belg. 82, 124 (1823)

Leaf blades broadly linear, with arundinoid anatomy; silica bodies cross-shaped or rounded sometimes mixed with crescentic saddle-shaped ones; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence a large plumose panicle. Spikelets with 2- to many hermaphrodite florets, laterally compressed. Glumes equaling or shorter than spikelet. Rhachilla disarticulating above glumes and between florets. Lemma membranous with long silky hairs from its callus or dorsal side. Palea 2-keeled. Lodicules 2, truncate. Stamens 3(-2). Ovary glabrous. Styles 2. Hilum linear, oblong or punctiform. Starch grains compound. Chromosomes small; basic number 12.

Genera

100) Arundo

101) Phragmites

20. Tribe CORTADERIEAE Zotov. in New Zealand Journ. Bot. 1, 1: 83 (1963)

Leaf blades broadly linear, with arundinoid anatomy; silica bodies rounded or dumb-bell shaped; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence a large plumose panicle. Spikelets dioecious, laterally compressed, with 2-7 florets. Glumes unequal. Rhachilla disarticulating above glumes and each floret. Lemma membranous, with a terminal awn. Palea 2-keeled. Lodicules 2, ciliate. Stamens 3. Ovary glabrous. Styles 2. Hilum linear. Starch grains compound. Chromosomes small; basic number 9.

Genera

102) Cortaderia

21. Tribe DANTHONIEAE (C. Beck.) C.E. Hubbard ex Riddelsdell & al., Fl. Glouc.:535 (1948)

Leaf blades linear or setaceous, with bambusoid anatomy; silica bodies rounded or dumb-bell shaped; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence a panicle. Spikelets with 2-10 florets, hermaphrodite, laterally compressed. Glumes about as long as lowest lemma. Rhachilla disarticulating above glumes and between florets. Lemma membranous to coriaceous, bilobed and often awned from sinus. Palea 2-keeled. Lodicules 2. Stamens 3. Ovary glabrous. Styles 2. Hilum elliptic or linear. Starch grains compound. Chromosomes small; basic number 6, 9, 12.

Genera

103) Danthonia

104) Schismus

22. Tribe ARISTIDEAE C.H. Hubbard in Bor, Grass. Burma, Ceyl. Ind. Pakist.: 685 (1960)

Leaf blades setaceous to linear-convolute, with aristidoid anatomy; silica bodies dumb-bell shaped, or elliptic-oblong; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence a panicle. Spikelet with 1 hermaphrodite floret, laterally compressed or terete. Glumes shorter or longer than florets. Rhachilla disarticulating above glumes. Lemma chartaceous, becoming coriaceous, with 3-fid terminal awn. Palea 2-keeled. Lodicules 2-3. Stamens 3(-1). Ovary glabrous. Styles 2. Hilum linear, as long as caryopsis. Starch grains compound. Chromosomes small; basic number 11, 12.

Genera

105) Aristida

106) Stipagrostis

23. Tribe AELUROPODEAE Nevski ex Bor in Ost. Bot. Zeitschr. 112: 184 (1965)

Leaf blades linear to convolute, with panicoid anatomy; (see Fig. 3, c) silica bodies dumb-bell or cross-shaped; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence of racemosely arranged, more or less sessile spikes. Spikelets with 2-many hermaphrodite florets, laterally compressed. Glumes shorter than spikelet. Rhachilla disarticulating above glumes and between florets. Lemma coriaceous. Palea 2-keeled. Lodicules 2, oblong-truncate. Stamens 3. Ovary glabrous. Styles 2. Hilum punctiform. Starch grains compound. Chromosomes small; basic number 10.

Genera

107) Aeluropus

24. Tribe ERAGROSTIDEAE Stapf in Dyer, Fl. Cap. 7: 316 (1898)

Leaf blades linear or setaceous, with chloridoid anatomy; silica bodies saddle-shaped; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence a panicle, spike or spike-like raceme. Spikelets with 2- many hermaphrodite florets, laterally compressed or subterate. Glumes shorter than spikelet. Rhachilla disarticulating above glumes and between florets, but occasionally spikelets falling entire. Lemma membranous to coriaceous, awnless or rarely with an apical awn. Palea 2-keeled. Lodicules 2, truncate. Stamens 2-3. Ovary glabrous. Styles 2. Hilum punctiform. Starch grains compound. Chromosomes small; basic number 9, 10, 12.

Genera

108) Eragrostis
109) Eleusine
110) Dactyloctenium
111) Cleistogenes

25. Tribe CHLORIDEAE J.G. Agardh, Aphor. Bot. 150 (1823)

Leaf blades linear, with chloridoid anatomy; silica bodies saddle-shaped; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence branches digitately arranged. Spikelets laterally compressed, with 1 hermaphrodite floret. Glumes subequal, shorter than spikelet. Rhachilla disarticulating above glumes. Lemma chartaceous. Palea 2-keeled. Lodicules 2, cuneate, concave or bilobed. Stamens 3. Ovary glabrous. Styles 2. Hilum punctiform. Chromosomes small; basic number 9, 10.

Genera

112) Cynodon

26. Tribe SPOROBOLEAE R. Br., Prodr. Fl. Nov. Holl. 169 (1810)

Leaf blades linear, with chloridoid anatomy; silica bodies saddle shaped; 2-celled micro-hairs present, somewhat 1-celled, distal cell swollen; ligule usually a fringe of hairs. Inflorescence a panicle. Spikelets terete, with 1 floret, hermaphrodite. Glumes equal to subequal. Rhachilla disarticulating above glumes. Lemma membranous. Palea 2-keeled. Lodicules 2, broadly cuneate. Stamens 2-3. Ovary glabrous. Styles 2. Hilum punctiform. Starch grains compound. Chromosomes small; basic number 6, 9, 10, 12.

Genera

113) Sporobolus

114) Crypsis

27. Tribe ZOYSIEAE Miq., Fl. Ind. Bot. 3: 365 (1857), emend. Stapf in Dyer, Fl. Cap. 7: 315 (1898)

Leaf blades convolute, piliate or setaceous, with chloridoid anatomy; silica bodies saddle, bumb-bell or cross-shaped or nodular; 2-celled micro-hairs present; ligule absent or a fringe of hairs. Inflorescence a panicle or a raceme. Spikelets with 1 floret, hermaphrodite or some male, dorsally compressed. Glumes longer than lemma. Rhachilla disarticulating below glumes and spikelets falling in groups of 2-5. Lemma hyaline. Palea 2-keeled. Lodicules 2, obliquely truncate. Stamens 3. Ovary glabrous. Styles 2. Hilum punctiform. Starch grains compound. Chromosomes small; basic number 9, 10.

Genera

115) Tragus

28. Tribe PANICEAE R. Br. in Flinders, Voy. Terra Austr. 2: 582 (1814)

Leaf blades lanceolate or linear, with panicoid anatomy; silica bodies nodular, bumb-bell or cross shaped; 2-celled micro-hairs present; ligule membranous or a fringe of hairs. Spikelets hermaphrodite, bristly or not, with 2 florets, lower floret male or barren, upper one hermaphrodite, dorsally compressed or terete. Glumes usually unequal, lower glume very tiny or absent, upper one equalling spikelet or shorter. Rhachilla disarticulating below glumes. Upper lemma firmer than lower one, awnless or shortly mucronate at apex. Lodicules 2, truncate. Stamens 3. Ovary glabrous. Styles 2. Hilum punctiform. Starch grains simple. Chromosomes small; basic number 7, 9, 10, 15, 17, 19.

Genera

116) Oplismenus
117) Panicum
118) Echinochloa
119) Brachiaria
120) Paspalum
121) Digitaria
122) Setaria
123) Pennisetum

29. Tribe ANDROPOGONEAE Dumort., Obs. Gram. Belg. 84, 141 (1823)

Leaf blades linear to lanceolate or ovate, with panicoid anatomy; silica bodies bumb-bell or cross-shaped; 2-celled micro-hairs present; ligules membranous to ciliate. Inflorescence a digitate spike to false raceme or panicle. Spikelets rarely solitary or in threes, usually in pairs and one of each pair sessile, dorsally or laterally compressed or terete, with 2 florets, lower floret male or sterile, upper one hermaphrodite. Glumes longer than florets. Rhachilla disarticulating below glumes. Lemma membranous, upper often with a geniculate awn. Palea often absent. Lodicules 2, truncate or absent. Stamens 1-3. Ovary glabrous. Styles 2. Hilum punctiform. Starch grains simple.

Chromosomes small; basic number 5, 9, 15, 17, 19.

Genera

124) Spodiopogon
125) Saccharum
126) Imperata
127) Sorghum
128) Chrysopogon
129) Botriochloa
130) Dichanthium
131) Andropogon
132) Hyparrhenia
133) Arthraxon
134) Themeda
135) Phacelurus
136) Hemarthria
137) Coix
138) Zea

Chapter X

10. Generic Keys to Turkish Gramineae

10.1. Introduction

Boissier's Flora Orientalis is the only Flora that covers all of Turkey and contains most of the Turkish genera. Unfortunately no attempt was made by Boissier to provide a dichotomous key to the genera in his work. In fact, many of the grass genera accepted in his book are rather heterogeneous. Since Boissier's time a number of those heterogeneous genera have been split into numerous small but more natural ones, though the status of some of them may be open to question.

In this chapter two types of generic keys have been prepared for the identification of Turkish genera. For this reason 486 species belonging to 138 genera and 29 tribes have been examined. In the Formula Key, 8 morphological characters have been broken down into 26 states. In the dichotomous key I recognized 9 major groups, under each of which the genera are keyed out.

The floral organs as well as the vegetative ones can be studied by the use of a x 10 hand lens or binocular dissecting microscope. For detailed morphological checking, before dissection spikelets require some pretreatment which has been described in Chapter III (3.1.) but is not necessary here. Spikelets should be placed on a smooth surface or tile and with two fine needles and a binocular dissecting microscope they can be dissected from below upwards. All spikelet organs should be examined carefully and arranged sequentially: lower glume, upper glume, lowest lemma, lowest palea, etc. and should be checked against the character states in both keys.

10.2. Formula Key to Genera

138 Turkish genera belonging to 29 tribes have been recognized on the basis of microscopic, vegetative, floral and caryopsis characters. In fact all character states used in this Formula (multi-access) Key have long been accepted as useful by various taxonomists and are commonly used for identification purposes, but some of these character states have been combined together or slightly altered for practical checking with a x 10 hand lens. However, a selection of eight of these character states was made so that permutations of them were sufficient to distinguish most of the genera. Each of the character states was given an alphabetical symbol and a formula was then presented for Turkish species in all the genera. These formulae were arranged in alphabetical order to give an indexed guide to the genera.

This key has been prepared in a similar manner to that already published for the Umbelliferae genera and Compositae genera (Flora of Turkey 4:280, 1972; 5:25, 1975).

The specimen has to be checked carefully against the character states and the 8-lettered formula thus produced should be written down and traced in the following alphabetically arranged index.

To take an example, an unrecognized genus with a lax non-plumose panicle, laterally compressed (at right angles to glumes) or not compressed with 2-many flowered spikelets, glumes shorter than floret (excluding awns), awn dorsal (including subbasal) on the lemma, ligule membranous, auricle absent, leaf sheath glabrous and habit annual, will be found to have the formula GKMQTVXY. In the alphabetical index this formula refers only to the genus Ventenata. In this case the formula is sufficient for identification. If, however, character states lead to the formula HLNRTVXY, which is shared by three genera, the supplementary notes following the formula must be consulted.

If the glumes are coriaceous and swollen at the base Castridium is excluded. If the lemma is 3-veined and awned Alopecurus is also excluded, and the remaining third genus Phleum is defined on the basis of its 5-7-veined and awnless lemma.

If the material is not adequate for identification all the possibilities of lacking characters must be tried. In most cases it is not easy to know the duration of grasses because this is due to either early or bad collecting. In such cases the two possible choices of habit (Y and Z), e.g. HLNRTVXY, HLNRTVXZ, should be consulted and both of these formulae have to be tried in the alphabetically arranged index.

Wherever a minus sign (-) appears in a formula, it means that this organ is missing, e.g. the formula GJNO(-)VXY represents Echinochloa which lack a ligule; GL(-)RTVXZ represents Leersia which has no glumes.

Inflorescence Type

Nine character states are based on the inflorescence can be recognised in Turkish grasses. These character states mainly differ from each other in their branching system, panicle shape and spikelet arrangement on the axis. Only the terminal inflorescence is scored (allowing for the anomalous situation in Zea and Coix).

A) Inflorescence a distinctly interrupted spike, with 1 (sessile) spikelet at each node (Fig. 25, A).

The spikelets have no pedicels, being sessile on the main axis. Each spikelet is attached to the main axis at each node, and between two spikelets on the axis there is a rather long conspicuous internode, as in Lolium, Elymus, Psilurus, Gaudinia, Henrardia, Parapholis, etc.

B) Inflorescence an uninterrupted spike, with 1 or more sessile spikelets at each node (Fig. 25, B).

In certain genera the spikelets, as well as being sessile on the main axis, have at least two of them attached to the same node of the main axis. Spikelets are rather dense and almost hiding the internodes. The inflorescence is oblong in outline, as in Dasypyrum, Secale, Eremopyrum, Taeniatherum, Triticum, Agropyron, etc.

Hordeum and Hordelymus present a slightly different variant of this character state, having two shortly pedicellate lateral spikelets; however, since each of the three spikelets forms a unit and fall together, this can also be treated as a spike.

C) Inflorescence of digitate spikes or false racemes (Fig. 25, C).

The spikelets and their arrangements on the axis are not considered here. The diagnostic feature is the first branching system of the inflorescence. The branches coming out from the top of the stem are 3-5, such as Dichanthium, Cynodon, Arthraxon, Eleusine, Dactyloctenium, Hemarthria, etc.

D) Inflorescence of paired spikes or false racemes (Fig. 25, D).

This state differs from state C only in having two terminal branches, such as Dichanthium, Andropogon, Paspalum, Hyparrhenia, Arthraxon, etc.

E) Inflorescence a raceme (Fig. 26, E).

Each spikelet is directly connected to the main axis by a short or relatively long pedicel. In certain cases the pedicels are so short that the spikelets may be mistakenly thought to be sessile. In Turkey, there are certain examples for this character state,

such as Brachypodium, Gaudinensis, Vulpia, Micropyrum, Danthonia, Catapodium, etc.

F) Inflorescence a lax plumose panicle (Fig. 26, F)

Secondary branching is present and the branches are rather long, but the most striking feature is the long soft hairs which give a plumose appearance to the panicle. The hairs can be attached to different parts of the spikelet, such as awn, rhachilla, dorsal side of lemma, glumes, or below the spikelet. The typical examples for this character state are Schismus, Arundo, Imperata, Stipagrostis, and Phragmites. (It can also be seen in Calamagrostis epigejos (L.) Roth and Agrostis olympica (Boiss.) Bor).

G) Inflorescence a lax non-plumose panicle (Fig. 26, G)

Differing from F only in lacking long soft hairs in the panicle and thereby not having a plumose appearance. Examples are Bromus, Festuca, Oryza, Milium, Agrostis, Helictotrichon and Arrhenatherum.

H) Inflorescence a spike-like panicle, more than twice as long as broad (Fig. 27, H)

The panicle branches are extremely short, and secondary branching is present. The length/breadth ratio of such an inflorescence is more than 2:1, being cylindrical to oblong in outline, as in Gastridium, Koeleria, Rostraria, Sesleria, Phalaris, Phleum, etc.

I) Inflorescence a dense head-like panicle, 1-2 x as long as broad (Fig. 27, I)

Differing from state H only in length/breadth ratio of the panicle. The length/breadth ratio is less than 2, being old to

spherical, such as in Rhizocephalus, Cornucopia, Lagurus, Echinaria, Phleum crypsoides (D'Urv.) Hackel, Alopecurus textilis Boiss., etc.

Spikelet Compression

The compression of the spikelet and its direction provide taxonomically useful characteristics. When the spikelet is compressed it is easy to see the plane of compression, but in certain genera it is almost impossible to decide whether it is dorsally or laterally compressed. Under these circumstances, the compression of spikelets is combined with floret number in scoring the character state.

J) Spikelets dorsally or ventrally compressed in line with glumes, with 1-2 florets (Fig. 28, J)

It is not always easy to find a spikelet equally compressed from both sides. Sometimes the compression is only on one side of the spikelet. Examples are Panicum, Sorghum, Setaria, Hainardia, Saccharum and Dichanthium.

K) Spikelets laterally compressed (at right angles to glumes) or not compressed, with 2-many florets (Fig. 28, K)

The spikelets are compressed laterally and always with two or more florets, but occasionally the spikelets are not compressed at all. This is the commonest case in Turkish grasses, such as Trisetum, Lolium, Bromus, Festuca, Glyceria, Aira, etc.

L) Spikelets laterally compressed or not compressed, always with 1 floret (Fig. 28, L)

Differing from state K only in having 1 floret per spikelet. Some examples illustrating this character state are Phleum, Alopecurus, Gastridium, Triplachne, Stipa and Lagurus.

Relative Length of Glumes to Lowest Lemma

In certain genera, the glumes are extremely small and reduced, while in others they reach the apex of the spikelet. In this group the relative length of the glumes is compared with the lowest lemma (the lowest lemma is the one that is always subtended by the lower glume). A small mucro (less than 0.5 mm) at the apex of the glumes is included within the length of the glumes, but awn length is always excluded.

M) Glumes shorter than lowest lemma (excluding awns), or rarely absent (-) (Fig. 29, M)

Glumes shorter than the lowest lemma, or very much reduced to scale-like organs, as in Oryza sativa L. Rarely spikelets have no glumes at all, for example Leersia oryzoides (L.) Swartz. The latter state is scored as (-), instead of M. Examples of glumes shorter than lowest lemma are Cynodon, Trisetum, Nardus, Rhiscocephalus, Gaudinopsis and Sclerochloa.

N) At least one glume as long as or longer than lowest lemma (Fig. 29, N)

At least one of the glumes is equal to the lowest lemma or longer than it, such as Agrostis, Calamagrostis, Alopecurus, Gastridium, Holcus, Polypogon, etc.

Awn Position on Lemma, or Awn Absent

In this group, the awn and its position of attachment to the lemmas (not glumes!) is dealt with, but small biaristate points at apex of lemma are excluded (e.g. Trisetaria).

O) Awn(s) of lemmas terminal (Fig. 30, O)

In some groups, awns arise from the tip of the lemma, but quite often they can be very small, and therefore need to be examined carefully. In certain genera the terminal awns are rather long and exserted. Examples for this character state are Aristida, Oryza, Festuca, Rhiscocephalus, Nardus and Lolielum. Sometimes the lemma has more than one terminal awn (e.g. Sesleria, Echinaria).

P) Awn(s) of lemmas subterminal (Fig. 30, P)

In this case the awn is attached in the upper one-fourth of the lemma, but is never at the top of the lemma. The awn may also be attached to the lemma either from its dorsal side or from the sinus of a bifid apex. Examples of this character state are Apera, Lolium, Rostraria, Ampelodesmos and Spodiopogon.

Q) Awn(s) of lemmas dorsal (incl. sub-basal) (Fig. 30, Q)

Here the attachment of awn to lemma is in the lower three-fourths of the lemma. This type also includes the sub-basal awn. Dorsal or subdorsal attachment of awn to lemma is the commonest case as far as Turkish grasses are concerned. Some examples for this character state are Trisetum, Deschampsia, Anthoxanthum, Avena, Alopecurus and Agrostis.

R) Awn(s) absent on all lemmas (Fig. 31, R)

As some of the species have an extremely short awn which can easily be overlooked (e.g. Cornucopia cuculatum L.). Examples of genera with awns absent include Poa, Aeluropus, Catabrosa, Briza, Panicum and Zingeria.

Ligule

The ligule of grasses occurs at the inner distal margin of the leaf sheath. It forms a short outgrowth made up of epidermal cells, and is a taxonomically important feature.

S) Ligule a fringe of hairs (Fig. 31, S)

In certain genera, especially in panicoid groups, the ligules consist only of a fringe of hairs. Examples for this character state are Eleusine, Dactyloctenium, Panicum, Cynodon, Arundo, Danthonia and Eragrostis.

T) Ligule membranous, of variable length, glabrous or hairy; rarely obsolescent (-) (Fig. 31, T)

A membranous ligule is present, but may become lacerate with age. Examples of this character state are Bromus, Hordeum, Festuca, Poa, Avena, Briza and Alopecurus. Sometimes the ligule is completely missing, as in Echinochloa. The latter state is scored as (-) instead of T.

Auricles

At the top of the leaf sheath, small usually falcate outgrowths are called auricles.

U) Auricles present (Fig. 32, U)

Auricles are present at the top of the sheath margins, but vary in shape from falcate to a protuberance. Examples for this character state are Eremopyrum, Secale, Agropyron, Lolium, Taeniatherum, Imperata and Hordeum.

V) Auricles absent (Fig. 32, V)

Auricles are completely absent. This is the commonest case as far as Turkish grasses are concerned. Examples for this character state are Lamarckia, Psilurus, Helictotrichon, Poa, Cornucopia and Briza.

Leaf Sheath

In this group, the hairiness or glabrousness of the lower sheaths is investigated. In some of the larger genera, both hairy and non-hairy species occur.

W) Leaf sheaths hairy (Fig. 32, W)

Relatively hairy lower sheaths that can usually be seen with the naked eye because the hairs are long and conspicuous, as is Holcus, Helictotrichon, Secale, Alopecurus, Amblyopyrum, Lagurus, Oplismenus, etc.

X) Leaf sheaths glabrous (Fig. 32, X)

The lower sheaths are glabrous or scabrid, never conspicuously hairy. This is the commonest case in Turkish grasses, such as Aira, Echinaria, Apera, Agrostis, Catabrosella, Poa, Vulpia, Echinochloa, etc.

Habit

The duration of grasses, either annual or perennial, is an important diagnostic feature.

Y) Annual (rarely biennial):

Annual grasses have a rooting system which does not show any rhizomes or stolons. As the same features also apply to the very few biennials, the latter are assigned the same character state. Examples for this character state are Avena, Apera, Lagurus, Rostraria, Setaria, Vulpia, Eleusine and Echinaria.

Z) Perennials:

Perennial grasses are rhizomatous, stoloniferous or tufted, usually thickened at the base and with non-flowering shoots. It is possible to see dead sheath remains at the base. Examples of perennial grasses are Koeleria, Calamagrostis, Sesleria, Phragmites, Aeluropus, Deschampsia, Helictotrichon, etc.

Character States for Formula Key

A) Inflorescence a distinctly interrupted spike, with 1 (sessile) spikelet at each node

B) Inflorescence an uninterrupted spike, with 1 or more (sessile) spikelets at each node

C) Inflorescence of digitate spikes or false racemes

D) Inflorescence of paired spikes or false racemes

E) Inflorescence a raceme (though pedicels often very short)

F) Inflorescence a lax plumose panicle (spikelets with long hairs)

G) Inflorescence a lax non-plumose panicle

H) Inflorescence a spike-like panicle, more than twice as long as broad

I) Inflorescence a dense head-like panicle, 1-2 x as long as broad (sometimes involucrate)

J) Spikelets dorsally or ventrally compressed in line with glumes, with 1-2 florets

K) Spikelets laterally compressed (at right angles to glumes) or not compressed, with 2-many florets

L) Spikelets laterally compressed or not compressed, always with 1 floret

M) Glumes shorter than lowest lemma (excluding awns), or rarely absent (-)

N) At least one glume as long as or longer than lowest lemma

O) Awn(s) of lemmas terminal

P) Awn(s) of lemmas subterminal

Q) Awn(s) of lemmas dorsal (including sub-basal)

R) Awn(s) absent on all lemmas

S) Ligule a fringe of hairs

T) Ligule membranous, of variable length, glabrous or hairy, rarely obsolescent (-)

U) Auricles present

V) Auricles absent

W) Leaf sheaths (especially lower ones) hairy

X) Leaf sheaths glabrous (smooth or scabrid)

Y) Annual (rarely biennial)

Z) Perennial

Fig. 25. Character States used in the Formula Key

A) Inflorescence a distinctly interupted spike, with 1 (sessile) spikelet at each node

a) Lolium b) Hainardia c) Henrardia

B) Inflorescence an uninterrupted spike, with 1 or more (sessile) spikelets at each node

d) Hordeum e) Eremopyrum

f) A spikelet unit of Hordeum

g) Spikelet of Eremopyrum

C) Inflorescence of digitate spikes or false racemes (i.e. Dactyloctenium)

D) Inflorescence of paired spikes or false raceme (i.e. Paspalum)

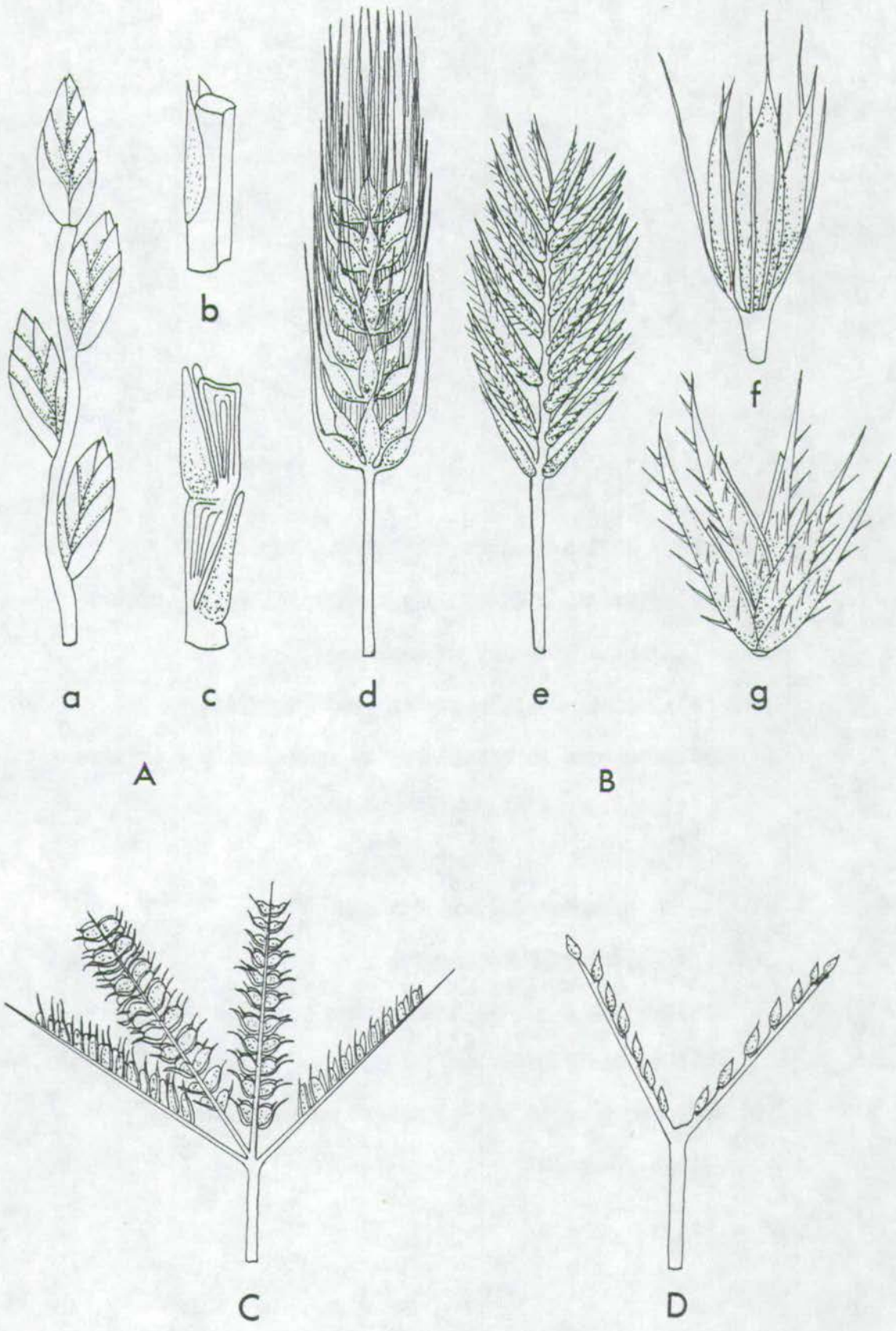


Fig. 25

Fig. 26. Character States used in the Formula Key

E) Inflorescence a raceme (though pedicels often very short)
(i.e. Brachypodium)

F) Inflorescence a lax plumose panicle (spikelets with long hairs)

a) Saccharum b) Spikelets of Saccharum

G) Inflorescence a lax non-plumose panicle
(i.e. Zingeria)

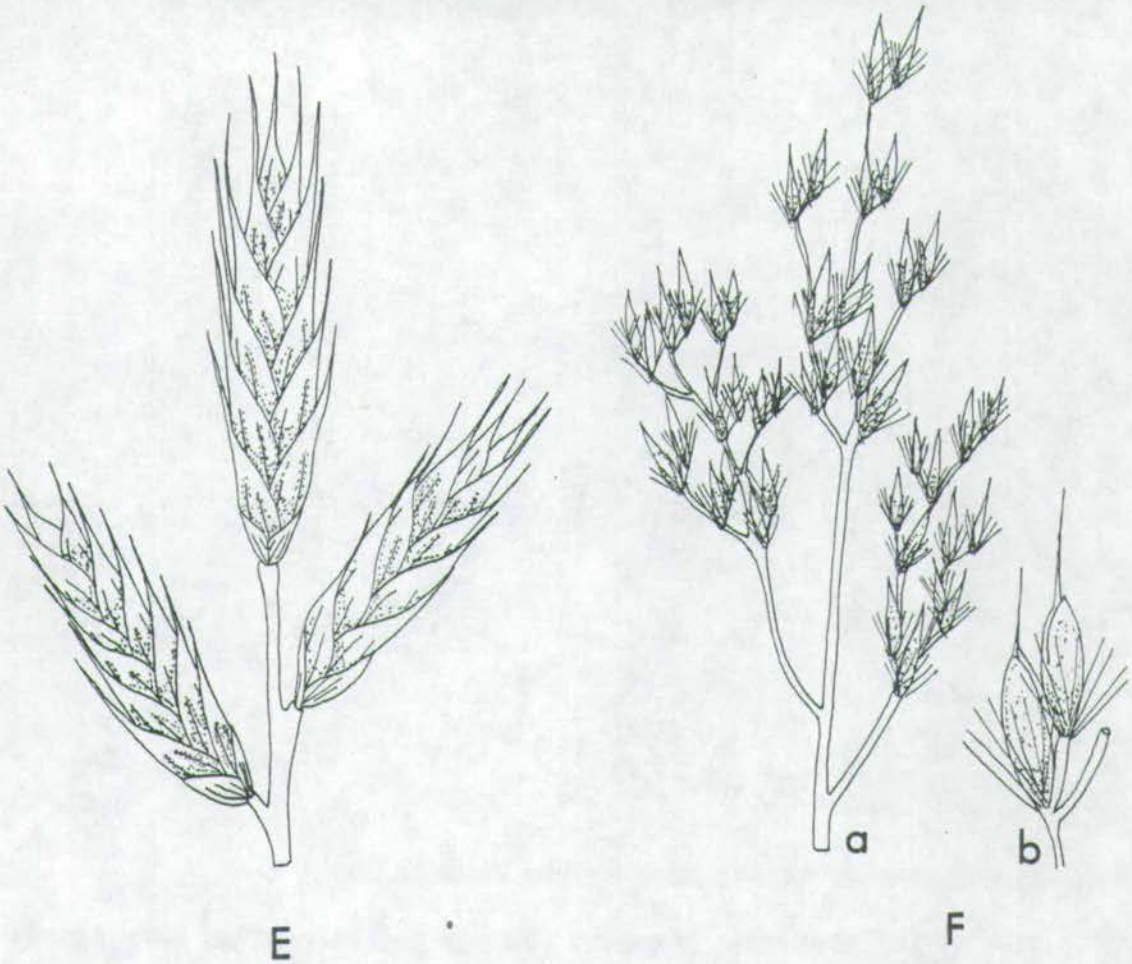


Fig. 26

Fig. 27. Character States used in the Formula Key

H) Inflorescence a spike-like panicle, more than twice as long as broad

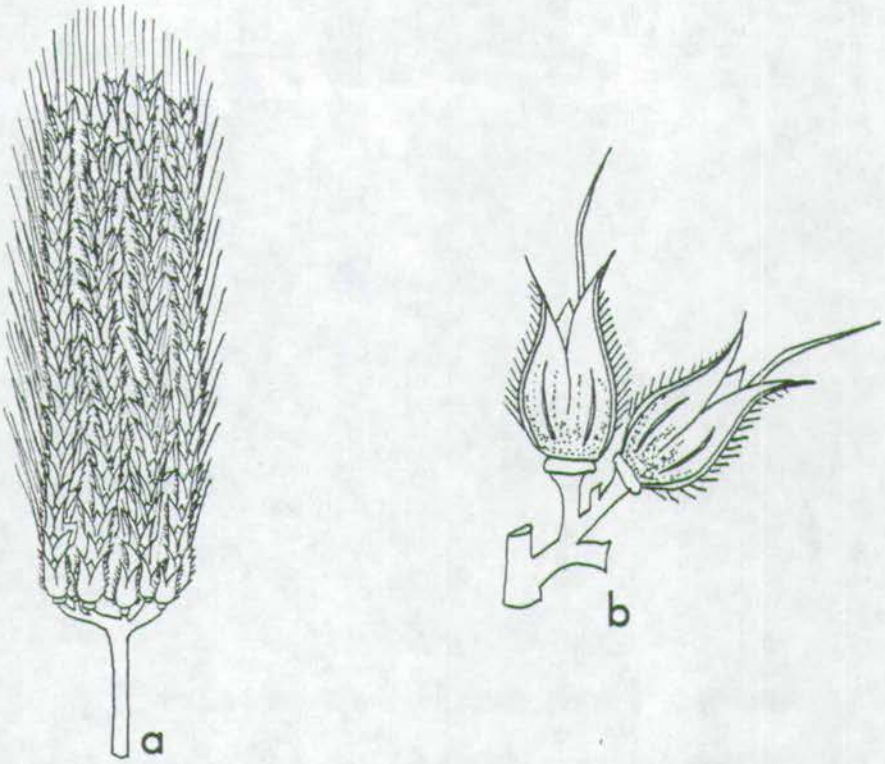
a) Inflorescence of Alopecurus

b) Spikelets of Alopecurus

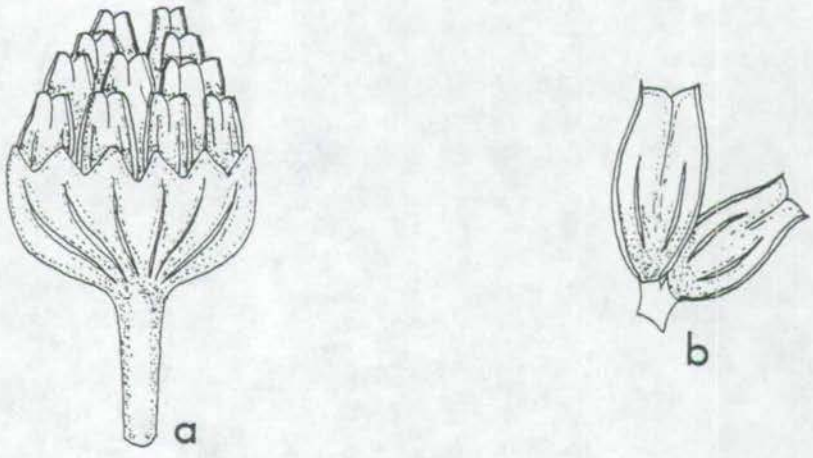
I) Inflorescence a dense head-like panicle, 1-2 x as long as broad (sometimes involucrate)

a) Inflorescence of Cornucopiae

b) Spikelets of Cornucopiae



H



I

Fig. 27

Fig. 28. Character States used in the Formula Key

J) Spikelets dorsally or ventrally compressed in line with glumes, with 1-2 florets

a) Spikelet of Panicum from dorsal view

b) Floret of Panicum from ventral view

c) Cross section of spikelet in Panicum

K) Spikelets laterally compressed (at right angles to glumes) or not compressed, with 2- many florets

(i.e. Gaudinopsis)

L) Spikelets laterally compressed or not compressed, always with 1 floret

(i.e. Alopecurus)

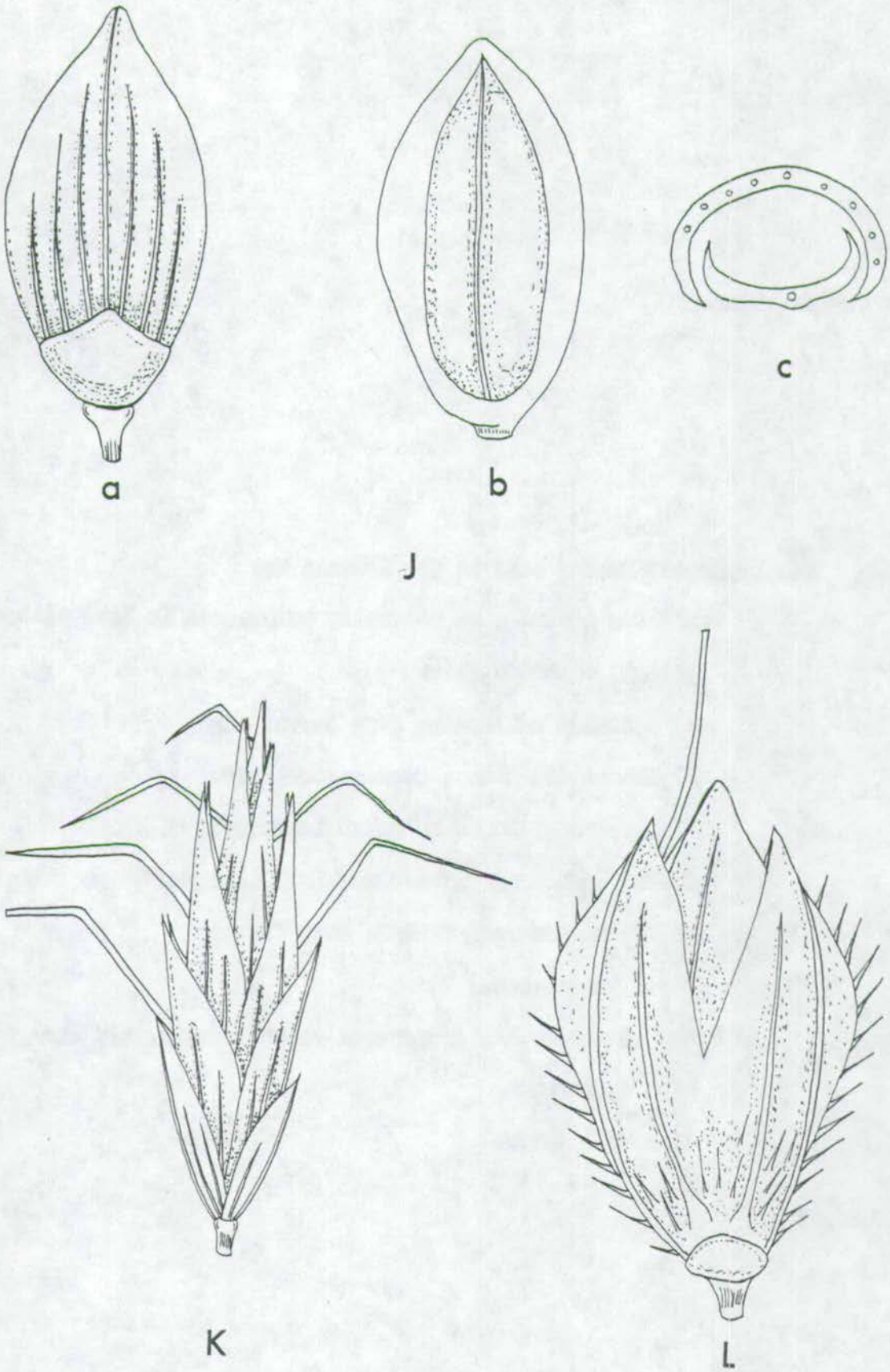


Fig. 28

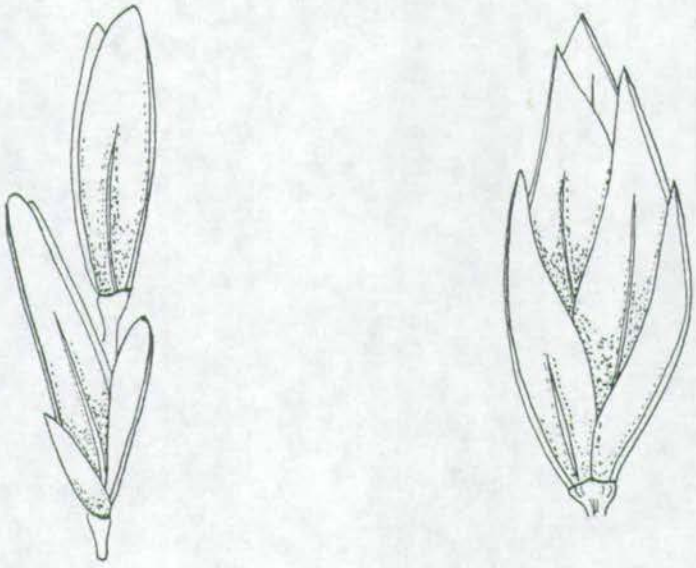
Fig. 29. Character States used in the Formula Key

M) Glumes shorter than lowest lemma (excluding awns), or rarely absent (-)

a) Catabrosa b) Poa

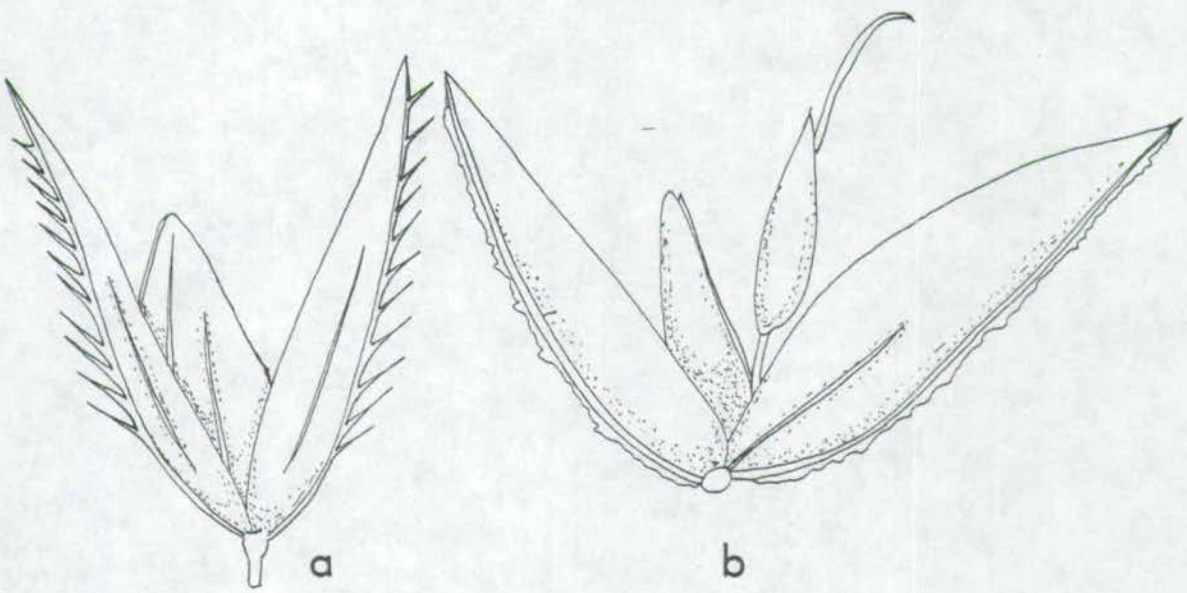
N) At least one glume as long as or longer than lowest lemma

a) Phleum b) Holcus



a b

M



a b

N

Fig. 29

Fig. 30. Character States used in the Formula Key

O) Awn(s) of lemmas terminal

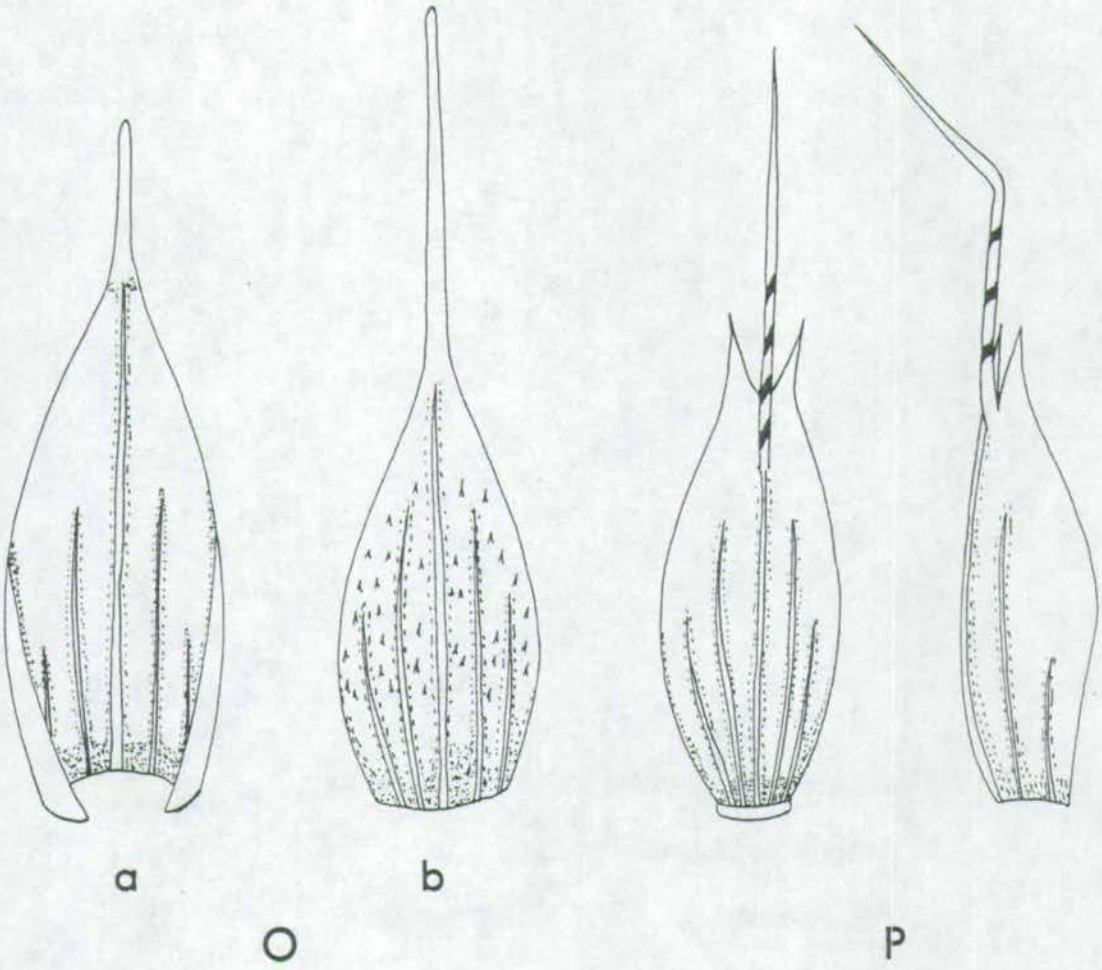
a) Festuca b) Agropyron

P) Awn(s) of lemmas subterminal

(i.e. Arrhenatherum)

Q) Awn(s) of lemmas dorsal (incl. sub-basal)

(i.e. Trisetum)



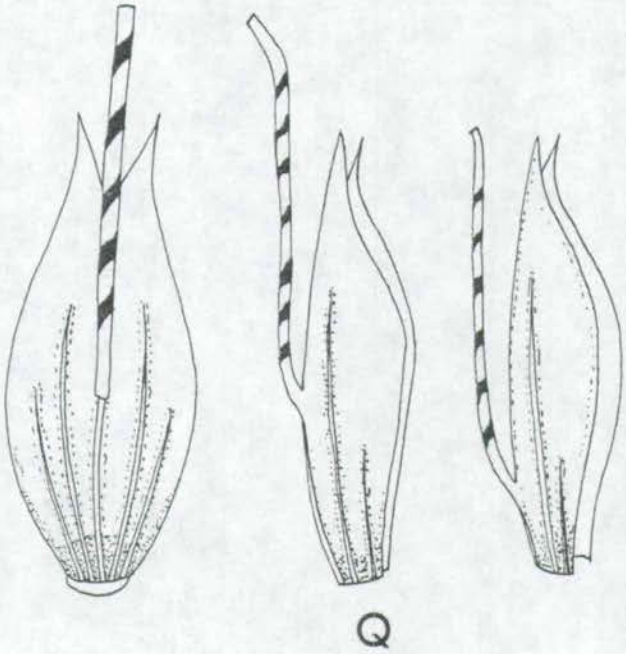


Fig.30

Fig. 31. Character States used in the Formula Key

R) Awn(s) absent on all lemmas

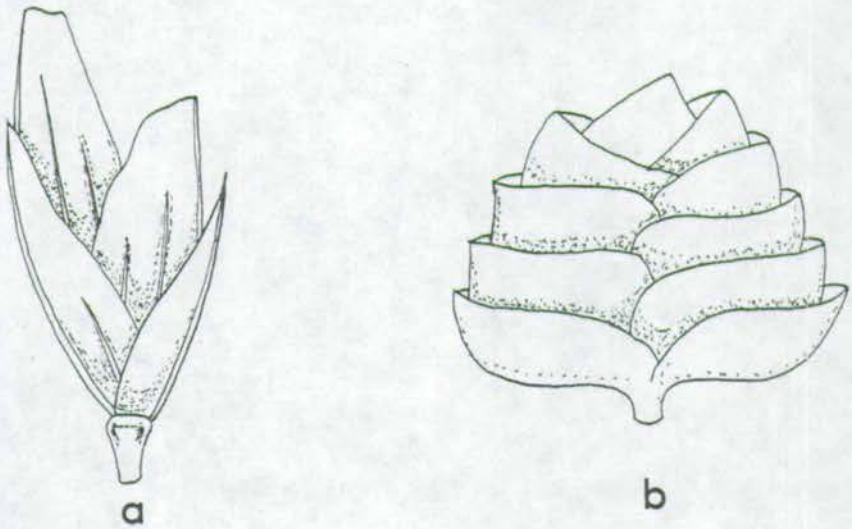
a) Colpodium b) Brisa

S) Ligule a fringe of hairs

(i.e. Brachiaria)

T) Ligule membranous, of variable length, glabrous or hairy, rarely obsolescent (-)

(i.e. Eremopoa)



R

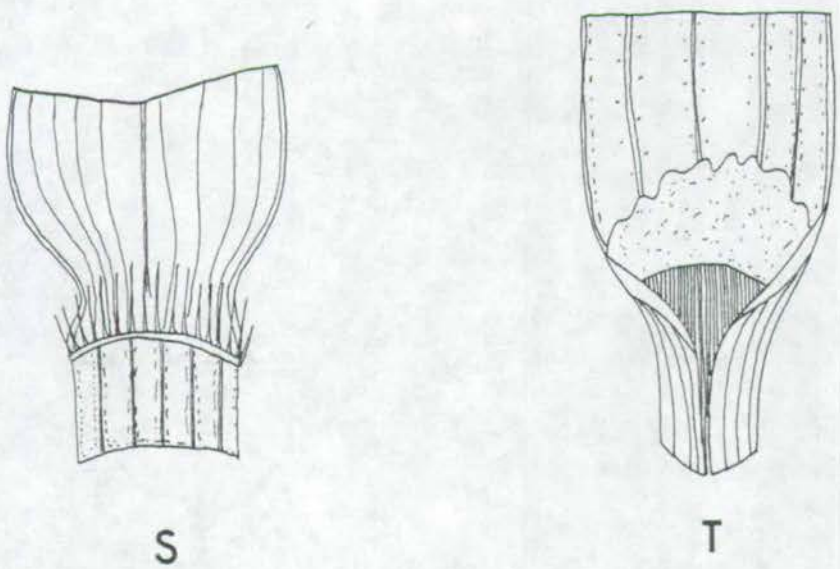


Fig. 31

Fig. 32. Character States used in the Formula Key

U) Auricles present

(i.e. Agropyron)

V) Auricles absent

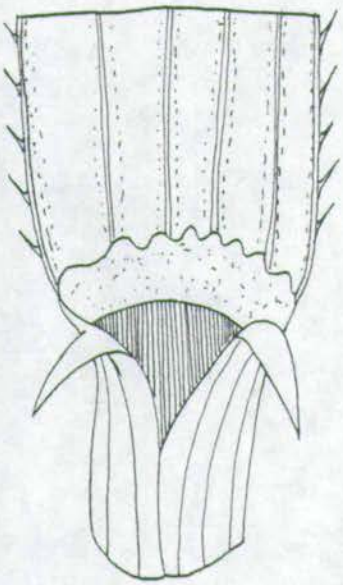
(i.e. Alopecurus)

W) Leaf sheaths (especially lower ones) hairy

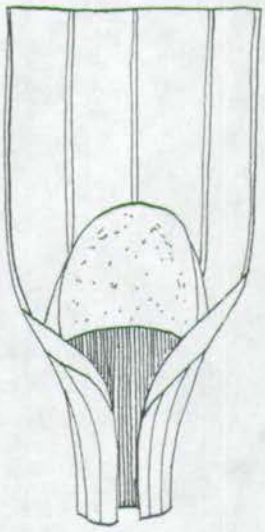
(i.e. Helictotrichon)

X) Leaf sheaths glabrous (smooth or scabrid)

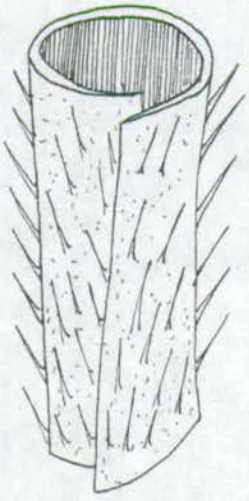
(i.e. Cormucopia)



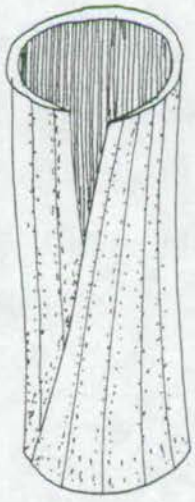
U



V



W



X

Fig. 32

FORMULA KEY TO GENERA

AJNRTUXY Lateral spikelets with 1 glume, not sunken ..... 64. *Lolium*

AJNRTVXY Lateral spikelets sunken into axis, with 1 floret ..... 89. *Hainardia*

AKMOTUWY Glumes with 1 or more teeth or awns ..... 11. *Aegilops*

AKMOTUXY Glumes with 1 or more teeth or awns ..... 11. *Aegilops*

AKMOTUXZ Glumes not keeled, 1-11-veined ..... 6. *Elymus*

AKMOTVXY Inflorescence curved; spikelets with 1 floret ..... 72. *Pailurus*

AKMPTUXY Glumes not keeled, 1-11-veined ..... 6. *Elymus*

AKMRTUWY Glumes ± truncate-cuneate ..... 9. *Amblyopyrum*

AKMRTUWZ Glumes not keeled, 1-11-veined ..... 6. *Elymus*

AKMRTUXZ Glumes not keeled, 1-11-veined ..... 6. *Elymus*

AKMRTVXZ Glumes not keeled, 1-11-veined ..... 6. *Elymus*

AKNOTUWZ Glumes not keeled, 1-11-veined ..... 6. *Elymus*

AKNOTUXZ 1. Spikelets in pairs at each node ..... 6. *Elymus*

2. Spikelets in groups of 2-6 at each node ... 15. *Leymus*

AKNOTVWY Glumes with 1 or more teeth or awns ..... 11. *Aegilops*

AKNOTVXY Lateral spikelets with 2 glumes ..... 68. *Loliolum*

AKNPTUXY Lateral spikelets with 1 glume ..... 64. *Lolium*

AKNPTVXY Lateral spikelets with 1 glume ..... 64. *Lolium*

ANKQTVWY Glumes 3(-5) to 5-7(-11)-veined ..... 25. *Gaudinia*

AKNRTUWZ Glumes not keeled, 1-11-veined ..... 6. *Elymus*

AKNRTUXY 1. Lateral spikelets with 1 glume ..... 64. *Lolium*

2. Lateral spikelets with 2 glumes, sunken . 20. *Henrardia*

AKNRTUXZ Lateral spikelets with 1 glume ..... 64. *Lolium*

AKNRTVXY Spikelets with 2 florets ..... 87. *Pholiurus*

Spikelets with 4-6 florets ..... 67. *Narduroides*

ALMOTVXY Inflorescence curved; spikelets with 1 fertile floret ..... 72. Psilurus

ALMOTVXZ Spikelets secund, triangular ..... 96. Nardus

ALNETUXY Lateral spikelets with 2 glumes, sunken .... 20. Henrardia

ALNETVXY Inflorescence curved; lateral spikelets with 2 glumes ..... 88. Parapholis

BKMOTUWY 1. Glumes truncate, with 1 or more teeth or awns ..... 11. Aegilops

2. Glumes abruptly ending into awns, 2-keeled ..... 13. Dasypyrum

3. Lemma acuminate to shortly aristate .... 7. Eremopyrum

4. Spikelets dimorphic, the fertile ones warty ..... 8. Heteranthelium

5. Spikelets with 2(-3) florets; glumes subulate ..... 14. Secale

BKMOTUWZ Glumes boat-shaped, keeled ..... 5. Agropyron

BKMOTUXY 1. Glumes truncate, with 1 or more teeth or awns ..... 11. Aegilops

2. Spikelets with 3-6 florets ..... 7. Eremopyrum

3. Lemma with a long awn ..... 14. Secale

BKMOTUXZ 1. Glumes not keeled ..... 6. Elymus

2. Spikelets with 2 florets; glumes 0-1-veined ..... 14. Secale

3. Glumes boat-shaped, with 1-2 lateral veins ..... 5. Agropyron

BKMOTVXY Spikelets with 3-6 florets; glumes keeled ..... 7. Eremopyrum

BKMOTVXZ Glumes boat-shaped, with 1-2 lateral veins ..... 5. Agropyron

BKMPTUWY Glumes truncate, keeled ..... 12. Triticum

BKMPTUXY Glumes truncate, keeled ..... 12. Triticum

BKMPTVXY Glumes truncate, keeled ..... 12. Triticum

BKMRSVXZ Leaves patent; ligule a fringe of hairs ... 107. Aeluropus

BKNOTUWY Glumes truncate, rounded dorsally ..... 11. Aegilops

BKNOTUWZ Lateral spikelets hermaphrodite ..... 18. Hordelymus

BKNOTUXY 1. Awn of lemma 6-12 cm, recurved ..... 19. Taeniatherum

2. Spikelets solitary at each node ..... 14. Secale

3. Lemma (incl. awn) equaling glumes (incl. aristate points), axis pilose ..... 10. Crithopsis

BKNOTUXZ Glumes covering sides of lower floret ..... 15. Leymus

BKNOTVXY Spikelets with 3-6 florets ..... 7. Eremopyrum

BKNOTVXZ 1. Rhachis fragile; spikelets with 1-2 hermaphrodite florets ..... 16. Psathyrostachys

2. Rhachis tough; spikelets with 3-5 hermaphrodite florets ..... 15. Leymus

BKNPTUXY Glumes truncate, keeled ..... 12. Triticum

BKNRTVXZ Glumes covering sides of lower floret ..... 15. Leymus

BLNOTUXY Central spikelets sessile, hermaphrodite ... 17. Hordeum

BLNOTVXY Central spikelets sessile, hermaphrodite ... 17. Hordeum

BLNOTVXZ 1. Lateral spikelets sessile ..... 16. Psathyrostachys

2. Lateral spikelets pedicellate, sterile .... 17. Hordeum

BLNRTVXZ Only central spikelets sessile ..... 17. Hordeum

CJMRTVWY Spikelets secund, 2-3.5 mm, pedicellate .. 121. Digitaria

CJMRTVWZ Spikelets secund, 2-3.5 mm, pedicellate .. 121. Digitaria

CJNOSVXZ Sessile spikelets with 2 florets ..... 130. Dichanthium

CJNOTVXZ Stem nodes long hairy ..... 130. Dichanthium

CJNRSVWZ Spikelets 10-18 mm, paired ..... 135. Phacelurus

CJNRTVXY Spikelets secund, 1.8-2.2 mm ..... 121. Digitaria

CJNRTVXZ Spikelets 4-6 mm, sunk into rhachis .... 136. Hemarthria

CKMOTVXY Axis extending; upper glume terminally awned ..... 110. Dactyloctenium

CKMRSVXY Spikelets secund, 5-8 mm ..... 109. Eleusine

CKNQSVWY Leaf blades lanceolate ..... 133. Arthraxon

CKNQSVWZ Leaf blades lanceolate ..... 133. Arthraxon

CLMRSVXZ Spikelets secund, with 1 floret, 2 mm ..... 112. Cynodon

DJNOTVXZ Stem nodes covered by long hairs ..... 130. Dichanthium

DJNPTVXZ Sessile spikelets 8-16 mm, with 2 florets ..... 131. Andropogon

DJNQSVWZ Leaf blades lanceolate; ligule hairy .... 133. Arthraxon

DJNQTVXZ Sessile spikelets 8-16 mm, with 2 florets ..... 131. Andropogon

DJNRTVXZ Spikelets secund, 3 mm ..... 120. Paspalum

DKMRSVXY Spikelets secund; ligule a fringe of hairs ..... 109. Eleusine

DKNOTVXZ Sessile spikelets 4-6.5 mm, with 2 florets ..... 132. Hyparrhenia

DKNPTVXZ Sessile spikelets 4-6.5 mm, with 2 florets ..... 132. Hyparrhenia

EJNRSVWZ Spikelets 10-18 mm, paired ..... 135. Phacelurus

EKMOTVWZ Spikelets 1-3 cm; lemma with apical awn ..... 3. Brachypodium

EKMOTVXY 1. Glumes very unequal; lower glume 1-veined ..... 65. Vulpia

2. Spikelets 1-3 cm; palea with pectinate ciliate ..... 4. Trachynia

3. Awn of lemma 1-4 mm ..... 66. Micropyrum

EKMOTVXZ Spikelets 1-3 cm, only a few ..... 3. Brachypodium

EKMPTVXY Lowest lemma withour an awn ..... 27. Gaudinopsis

EKMRTVXY 1. Glumes unequal, obtuse, margins
hyaline ..... 82. Sclerochloa

2. Glumes subequal, acute, membranous ..... 69. Catapodium

EKNOTVXY 1. Glumes very unequal; lemma keeled ..... 65. Vulpia

2. Glumes subequal; lemma rounded
on back ..... 4. Trachynia

EKNRSVXZ Ligule a fringe of hairs ..... 103. Danthonia

EKNRTUXZ Spikelets 10-30 mm, with 5-15 florets .... 63.×Festulolium

EKNRTVXY 1. Spikelets with 5-9 florets; glumes
acute ..... 69. Catapodium

2. Spikelets with 3(-5) florets; glumes
obtuse ..... 67. Narduroides

FJNOTVWZ Spikelets surrounded by hairs; lemmas
terminally awned ..... 125. Saccharum

FJNOTVXZ Spikelets surrounded by hairs; lemmas
terminally awned ..... 125. Saccharum

FJNPTVXZ Spikelets surrounded by hairs; upper
awned from sinus ..... 124. Spodiopogon

FJNRSVXY Spikelets surrounded by bristles ..... 122. Setaria

FKMOSVXZ 1. Spikelets surrounded by bristles ..... 123. Pennisetum

2. Rhachilla with long hairs ..... 101. Phragmites

FKMRSVXZ 1. Hairs from involucral bristles ..... 123. Pennisetum

2. Hairs from rhachilla ..... 101. Phragmites

FKNOSVXZ Dioecious; leaf blades sharply
serrulate ..... 102. Cortaderia

FKNPSVXY Spikelets with 5-10 florets; lemma
9-veined ..... 104. Schismus

FKNPSVXZ Ligule a fringe of hairs; panicle 30-60 cm ... 100. Arundo

FKMPTVXZ Spikelets surrounded by hairs ..... 124. Spodiopogon

FKNQTVXZ Lemma dorsally awned; spikelets 8-11 mm .... 28. Trisetum

FKNRSVXY Spikelets with 5-10 florets; lemma
9-veined ..... 104. Schismus

FKNRTUXZ Spikelets terete, with 2 florets;
branches though ..... 126. Imperata

FKNRTVWZ Hairs from dorsal side of lemma ..... 93. Melica

FKNRTVXZ 1. Spikelets surrounded by hairs ..... 124. Spodiopogon
2. Hairs from dorsal side of lemma ..... 93. Melica

FLNOSVWZ Awns 3-fid, at least middle awn long
hairy ..... 106. Stipagrostis

FLNOTVWZ Awns 3-fid, at least middle awn long
hairy ..... 106. Stipagrostis

FLNOTVXZ Awns hairy; callus acuminate ..... 97. Stipa

FLNPTVXY Awns coming from sinus of glumes ..... 45. Polypogon

FLNPTVXZ Hairs from callus; glumes acuminate to
aristate ..... 40. Calamagrostis

FLNQTVXZ 1. Spikelets 1.5-3.8 mm; glumes acute ..... 43. Agrostis
2. Glumes acuminate or shortly
aristate ..... 40. Calamagrostis

GJMRTVWY Spikelets 2.3-3.5 mm; glumes unequal .... 121. Digitaria

GJMRTVXY Branches verticillate; lemma clavate
hairy ..... 50. Zingeria

GJNO-VXY Spikelets 3-5 mm; ligule absent ..... 118. Echinochloa

GJNOTVXZ 1. Spikelets surrounded by spathe;
awn 4-6 cm ..... 134. Themeda
2. Pedicels with a translucent median
groove ..... 129. Bothriochloa

3. Spikelets with 1 floret, glabrous .... 98. Pintatherum

4. Spikelets in threes; sessile spikelets with long gloden hairs on their callus ..... 128. Chrysopogon

GJNPSVXY Sessile spikelets 4.5-5.5 mm; lemma thick ..... 127. Sorghum

GJNPTVXY Sessile spikelets 4. 5-5. 5 mm; lemma thick ..... 127. Sorghum

GJNRSVWY 1. Panicle branches very long ..... 117. Panicum

2. Glumes hairy; pedicels shorter than 1 mm ..... 119. Brachiaria

GJNRSVWZ Spikelets 10-18 mm; branches 14-30 cm .... 135. Phacelurus

GJNRSVXZ Lower glume minute; lemma coriaceous ..... 117. Panicum

GJNRTVWZ Spikelets secund, usually orbicular ..... 120. Paspalum

GJNRTVXY 1. Terminal inflorescence contains only male spikelets ..... 138. Zea

2. Female spikelets on a bony involucre ..... 137. Coix

3. Lemmas covered by clavate hairs ..... 50. Zingeria

4. Spikelets with 1 floret; lemma shiny ..... 49. Milium

GJNR-VXY Ligule absent; glumes unequal ..... 118. Echinochloa

GJNRTVXZ 1. Spikelets sunken into rhachis ..... 136. Hemarthria

2. Spikelets surrounded by spathe, awned .... 134. Themeda

3. Spikelets with 1 floret; lemma shiny ..... 49. Milium

GKMOTUXY Glumes scale like; 2 lower florets sterile ..... 1. Oryza

GK-OTUXY Glumes scale like; cultivated ..... 1. Oryza

GKMOTUXZ Lemma lanceolate, dorsally rounded ..... 61. Festuca

GKMOTVWZ Lemma lanceolate, dorsally rounded ..... 61. Festuca

GKMOTVXY Branches divaricate; spikelets 9-17 mm .... 70. Cutandia

GKMOTVXZ 1. Glumes navicular; rhachilla disarticulating below glumes ..... 56. Beckmannia

2. Callus with a fringe of hairs .... 62. Bellardiochloa

3. Awn of lemma 1-1.2 mm ..... 83. Dactylis

4. Lemma gradually terminating into awns, lanceolate; awn at least 2 mm ..... 61. Festuca

GKMPSVXZ Spikelets 6-10 mm; glumes 1-veined .... 111. Cleistogenes

GKMPTVWY Leaf sheaths with connate margins ..... 21. Bromus

GKMPTVWZ Caryopsis with a terminal appendage ..... 21. Bromus

GKMPTVXY 1. Lowest lemma without a dorsal awn ... 27. Gaudinopsis

2. Branches verticillate; spikelets up to 5.2 mm ..... 75. Nephelochloa

3. Branches divaricate at maturity ..... 70. Cutandia

4. Leaf sheaths with connate margins ..... 21. Bromus

GKMPTVXZ 1. Stem up to 250 cm, solid; lemma coriaceous ..... 99. Ampelodesmos

2. Leaf sheaths with connate margins ..... 21. Bromus

GKMQTVWY Leaf sheaths with connate margins ..... 21. Bromus

GKMQTVWZ Spikelets 4-11 mm, shiny ..... 28. Trisetum

GKMQTVXY Glumes 3-7 to 3-9-veined; lemmas awned .... 26. Ventenata

GKMQTVXZ Spikelets 7-16 mm; lemmas 5-9-veined ... 24. Arrhenatherum

GKMRSVXY Spikelet with 2-many florets; glumes 1-veined ..... 108. Eragrostis

GKMRSVXZ 1. Spikelets secund; leaves patent ..... 107. Aeluropus

2. Stem 1-noded; lowest lemma 3-3.5 mm ..... 95. Molinia

3. Spikelets with many florets; glumes 1.5-2 mm ..... 108. Eragrostis

GKMRTUXY Glumes scale-like; cultivated ..... 1. Oryza

GK-RTUXY Glumes scale-like; spikelet with 3 florets .... 1. Oryza

GKMRTUXZ Lemma lanceolate, dorsally rounded ..... 61. Festuca

GKMRTVXY 1. Glumes 3-9-veined; spikelet broadly ovate ... 86. Briza

2. Glumes 0-1-veined, 0.4-1 mm ..... 71. Sphenopus

3. Spikelets 8-18 mm; glumes acuminate ..... 70. Cutandia

4. Spikelets 2 mm; lemma veins conspicuous

..... 35. Molineriella

5. Lemmas keeled; spikelet ovate ..... 73. Poa

6. Glumes ½ as long as spikelet 69. Catapodium

7. Lower branches verticillate; lemma

acute ..... 74. Eremopoa

GKMRTVXZ 1. Spikelets ± terete; glumes 1-veined ..... 94. Glyceria

2. Leaf sheaths with connate margins ..... 21. Bromus

3. Spikelets broadly ovate; glumes

3-9-veined ..... 86. Briza

4. Uppermost 2-3 sterile florets clavate ..... 93. Melica

5. Lemmas lanceolate, 5-veined ..... 61. Festuca

6. Upper floret sticking out between glumes

..... 78. Catabrosa

7. Spikelets 3.5-4 mm; lemma margins

hyaline ..... 76. Catabrosella

8. Pedicels puberulent; lemma 3-veined ..... 33. Koeleria

9. Spikelets ovate, with 2-10 florets ..... 73. Poa

10. Spikelet oblong; glume obtuse at apex . 81. Puccinellia

GKNOTVXY Glumes 5-7 to7-9-veined; upper lemmas

dorsally awned ..... 26. Ventenata

GKNOTVXZ 1. Spikelets 3-6 mm; smelling coumarin .... 53. Hierochloe

2. Spikelets in threes; sessile spikelets

with long golden hairs ..... 128. Chrysopogon

GKNPTVWY Leaf sheath margins connate; caryopsis with a hairy terminal appendage ..... 21. Bromus

GKNPTVWZ Spikelets with 2 florets, 3-4 mm ..... 39. Holcus

GKNPTVXY 1. Spikelets dimorphic; glumes subequal .... 85. Lamarckia

2. Spikelets with 2-4 florets; glumes unequal ..... 31. Avellinia

GKNPTVXZ 1. Lowest floret with geniculate awn ... 24. Arrhenatherum

2. Stem up to 200 cm; palea equaling lemma ..... 60. Scolochloa

GKNQTVWY 1. Spikelets 2.6-6 mm; lemmas with 2 setae ..... 29. Trisetaria

2. Spikelets 15-40 mm; lemma 7-veined ..... 22. Avena

GKNQTVWZ Spikelets 11-25 mm, with 3-6 florets .. 23. Helictotrichon

GKNQTVXY 1. Glumes 5-7 to 7-9-veined; lowest lemma terminally awned ..... 26. Ventenata

2. Spikelets 15-40 mm; lemma 7-veined ..... 22. Avena

3. Awn clavate shaped in upper half ..... 38. Corynephorus

4. Rhachilla not prolonged above second floret ..... 37. Aira

5. Lemma bifid at apex; teeth aristate ..... 30. Parvotrisetum

GKNQTVXZ 1. Lower floret male, upper hermaphrodite ..... 24. Arrhenatherum

2. Spikelets 3.5-6 mm ..... 34. Deschampsia

3. Spikelets 4-11 mm, shiny ..... 28. Trisetum

4. Spikelets 11-25 mm, with 3-6 florets ..... 23. Helictotrichon

GKNRSVXY Glumes 1-veined; lemmas 1.4-2 mm ..... 108. Eragrostis

GKNRSVXY Ligule a fringe of hairs; upper glume and lemma 1-veined ..... 113. Sporobolus

GKNRTUXZ Spikelets 10-30 mm, with 5-15 florets .. 63. x Festulolium

GKNRTVXY 1. Glumes shorter than spikelet; lemma acute ..... 73. Poa

2. Glumes equaling spikelets; lemma truncate ..... 36. Antinoria

GKNRTVXZ 1. Upper 2-3 sterile lemmas clavate like ..... 93. Melica

2. Glumes equaling spikelet; smells of coumarin ..... 53. Hierochloë

3. Stem up to 200 cm; glumes 3-5-veined ... 60. Scolochloa

4. Lemma ± truncate, margins hyaline ..... 77. Hyalopoa

GLMOSVXY Lemma with 3-fid terminal awn ..... 105. Aristida

GLMOSVXZ Lemma with 3-fid terminal awn ..... 105. Aristida

GLMOTUXY Lower 2 lemmas empty, glume like; cultivated .... 1. Oryza

GL-OTUXY Glumes small, scale like; cultivated ..... 1. Oryza

GLMRTUXY Lower 2 lemmas empty; cultivated ..... 1. Oryza

GL-RTUXY Glumes small scale like; cultivated ..... 1. Oryza

GLMRTVXZ Glumes largely hyaline; lemmas truncate, hairy below ..... 79. Paracolpodium

GL-RTVXZ Spikelets 5-6 mm; glumes absent ..... 2. Leersia

GLNOTVWY Awns 6-7 cm; glumes equaling spikelet ..... 97. Stipa

GLNOTVXY Spikelets 2.4-3.7 mm; terminal awn 1-2.3 mm .... 42. Apera

GLNOTVXZ 1. Awn caducous; lemma shiny; glumes 5 to 3(-5)-veined ..... 98. Piptatherum

2. Lemma shorter than glumes; awn 0.6-40 cm .... 97. Stipa

GLNPTVXY 1. Glumes swollen, shiny, coriaceous below ..... 47. Gastridium

2. Glumes as long as lemma ..... 42. Apera

GLNPTVXZ 1. Glumes acuminate to aristate ..... 40. Calamagrostis

2. Spikelets 1.5-3.8 mm; glumes acute ..... 43. Agrostis

GLNQTVXZ 1. Glumes acuminate to aristate ..... 40. Calamagrostis

2. Glumes acute; spikelets 1.5-3.8 mm ..... 43. Agrostis

GLNRTVXZ 1. Spikelets falling entire ..... 45. Polypogon

2. Lemma puberulent in lower half;

pedicels glabrous ..... 80. Colpodium

3. Rhachilla disarticulating above glumes ... 43. Agrostis

HJMRSVXY Spikelets subtended by bristles ..... 122. Setaria

HJMRSVWZ Leaf blades lanceolate; glumes with

an awn ..... 116. Oplismenus

HJMRTVWZ Leaf blades lanceolate; glumes with

an awn ..... 116. Oplismenus

HJNO-VXY Spikelets with 2 florets, upper one

hermaphrodite ..... 118. Echinochloa

HJNRSVWY Spikelets 2-2.5 mm; glumes very unequal .. 119. Brachiaria

HJNRSVXY 1. Spikelets surrounded by bristles ..... 122. Setaria

2. Glumes covered by hooked spines ..... 115. Tragus

HJNR-VXY Glumes unequal; upper lemma shiny; ligule

absent ..... 118. Echinochloa

HKMOTVXY Lemma rounded dorsally, terminally awned ..... 65. Vulpia

HKMOTVXZ 1. Spikelets dimorphic ..... 84. Cynosurus

2. Glumes aristate; lemma teeth aristate .... 90. Sesleria

3. Spikelets navicular, arranged in 2 rows

along one side of branches ..... 56. Beckmannia

4. Lemmas terminating into awn ..... 61. Festuca

5. Pedicels puberulent ..... 33. Koeleria

6. Spikelets densely clustered in lobed panicle

..... 83. Dactylis

HKMPTVWY Lemma keeled, 5-veined, bifid at apex ..... 32. Rostraria

HKNQTVXY Lowest lemma awnless; glumes 3 to
3(-5)-veined ..... 27. Gaudinopsis

HKMRSVXZ Ligule a fringe of hairs ..... 107. Aeluropus

HKMRTVWZ Pedicels puberulent; spikelets with
2-5 florets ..... 33. Koeleria

HKMTTVXY 1. Glumes unequal, margins hyaline ..... 82. Sclerochloa
2. Glumes subequal; lowest lemma 2-2.5 mm
..... 69. Catapodium

HKMRTVXZ 1. Lemma truncate, margins hyaline .... 76. Catabrosella
2. Pedicels puberulent; lemma 4-6 mm ..... 33. Koeleria
3. Pedicels glabrous or not; spikelets
with 2-10 florets ..... 73. Poa

HKNOTVWZ Pedicels puberulent; lemma 4-6 mm ..... 33. Koeleria

HKNOTVXY Lemma dorsally rounded, terminally awned .... 65. Vulpia

HKNOTVXZ 1. Lemmas with aristate teeth at apex ..... 90. Sesleria
2. Spikelets dimorphic; lemma (fertile)
with 1 terminal awn ..... 84. Cynosurus

HKNPSVXY Ligule a fringe of hairs; lemma 9-veined ... 104. Schismus

HKNPTVWY Spikelets with 2-5(-10) florets ..... 32. Rostraria

HKNPTVWZ Lower 2 lemmas with obtuse lobes
at apex ..... 52. Anthoxanthum

HKNPTVXY 1. Spikelets strongly dimorphic ..... 85. Lamarckia
2. Lower floret male, without an awn ..... 39. Holcus
3. Lemmas dorsally rounded; glumes unequal . 31. Avellinia
4. Lemmas keeled; glumes subequal ..... 32. Rostraria

HKNPTVXZ Lower 2 lemmas with obtuse lobes
at apex ..... 52. Anthoxanthum

HKNQTVWZ Lower 2 lemmas with obtuse lobes
at apex ..... 52. Anthoxanthum

HKNQTVXY 1. Spikelets 1.5-3.5 mm; glumes equal ..... 37. Aira

2. Lower 2 florets male, upper floret hermaphrodite ..... 52. Anthoxanthum

3. Lemmas with 2 fine aristate point at apex ..... 29. Trisetaria

HKNQTVXZ Lower 2 lemmas with obtuse lobes at apex ..... 52. Anthoxanthum

HKNRSVWZ Leaf blades lanceolate; ligule hairy .... 116. Oplismenus

HKNRSVXY Ligule fringe hairy; lemma 9-veined ..... 104. Schismus

HKNRSVXZ Spikelets only a few, 8-8.5 mm ..... 103. Danthonia

HKNRTVXY 1. Glumes winged on keel, equaling spikelet ..... 51. Phalaris

2. Spikelets dimorphic; fertile spikelets awned ..... 85. Lamarckia

HKNRTVXZ 1. Uppermost 2-3 sterile lemmas clavate like .. 93. Melica

2. Lower 2 florets sterile; glumes winged ... 51. Phalaris

3. Lemmas 2-3 mm; spikelet with 2-10 florets ..... 73. Poa

4. Pedicels puberulent; lemma 3-veined ..... 33. Koeleria

HLMOTVXY Glumes unequal; lemma terminally awned .. 58. Pseudophleum

HLMOTVXZ Terminal awn 3-branched ..... 105. Aristida

HLMQTVXY Glumes 3-veined; lemma 3-veined ..... 54. Alopecurus

HLMQTVXZ Glumes 3-veined; lemma 3-veined ..... 54. Alopecurus

HLMRSVXY Ligule hairy; lemma and glumes 1-veined ..... 114. Crypsis

HLMRTVXY Glumes 3-veined; lemma 3-veined ..... 54. Alopecurus

HLMRTVXZ Glumes largely hyaline; lemma truncate ..... 79. Paracolpodium

HLNOSVWY Ligule fringe hairy; lemma 1-veined ..... 114. Crypsis

HLNOTVXY Spikelets 2.4-3.7 mm; awn 1-2.3 mm ..... 42. Apera

HLNPTVXY 1. Spikelets dimorphic; sterile ones awnless ..... 85. *Lamarckia*

2. Glumes swollen and coriaceous at base ..... 47. *Gastridium*

3. Glumes awned from sinus; spikelets falling entire ..... 45. *Polypogon*

4. Glumes persistent; spikelet with 1 floret ... 42. *Apera*

HLNPTVXZ 1. Spikelets 2-3 mm; glumes awned from sinus ..... 44. x *Agropogon*

2. Spikelets 10-14 mm; callus hairy ..... 41. *Ammophila*

HLNQTVXY 1. Lemma with 2 long apical setae ..... 48. *Triplachne*

2. Glumes 3-veined; rhachilla disarticulating below glumes ..... 54. *Alopecurus*

HLNQTVXZ Glumes 3-veined, connate below ..... 54. *Alopecurus*

HLNRSVXY Ligule a fringe of hairs ..... 114. *Crypsis*

HLNRSVXZ Spikelets 1.5-2.5 mm; glumes and lemmas 1-veined ..... 113. *Sporobolus*

HLNRTVXY 1. Glumes swollen, coriaceous at base ... 47. *Gastridium*

2. Lemma 3-veined, awned ..... 54. *Alopecurus*

3. Lemma 5-7-veined, awnless, rounded dorsally ..... 57. *Phleum*

HLNRTVXZ Lemma 5-7-veined, awnless, rounded dorsally ..... 57. *Phleum*

LJNQTVXZ Spikelets surrounded by spathe ..... 134. *Thomeda*

IKMQTVXY 1. Lemma with 5 aristate points at apex .... 91. *Echinaria*

2. Glumes 1-veined; lemma mucronate ..... 92. *Ammochloa*

3. Spikelets dimorphic; lemma with 1 awn ... 84. *Cynosurus*

IKMQTVXZ 1. Non-flowering shoots strongly compressed . 83. *Dactylis*

2. Non-flowering shoots ± terete ..... 33. *Koeleria*

IKMPTVWY Glumes as long as spikelet; annual ..... 32. Rostraria

IKMRSVXZ Ligule hairy; lemma 9-11-veined ..... 107. Aeluropus

IKMRTVXY Stem up to 5 cm; glumes 1-veined ..... 92. Ammochloa

IKNOTVXY Spikelets dimorphic, with long awn ..... 84. Cynocurus

IKNOTVXZ Lemma with 2-5 aristulate teeth at apex ..... 90. Sesleria

IKNRTVXY Glumes winged; spikelets with 3 florets ..... 51. Phalaris

ILMOTVXY Stem about 1 cm; lemma with an apical mucro ..... 59. Rhizocephalus

ILMRSVXY Ligule a fringe of hairs; glume 1-veined .... 114. Crypsis

ILNOSVWY Ligule a fringe of hairs; glumes 1-veined ... 114. Crypsis

ILNPTVWY Spikelets villous hairy; lemma with 2 setae ..... 46. Lagurus

ILNQTVWZ Spikelets hairy; lemma 3-veined, keeled ... 54. Alopecurus

ILNQTVXY 1. Panicle surrounded by obconical involucre ..... 55. Cornucopia

2. Spikelets ± hairy; involucre absent .... 54. Alopecurus

ILNQTVXZ Lemma 3-veined, awned, keeled ..... 54. Alopecurus

ILNRTVXY 1. Lemmas shorter than glumes, not keeled ..... 57. Phleum

2. Panicle surrounded by obconical involucre ..... 55. Cornucopia

ILNRTVXZ Lemmas shorter than glumes, rounded dorsally ..... 57. Phleum

10.3. DICHOTOMOUS KEY TO GENERA

In order to provide an indented key for the Turkish grasses at the generic level, almost all Turkish species belonging to 138 genera and 29 tribes have been examined on their external morphology.

Previously published literature records have been brought together and with the help of prepared accounts for the Flora of Turkey and treatments of the genera in various floral works, e.g. Flora Europaea, Flora Iranica, Flora of Iraq etc. the necessary changes have been made.

In the Flora Europaea by Tutin et al. (1980) and Poaceae by Tzvelev (1976), the difficulties of using a relatively long indented key can be seen. It is quite easy for the user to make a mistake during the identification process and to lose his way; it is also a slow and laborious procedure for routine herbarium identification.

For the preparation of an indented key, I have adopted a system that resembles the one accepted in Flora of Iraq Vol. 9 by Bor (1968). Nine major informal groups (lettered A to I) have been accepted in my account. The first group brings together those genera that have dimorphic spikelets. In Turkey these are Zea, Coix, Lamarckia, Cynosurus and Heteranthelium. The remaining eight groups have been based on inflorescence types (illustrated in the Formula Key) and their accepted definitions have been described and illustrated under the Formula Key.

DICHOTOMOUS KEY TO GENERA

1. Spikelets strongly dimorphic, male and female spikelets sometimes in different inflorescences ..... Group A

1. Spikelets monomorphic, or differing only in the presence or absence of an awn

2. Inflorescence a spike or a raceme

3. Inflorescence a raceme (pedicels often very short) ... Group B

3. Inflorescence a spike (spikelets completely sessile) ..... Group C

2. Inflorescence a panicle, or of 2-7 branches at top of stem

4. Inflorescence of digitate or paired spike-like branches ..... Group D

4. Inflorescence a panicle

5. Inflorescence a lax plumose (long-haired) panicle ..... Group E

5. Inflorescence a dense or non-plumose lax panicle

6. Inflorescence a lax non-plumose panicle

7. Spikelets laterally compressed or not compressed, always with 2 or more florets ..... Group F

7. Spikelets dorsally compressed with 1-2 florets, or if laterally compressed always with 1 floret ..... Group G

6. Inflorescence a dense panicle

8. Inflorescence a head-like panicle (1-2 x as long as broad) ..... Group H

8. Inflorescence a spike-like panicle (more than twice as long as broad) ..... Group I

Group A

Spikelets strongly dimorphic

1. Male and female spikelets in different inflorescences; male spikelets at top of stem, female further down stem ..... 138. Zea

1. Male and female spikelets in the same inflorescence

2. Female spikelets seated in a bony urceolate involucre ..... 137. Coix

2. None of the spikelets seated in a bony involucre

3. Inflorescence a spike; fertile spikelets warty ..... 8. Heteranthelium

3. Inflorescence a rather dense panicle; fertile spikelets not warty

4. Lemmas of fertile spikelets obtuse to truncate at apex; fertile and sterile spikelets falling together in fruit ..... 85. Lamarckia

4. Lemmas of fertile spikelets aristate to acuminate at apex; spikelets persistent in fruit ..... 84. Cynosurus

Group B

Inflorescence a raceme (pedicels often very short)

1. Ligule a fringe of hairs; glumes as long as spikelet ..... 103. Danthonia

1. Ligule membranous; glumes shorter than spikelet

2. Lemmas with a short or rather long terminal awn

3. Glumes very unequal; lower glume (0-)1-veined; lemma keeled ..... 65. Vulpia

3. Glumes subequal; lower glume 3- to 7-veined; lemma rounded

4. Spikelets 4-6(-9) mm; glumes acute to obtuse, awnless ..... 66. Micropyrum

4. Spikelets longer than 10 mm; glumes usually acuminate, with a short terminal awn

5. Annual; spikelets strongly compressed laterally ..... 4. Trachynia

5. Perennial; spikelets terete to subterete .... 3. Brachypodium

2. Lemmas without a terminal awn, but sometimes with a dorsal awn

6. Lemmas with a long exserted awn, only the lowest lemma without an awn ..... 27. Gaudinopsis

6. All lemmas without an awn

7. Glumes subequal; leaf blades convolute when dry

8. Spikelets with 3(-5) florets; glumes obtuse at apex; anthers 0.8-1.2 mm ..... 67. Narduroides

8. Glumes acute at apex; spikelets with 5-9 florets; anthers 0.4-0.6 mm ..... 69. Catapodium

7. Glumes unequal; leaf blades flat when dry

9. Spikelets 6-8 mm, with 3-5 florets; glumes obtuse at apex, largely hyaline margins ..... 82. Scleropoa

9. Spikelets 10-30 mm, with 5-15 florets; glumes acute at apex, not hyaline on margins ..... 63. x Festulolium

Group C

Inflorescence a spike (spikelets completely sessile)

1. Ligule a fringe of hairs ..... 107. Aeluropus

1. Ligule membranous, sometimes reduced to a rim

2. Inflorescence an interrupted spike, with 1 spikelet at each node; internodes always visible

3. Lateral spikelets with only 1 glume

4. Lemmas terminally awned; glume up to ½ as long as the lowest lemma of lateral spikelets

5. Perennial; spikelets with 1 floret ..... 96. Nardus

5. Annual; spikelets with 2 florets ..... 72. Psilurus

4. Lemmas usually awnless, sometimes with a subterminal awn; glume longer than the lowest lemma in lateral spikelets

6. Lateral spikelets dorsally compressed, embedded in concavities of axis, with 1 floret ..... 89. Neinardia

6. Lateral spikelets usually laterally compressed, not embedded in concavities of axis, with 3-11 florets ..... 64. Lolium

3. Lateral spikelets with 2 glumes

7. Glumes truncate or concave at apex

8. Glumes usually with 1 or more teeth or awns at apex, usually ± equaling spikelet; veins of lower glume parallel ..... 11. Aegilops

8. Glumes without teeth or awns at apex, up to half of spikelets; veins of lower glume not parallel ..... 9. Amblyopyrum

7. Glumes obtuse, acute to acuminate, or aristate at apex

9. Both glumes shorter than spikelet

10. Glumes markedly unequal; lemmas dorsally awned; veins of glumes forming prominent longitudinal ridges ..... 25. Gaudinia

10. Glumes subequal; lemmas awnless or with a terminal awn; veins of glumes not forming prominent longitudinal ridges

11. Annual; spikelet 4-5.5 mm; glumes obtuse and keeled ..... 67. Narduroides

11. Perennial; spikelets longer than 10 mm; glumes rather pointed and rounded dorsally ..... 6. Elymus

9. At least one of the glumes as long as spikelet

12. Lemmas with a short terminal awn ..... 68. Loliolum

12. Lemmas without a terminal awn

13. Spikelets with 1 floret; lateral veins of glumes very short ..... 88. Parapholis

13. Spikelets with 2 florets; lateral veins of glumes extending to apex

14. Auricle present; spikelets usually hairy ..... 20. Henrardia

14. Auricle absent; spikelets glabrous ..... 87. Pholiurus

2. Inflorescence a dense spike, with 1 or more spikelets at each node (internodes hidden by spikelets)

15. Spikelets 2 or more at each node of axis

16. Spikelets with 3-5 hermaphrodite florets; awn 1/2 to 1/6 as long as lemma (when present) ..... 15. Leymus

16. Spikelets with 1-2 hermaphrodite florets; awn at least as long as lemma

17. Spikelets 2 at each node of main axis

18. Axis of inflorescence densely pilose; awns up to 2.5 cm, straight ..... 10. Crithopsis

18. Axis of inflorescence glabrous; awns 6-12 cm, recurved ..... 19. Taeniatherum

17. Spikelets usually 3 at each node of main axis

19. Spikelets all sessile at each node of main axis; axis fragile ..... 16. Psathyrostachys

19. At least lateral 2 spikelets at each node of main axis shortly pedicellate; axis fragile or tough

20. All 3 spikelets in each unit shortly pedicellate; lateral spikelets hermaphrodite; central spikelet male or hermaphrodite ..... 18. Hordelymus

20. Only the lateral 2 spikelets in each unit pedicellate; lateral spikelets male or sterile, central spikelet hermaphrodite ..... 17. Hordeum

15. Spikelets solitary at each node of the main axis

21. Glumes truncate, with or without 1 or more teeth or awns at apex

22. Glumes with 2 prominent keels, bearing tufts of hair only on dorsal side of middle vein ..... 13. Dasypyrum

22. Glumes with 1 keel or rounded dorsally, without tufts of hair on dorsal side of middle vein

23. Glumes usually rounded dorsally, with 1 or more teeth or awns at apex; rhachis fragile ..... 11. Aegilops

23. Glumes keeled, usually with 1 or 2 teeth at apex; rhachis tough ..... 12. Triticum

21. Glumes gradually or abruptly terminating in an awn, or acuminate at apex

24. Glumes covering sides of lower florets ..... 15. Leymus

24. Glumes covering back of lower florets

25. Glumes dorsally rounded ..... 6. Elymus

25. Glumes dorsally keeled

26. Spikelets with 2(-3) florets; glumes subulate, with 0-1 veins ..... 14. Secale

26. Spikelets with 3 or more florets; glumes boat-shaped, with several veins

27. Annual; glumes slightly connate at base; rhachis fragile ..... 7. Eremopyrum

27. Perennial; glumes free at base; rhachis tough ..... 5. Agropyron

Group D

Inflorescence of digitate or paired spike-like branches

1. Some of the spikelets with an exserted awn

2. Leaf blades lanceolate ..... 133. Arthraxon

2. leaf blades linear

3. Inflorescence digitate, with 3-7 or more spike-like branches

4. Pedicels grooved; lower glume of sessile spikelets oblong, tapering at both ends ..... 129. Botriochloa

4. Pedicels not grooved; lower glume of sessile spikelets broadly elliptic, or slightly broader above the middle, rounded at apex ..... 130. Dichanthium

3. Inflorescence of only 2 paired spike-like branches

5. Sessile spikelets 8-16 mm ..... 131. Andropogon

5. Sessile spikelets 3-6 mm

6. Sessile spikelets 4-6.5 mm; bases of awns hirsute; stem nodes glabrous ..... 132. Hyparrhenia

6. Sessile spikelets 3-4 mm; bases of awns glabrous; stem nodes covered by long hairs ..... 130. Dichanthium

1. All spikelets without an exserted awn

7. Spikelets dorsally compressed

8. Spikelets 10-18 mm, containing sessile spikelets as well as pedicellate ones ..... 135. *Phacelurus*

8. Spikelets 2.2-3 mm; all shortly pedicellate

9. Inflorescence a paired spike (with 2 branches), with one shortly pedicellate spikelet at each node ..... 120. *Paspalum*

9. Inflorescence a digitate spike (with at least 3 branches); usually 2 spikelets at each node ..... 121. *Digitaria*

7. Spikelets laterally compressed

10. Axis of inflorescence branches exserted; upper glume obtuse and terminally awned ..... 110. *Dactyloctenium*

10. Axis of inflorescence branches not exserted; upper glume acute to acuminate, without an awn

11. Spikelets with 1 floret; glumes subequal; perennial ..... 112. *Cynodon*

11. Spikelets with 2 or more florets; glumes unequal; annual ..... 109. *Eleusine*

Group E

Inflorescence a lax plumose panicle

1. Spikelets with 1 floret

2. Plumose hairs attached to long terminal awn of lemma, or one of its branches

3. Terminal awn of lemma with 3 branches, at least middle branch plumose; ligule a fringe of hairs ..... 106. *Stipagrostis*

3. Terminal awn of lemma not branches (simple), when hairs present attached awn; ligule membranous ..... 97. *Stipa*

2. Plumose hairs coming out from callus of lemma

4. Spikelets 1.5-3.8 mm; glumes acute; lemma almost as long as glumes ..... 43. Agrostis

4. Spikelets 4-6 mm; glumes acuminate; lemmas shorter than glumes ..... 40. Calamagrostis

1. Spikelets with 2-10 florets

5. Hairs from involucral bristles; spikelets surrounded by an involucral bristles ..... 123. Pennisetum

5. Hairs not from involucral bristles; spikelets not surrounded by an involucral bristles

6. Hairs surrounding spikelets, some hairs attached to glumes

7. Lemmas without an awn; panicle branches tough; hairs completely covering spikelets ..... 126. Imperata

7. Lemmas with an awn; panicle branches easily breaking up; spikelets ± visible

8. Spikelets 6-7 mm; awn of lemma exceeding spikelets by 8.5-11 mm ..... 124. Spodiopogon

8. Spikelets 5-5.5 mm; awn of lemma exceeding spikelet by 1.5-4.5 mm ..... 125. Saccharum

6. Hairs arising between 2 glumes; glumes glabrous

9. Ligule membranous

10. Hairs arising from rhachilla segments; all florets alike, with a dorsal awn, lemmas bifid at apex ..... 28. Trisetum

10. Hairs arising from dorsal side of lemmas; florets dimorphic, upper 2 sterile florets forming clavate-like structure; awn absent; lemmas acute to obtuse at apex ..... 93. Melica

9. Ligule a fringe of hairs

11. Spikelets unisexual; glumes 1-veined .... 102. Cortaderia

11. Spikelets bisexual; glumes 3-veined

12. Rhachilla with long hairs; lemma glabrous on dorsal surface ..... 101. Phragmites

12. Rhachilla glabrous; lemma with long hairs on dorsal surface ..... 100. Arundo

Group F

Spikelets laterally compressed or not compressed, always with 2 or more florets

1. Ligule a fringe of hairs

2. At least one of glumes as long as lowest lemma; lemmas 1.4-2 mm ..... 108. Eragrostis

2. Both glumes shorter than lowest lemma; lemma 3.5-6.5 mm

3. Stem with 1 node; glumes subequal; lemma acute at apex ..... 95. Molinia

3. Stem with several nodes; glumes unequal; lemma 2 dentate at apex and with a short awn from sinus ..... 111. Cleistogens

1. Ligule membranous

4. Spikelets with an awn

5. At least one of the glumes as long as spikelet

6. Spikelets 1.3-1.6 mm; lemma 0.8-1 mm; annual ..... 36. Antinoria

6. Spikelets longer than 4 mm; lemma 3-3.5 mm; perennial

7. Only uppermost floret hermaphrodite; lower 2 florets male; smelling of coumarin ..... 53. Hierochloë

7. Lower florets hermaphrodite; uppermost 2-3 florets sterile and forming clavate-like structure; not smelling of coumarin ..... 93. Melica

5. Both glumes shorter than spikelet

8. Lemmas of fertile florets dorsally keeled

9. Lower 2 florets represented by 2 sterile lemmas; glumes reduced to 2 inconspicuous scales ..... 1. Oryza

9. Lower 2 florets hermaphrodite; glumes not reduced to 2 scales

10. Panicle branches dichotomously arranged ..... 70. Cutandia

10. Panicle branches not dichotomously arranged

11. Lemmas truncate; margins of lemma largely hyaline ..... 76. Catabrosella

11. Lemmas acute to obtuse; margins of lemma not largely hyaline

12. Spikelets ± orbicular; glumes 3- to 9-veined; lemma 7- to 9-veined, cordate at base ..... 86. Brisa

12. Spikelets ovate; glumes 3(-1) to 3-veined; lemma 5-veined, not cordate at base ..... 73. Poa

8. Lemmas rounded dorsally

13. Lower glume 3-veined, upper glume 5-veined

14. Uppermost 2-3 fertile florets forming clavate-like structures; fertile lemmas acute at apex ..... 93. Melica

14. Florets in each spikelet all alike; lemmas truncate-lacerate at apex ..... 60. Scolochloa

13. Lower glume 1(0-3), upper glume 3(-1)-veined

15. Annuals

16. Lemmas obtuse to truncate at apex; glumes equal ..... 35. Molineriella

16. Lemmas acute at apex; glumes unequal

17. Lemmas 1-2 mm; panicle branches spreading, 2-3 at each node ..... 71. Sphenopus

17. Lemmas 2.5-3.5 mm; panicle branches verticillately arranged, usually 3 or more at each node ..... 74. Eremopoa

15. Perennials

18. Upper glume as long as or longer than lowest lemma ..... 77. Hyalopoa

18. Upper glume shorter than lowest lemma

19. Lemmas acute at apex, 7-9 mm ..... 61. Festuca

19. Lemmas obtuse to truncate at apex, 2.5-4(4.5) mm

20. Spikelets with 2 florets ..... 78. Catabrosa

20. Spikelets with 3 to many florets

21. Glumes 1-veined; lemma 7-9-veined .... 94. Glyceria

21. Glumes 1(-3) to 3-veined; lemma 5-veined ..... 81. Puccinellia

4. Spikelets awned

22. Lemmas terminally awned

23. Lower 2 florets reduced to empty lemmas; glumes scale-like ..... 1. Oryza

23. Lower 2 florets hermaphrodite; glumes not scale-like

24. Annual; panicle branches dichotomously arranged ..... 70. Cutandia

24. Perennial; panicle branches not dichotomously arranged

25. Rhachilla and basal part of lemma glabrous ..... 61. Festuca

25. Rhachilla and basal part of lemma covered by short stiff hairs ..... 62. Bellardiochloa

22. Lemmas subterminally, dorsally or subdorsally awned, but lowest lemma sometimes awnless

26. Lowest lemma without an awn or terminally awned

27. Spikelets 3-5(-6) mm; lower glume 1-veined, upper glume 3-veined and with a seta at apex ..... 39. Holcus

27. Spikelets 6-17 mm; glumes 3-7 to 3-9-veined; upper glume without a seta at apex

28. Glumes 3(-5)-veined; lowest lemma acute to 2-fid at apex ..... 27. Gaudinopsis

28. Glumes 5-7 to 7-9-veined; lowest lemma aristate at apex ..... 26. Ventenata

26. Lowest lemmas with an awn from back

29. Perennial

30. Glumes both terminally awned; awn of lemmas from just below tip, 1-2 mm ..... 99. Ampelodesmos

30. Glumes not terminally awned; awn longer than 2 mm, from further below tip

31. Florets only 2, lower floret male, upper floret hermaphrodite or female .... 24. Arrhenatherum

31. Florets 2-8, at least lower 2 florets hermaphrodite

32. Spikelets 10-30 mm, with 3-8 florets; caryopsis hairy at apex ..... 23. Helictotrichon

32. Spikelets 3-11 mm, with 2-4 florets; caryopsis glabrous at apex

33. Spikelets with 2(-3) florets; lemmas usually truncate-denticulate at apex 34. Deschampsia

33. Spikelets with 2–4 florets; lemmas 2-fid at apex ..... 28. *Trisetum*

29. Annual

34. Both glumes shorter than spikelet

35. Branches verticillately arranged; spikelets 3.5–5 mm ..... 75. *Nephelochloa*

35. Branches not verticillately arranged; spikelets 12–30 mm ..... 21. *Bromus*

34. At least one of the glumes as long as spikelet

36. Spikelets longer than 10 mm; glumes 5–7 to 7–9-veined ..... 22. *Avena*

36. Spikelets 1.3–4.5 mm; glumes 1–3-veined

37. Spikelets 4–4.5 mm; upper half of awn clavate ..... 38. *Corynephorus*

37. Spikelets 1.5–3.5 mm; upper half of awn tapering to a point

38. Spikelets with 2 or more florets; rhachilla prolonged beyond upper floret ..... 30. *Parvotrisetum*

38. Spikelets with 2 florets; rhachilla not prolonged beyond upper floret ..... 37. *Aira*

Group C

Spikelets dorsally compressed with 1-2 florets, or laterally compressed and always only with 1 floret

1. Spikelets dorsally compressed with 1-2 florets
  2. Spikelets sunk in concavities of branches
    3. Sessile spikelets 4-6 mm; branches 4-10 cm ..... 136. Hemarthria
    3. Sessile spikelets 10-18 mm; branches 14-30 cm ..... 135. Phacelurus
  2. Spikelets not sunk in concavities of branches
    4. Spikelets without an exserted awn
      5. Glumes equal; spikelets with 1 floret
        6. Lemma glabrous and shiny ..... 49. Milium
        6. Lemma with clavate hairs on dorsal surface, not shiny ..... 50. Zingeria
      5. Glumes unequal; spikelets with 2 florets
        7. Upper glume equaling spikelet; lower glume 0.7-3 mm, surrounding entire spikelet ..... 117. Panicum
        7. Upper glume shorter than spikelet; lower glume 0.2-0.3 mm, not surrounding spikelet ..... 121. Digitaria
    4. Spikelets with an exserted awn
      8. Ultimate unit of panicle subtended by spathes ..... 134. Themeda
      8. Ultimate units of panicle not supported by spathes
        9. Some of spikelets with a tuft of long reddish-brown hairs from callus ..... 128. Chrysopogon
        9. None of spikelets with a tuft of long reddish-brown hairs from callus

10. Glumes unequal; ligule absent ..... 118. Echinochloa

10. Glumes equal to subequal; ligule present

11. All spikelets pedicellate and with

1 floret ..... 98. Piptatherum

11. Some of spikelets sessile on the branches;

spikelets with 2 florets

12. Pedicels with a median groove; spikelets

3-4 mm ..... 129. Botriochloa

12. Pedicels terete; spikelets 4.7-7 mm ..... 127. Sorghum

1. Spikelets laterally compressed always only with 1 floret

13. Ligule a fringe of hairs; at least middle branch of

terminal awn plumose ..... 106. Stipagrostis

13. Ligule membranous; when awn branched, branches

glabrous

14. Lemma with a long terminal awn

15. Awn of lemma 3-branched ..... 105. Aristida

15. Awn of lemma simple ..... 97. Stipa

14. Lemma with or without a short dorsal, subterminal

or subbasal awn

16. Lemmas with an awn

17. Annual

18. Spikelets 2-3.1 mm; glumes 1-3-veined ..... 42. Apera

18. Spikelets usually longer than 10 mm;

glumes 5-7 to 7-9-veined ..... 22. Avena

17. Perennial

19. Spikelets 1.5-3.8 mm; glumes acute ..... 43. Agrostis

19. Spikelets 4-6 mm; glumes acuminate

..... 40. Calamagrostis

16. Lemma without an awn

20. Both glumes absent ..... 2. Leersia

20. Both glumes present

21. Glumes shorter than spikelets, largely hyaline, obtuse; lemma truncate ..... 79. Paracolpodium

21. Glumes equaling spikelet, not largely hyaline, acute, acuminate to aristate at apex, lemma very occasionally truncate

22. Lemma minutely puberulent in lower half; pedicels glabrous ..... 80. Colpodium

22. Lemma not puberulent in lower half; pedicels ± scabridilous

23. Rhachilla disarticulating above glumes; lemma usually awned ..... 43. Agrostis

23. Rhachilla disarticulating below glumes; lemma awnless .... 45. Polypogon

Group H

Inflorescence a dense head-like panicle

1. Ligule a fringe of hairs

2. Spikelets with 1 floret; lemma keeled, 1-veined ... 114. Crypsis

2. Spikelets with 5-10 florets; lemmas rounded dorsally, 9-veined ..... 104. Schismus

1. Ligule membranous

3. Spikelets with 1 floret

4. Spikelets seated in a cup-shaped toothed involucre ..... 55. Cornucopia

4. Spikelets not seated in a cup-shaped toothed involucre

5. Glumes 1-veined, covered by long dense hairs; lemma with 2 setae at apex ..... 46. Lagurus

5. Glumes 3-veined, glabrous to shortly hairy; lemma without a setae at apex

6. Glumes shorter than lemma; lemma mucronate at apex ..... 59. Rhizocephalus

6. Glumes equaling lemma or longer; lemma obtuse, acute to truncate at apex

7. Lemma 3-veined, keeled dorsally, usually with an awn; rhachilla disarticulating below glumes ..... 54. Alopecurus

7. Lemma 5-7-veined, rounded dorsally, awnless; rhachilla disarticulating above glumes ..... 57. Phleum

3. Spikelets with 2 or more florets

8. Lemmas terminally awned

9. Lemmas with a short aristate point or mucronate at apex

10. Annual; glumes 1-veined; inflorescence surrounded by leaf blades ..... 92. Ammochloa

10. Perennial; glumes 1-3-veined; inflorescence not surrounded by leaf blades ..... 83. Dactylis

9. Lemmas with 2-5 aristate points or aristulate teeth at apex

11. Annual; lemma with 5 aristate points at apex ..... 91. Echinaria

11. Perennial; lemma with 2-5 aristulate teeth at apex ..... 90. Sesleria

8. Lemmas subterminally to dorsally awned, or awnless

12. Lemmas without an awn

13. Spikelets with 3 florets; lower 2 florets male; glume equaling spikelet ..... 51. Phalaris

13. Spikelets with 3 to many florets; lower 2 florets hermaphrodite; glumes shorter than spikelet

14. Lemmas truncate at apex; glumes unequal; pedicels clearly visible ..... 82. Sclerochloa

14. Lemmas acute at apex; glumes subequal; pedicels almost absent ..... 92. Ammochloa

12. Lemmas with an awn (except the uppermost one)

15. Spikelets 15-70 mm; each lemma with 9 subterminal awns ..... 21. Bromus

15. Spikelets 5-12 mm; each lemma with a dorsal awn

16. Sterile lower 2 florets densely hairy and with 2 obtuse lobes at apex; uppermost floret hermaphrodite and awnless ..... 52. Anthoxanthum

16. Spikelets all alike; lemmas glabrous and with 2 apical setae ..... 29. Trisetaria

Group I

Inflorescence a dense spike-like panicle

(more than twice as long as broad)

1. Terminal awn 3-branched

2. Awn branches glabrous ..... 105. Aristida

2. Awn branches all or at least middle one plumose ..... 106. Stipagrostis

1. Terminal awn usually absent, when present always simple

3. Ligule a fringe of hairs

4. Leaf blades lanceolate ..... 116. Oplismenus

4. Leaf blades linear

5. Upper glumes covered by hooked spines ..... 115. Tragus

5. Upper glumes not covered by hooked spines

6. Spikelets with 1 floret

7. Perennial; rhachilla disarticulating above glumes ..... 113. Sporobolus

7. Annual; rhachilla disarticulating below glumes ..... 114. Crypsis

6. Spikelets with 2-18 florets

8. Both glumes shorter than spikelet ..... 107. Aeluropus

8. At least one of the glumes as long as spikelet

9. Glumes very unequal; spikelets 2-2.5 mm .... 119. Brachiaria

9. Glumes subequal; spikelets 4.5-9 mm

10. Annual; lemmas plumose; glumes 3-5-veined ..... 104. Schismus

10. Perennial; lemmas glabrous; glumes 5-7-veined ..... 103. Danthonia

3. Ligule membranous or occasionally absent

11. Spikelets usually with 1 floret

12. Lemma terminally awned, or with a short mucro at apex

13. Perennial; awn 0.6-40 cm; spikelet longer than 3 mm ..... 97. Stipa

13. Annual; awn less than 3 mm; spikelets 2.5-3 mm

14. Glumes unequal, shorter than lemma, awnless; lemmas mucronate at apex ..... 58. Pseudophleum

14. Glumes equal, equaling lemma, with a terminal seta; lemma with a terminal awn ..... 42. Apera

12. Lemma subterminally to dorsally awned, or awnless

15. Glumes with a seta arising from sinus, covered by a few stout hairs in lower part

16. Spikelets persistent; seta of glume 1.5-2 mm ..... 44. x Agropogon

16. Spikelets not persistent; seta of glumes 4-7 mm ..... 45. Polypogon

15. Glumes without a seta, not covered by a few stout hairs in lower part

17. Spikelets 10-14 mm; leaf blades up to 60 cm, convolute ..... 41. Ammophila

17. Spikelets up to 7 mm; leaf blades short and flat

18. Glumes rather swollen and rounded in lower part, compressed and keeled in upper half ..... 47. Gastridium

18. Glumes not swollen in lower part, compressed and keeled throughout their length

19. Glumes 1-veined; 2 outer veins of lemma exserted as setae, 1.2-1.5 mm ..... 48. Triplachne

19. Glumes 1(-3) to 3-veined; 2 outer veins of lemma not exserted as setae

20. Glumes 3-veined; both glumes equal in width

21. Lemma 3-veined, keeled dorsally, with an awn; rhachilla disarticulating below glumes ..... 54. Alopecurus

21. Lemma 5-7-veined, rounded dorsally, awnless; rhachilla disarticulating above glumes 57. Phleum

20. Glumes 1- to 3-veined; lower glume slightly narrower than upper one

22. Annual; lemmas rather firmer than glumes; awns 2-4 times as long as spikelet ..... 42. Apera

22. Perennial; Lemmas more delicate than glumes; awns extremely short or absent

23. Spikelets 1.5-3.8 mm; glumes acute ..... 43. Agrostis

23. Spikelets 4-6(-7) mm; glumes acuminate to aristate ..... 40. Calamagrostis

11. Spikelets always with 2 to several florets

24. Spikelets subtended by an involucre of bristles ..... 122. Setaria

24. Spikelets not subtended by an involucre of bristles

25. Lemmas without an awn

26. Spikelet ventrally compressed, with 2 florets; ligule absent ..... 118. Echinochloa

26. Spikelets laterally compressed, usually with more than 2 florets; membranous ligule present

27. At least one of the glumes as long as spikelet

28. Uppermost 2-3 sterile florets forming a clavate structure; glumes without a wing ..... 93. Melica

28. Uppermost floret hermaphrodite; lower 2 florets sterile; glumes usually winged ..... 51. Phalaris

27. Glumes shorter than spikelet

29. Annual

30. Glumes distinctly unequal, margins hyaline; lowest lemma 4.8-6 mm, obtuse at apex ..... 82. Sclerochloa

30. Glumes subequal, margins not hyaline; lowest lemma 2-2.5 mm, acute at apex ..... 69. Catapodium

29. Perennial

31. Glumes 3-veined; lemmas about 2.5-3.5 mm ..... 73. Poa

31. Glumes 1- to 3-veined; lemma 3.5-6.8 mm

32. Glumes distinctly hyaline, obtuse at apex; lemmas obtuse; pedicels glabrous ..... 76. Catabrosella

32. Glumes not hyaline, acute to acuminate, sometimes with an aristate point; pedicels puberulent ..... 33. Koeleria

25. Lemmas with an awn or mucro

33. Lemmas terminally awned

34. Both glumes terminating in an aristate point; lemmas with 2-5 aristate teeth at apex ..... 90. Sesleria

34. Glumes not terminating in an aristate point; lemmas with only 1 awn, or a mucro at apex

35. Annual; glumes distinctly unequal; awn at least 3-4 mm ..... 65. Vulpia

35. Perennial; glumes equal to subequal; awn 0.7-1.5 mm

36. Spikelets with 2 florets, arranged in 2 rows along one side of branches; glumes obtuse ..... 56. Beckmannia

36. Spikelets with 2-5 florets, irregularly arranged; glumes acuminate ..... 83. Dactylis

33. Lemmas subterminally or dorsally awned (except the uppermost lemma)

37. Spikelets with 3 florets; lower 2 florets sterile, awned and covered with long stiff hairs; only terminal fertile floret awnless ..... 52. Anthoxanthum

37. Spikelets with 2-11 florets; florets all alike, fertile and awned

38. Lemmas with 2 setae at apex ..... 29. Trisetaria

38. Lemmas shortly bifid at apex

39. Upper glume 4 x as long as lower glume; lemmas rounded dorsally; palea $\frac{1}{2}$ as long as lemma ..... 31. Avellinia

39. Lower glume $\frac{1}{2}$ to $\frac{3}{4}$ x as long as upper glume; lemmas keeled; palea equaling lemma ..... 32. Rostraria

APPENDIX I: GENERAL DISTRIBUTION OF SPECIES REVISED

Species		N. AMER.	E. ASIA	ASIA: ARABIA	SINAI	KHORAS	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASIA: CAUCASUS	GEORGIA	AZERB.	ARMENIA	MEDITERRANEAN: EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA	SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	C. EUR.: ROMANIA, HU	GE, CZ, PO, SW	HE, AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
x Agropogon littoralis																										x	x				x						x						x							x	x
Agrostis																																																			
balansae																		x			x																															x
canina		x	x					x	x	x					x	x	x	x	x	x				x			x			x	x	x	x	x	x						x	x	x		x		x	x	x
capillaris		x								x					x			x	x	x	x	x	x		x	x	x	x			x	x	x	x	x	x						x	x	x	x	x	x	x	x
castellana																																																			
subsp. byzantina																																x	x	x	x	x														x
subsp. castellana																								x	x	x	x	x		x																				x
gigantea		x	x				x			x		x						x						x		x	x				x					x							x	x	x	x	x	x	x	x
lazica																		x	x	x	x																														x
olympica									x	x	x	x		x		x	x	x	x	x	x																		x												x
planifolia																x		x	x	x	x																														x
stolonifera		x	x		x		x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x			x				x	x	x	x	x
Aira																																																		
caryophyllea		x																					x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x	x	x	x	x
elegantissima																																																		
subsp. ambigua						x			x	x								x	x	x																x														x
subsp. elegantissima		x																				x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
praecox		x																						x	x	x				x															x		x	x	x	x
Alopecurus																																																		
aequalis		x	x												x	x									x	x	x				x	x	x			x							x	x	x	x	x	x	x	x
arundinaceus		x					x	x	x	x	x	x	x	x	x	x		x	x	x	x			x	x	x	x				x	x	x	x	x	x		x		x		x	x	x	x	x	x	x	x
aucheri							x	x	x	x				x				x	x	x	x																													x	
bulbosus				•																				x		x	x	x	x	x																			x	x
creticus																																x	x			x	x													x
davisii																																				x															x
reniculatus		x													x									x	x	x	x			x	x		x										x	x	x		x	x	x	x
serardii																								x		x	x				x	x	x			x	x														x

APPENDIX I (continued)

TABLE VIIb

Species		N. AMER.	E. ASIA	ASIA: ARABIA	SINAI	KHORAS.	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASIA: CAUCASUS	GEORGIA	AZERB.	ARMENIA	MEDITERRANEAN: EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	SARDINIA	CORSICA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	C. EUR.: ROMANIA, HU	GE, CZ, PO, SLK	HE, AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
Alopecurus																																																		
glacialis															x			x	x	x	x																													x
laguroides																																																	x
lanatus																																																	x
myosuroides		x					x	x	x	x								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
pratensis		x	x					x							x		x	x	x					x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x
rendlei																									x	x	x	x	x	x	x	x		x		x												x	x
setarioides																																x			x														x
textilis																																																	
subsp. textilis							x	x	x	x		x						x	x	x	x																	x											x
subsp. tiflisiensis												x	x					x	x	x	x																												x
utriculatus																																																	
subsp. anthoxanthoides											x																											x	x									x
subsp. utriculatus								x	x		x	x						x	x	x	x															x	x	x	x	x	x	x						x
vaginatus								x	x	x					x			x	x	x	x																x	x		x	x			x					x
Ammophila																																																	
arenaria																																																	
subsp. arundinacea		x																						x	x	x	x	x	x	x	x	x		x	x	x							x						x
Anthoxanthum																																																	
aristatum																								x	x	x	x		x		x	x	x		x													x
gracile																							x					x	x							x													
odoratum																																																	
subsp. alpinum													x			x	x	x	x	x	x																							x	x	x		x	x		x
subsp. odoratum		x	x	•													x	x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Antinoria insularis																												x	x	x					x	x													x

APPENDIX I (continued)

Species		N. AMER.	E. ASIA	ASIA: ARABIA	SINAI	KHORAS.	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASIA: CAUCASUS	GEORGIA	AZERB.	ARMENIA	MEDITERRANEAN: EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA	SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	C. EUR.: ROMANIA, HU	GE, CZ, PO, SLK	HE, AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
Apera																																																	
baytopiana																																																		X
intermedia										X		X						X	X	X	X																												X
interrupta		X						X	X	X				X	X	X		X	X	X				X			X	X			X	X	X	X	X			X	X			X		X	X	X	X	X
spica-venti								X										X						X					X		X	X	X	X							X	X	X	X	X	X	X	X
triaristata																																																	X
Arrhenatherum																																																		
elatius																																																		
subsp. elatius		X						X				X					X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
kotschyi								X	X	X		X	X		X			X	X	X	X																X	X	X	X								X
palaestinum											X																					X	X			X	X	X	X	X	X								X
Avellinia michelii																								X	X	X	X	X	X	X	X	X	X			X	X												X
Avena																																																		
barbata																																																		
subsp. atherantha																														X																				X
subsp. barbata		X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
byzantina								X								X								X											X	X												X
clauda						X	X	X	X	X	X	X	X	X										X								X				X	X					X	X						X
eriantha			X					X	X	X	X	X			X									X												X	X					X			X				X
fatua		X	X			X	X	X	X	X		X	X	X	X	X		X		X	X	X	X	X	X	X					X	X			X	X			X	X	X	X	X	X	X	X	X	X
sativa		X	X				X	X	X			X				X		X	X	X	X			X	X	X	X	X	X	X				X						X	X	X	X	X	X	X	X
sterilis																																																	
subsp. ludoviciana			X			X	X	X	X	X		X		X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X
subsp. sterilis			X			X	X	X	X	X		X		X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X
wiestii				X	X	X	X	X	X	X	X	X	X	X	X	X				X		X		X		X				X		X									X	X							X
Beckmannia eruciformis		X	X						X				X				X	X	X	X	X								X	X	X	X		X	X					X	X		X	X	X			X

APPENDIX I (continued)

Species	ASIA																CAUCASIA				MEDITERRANEAN																				C. EUR.								
	N. AMER.	E. ASIA	ARABIA	SINAI	KHORAS.	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASUS	GEORGIA	AZERB.	ARMENIA	EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	ROMANIA,HU.	GE,CZ,PO,SW	HE, AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
Calamagrostis																																																	
arundinacea																	x	x	x	x									x	x	x	x		x	x						x	x	x		x	x	x	x	x
canescens																	x											x	x					x							x	x	x	x	x	x	x	x	x
epigejos	x	x			x	x	x	x	x			x	x	x		x	x	x	x	x	x					x	x		x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	x	x
parsana									x																																								x
pseudophragmites		x			x	x	x	x	x			x	x			x	x	x	x	x					x	x		x	x	x	x	x	x	x							x	x	x		x	x		x	x
Cornucopiae cucullatum										x	x																	x	x					x	x	x	x		x										x
Corynephorus divaricatus												x					x				x	x	x		x	x	x	x	x		x			x	x	x				x									x
Deschampsia																																																	
caespitosa	x	x											x			x	x	x	x	x		x	x		x	x	x		x	x	x	x	x	x	x						x	x	x	x	x	x	x	x	x
flexuosa																x	x	x	x	x			x												x												x	x	x
Gastridium																																																	
phleoides	x						x		x		x																												x	x									x
scabrum																							x		x	x			x					x	x	x													x
ventricosum										x	x												x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x							x	x
Gaudinia fragilis																							x	x	x	x	x	x	x	x	x		x		x	x							x	x			x	x	x
Gaudinopsis																																																	
macra																																																	
subsp. antalyensis																																																	x
subsp. macra										x	x		x				x	x	x	x														x		x								x					x
huber-morathii																																																	x
quercetorum																																																	x
sorgeri																																																	x

APPENDIX I (continued)

Species		N. AMER.	E. ASIA	ASIA: ARABIA	SINAI	KHORAS	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASIA: CAUCASUS	GEORGIA	AZERB.	ARMENIA	MEDITERRANEAN: EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA	SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	C. EUR.: ROMANIA, HU	GE, CZ, PO, SK	HE, AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
Helictotrichon																																																		
arvagum																																																		x
armeniacum																		x	x	x																														x
compressum																																	x			x	x						x	x	x	x				x
convolutum																													x	x	x			x	x	x												x
planiculme																															x	x										x	x		x				x
pratense								x	x									x	x	x	x			x		x	x			x	x	x	x	x								x	x	x		x	x	x	x
pubescens																																																		
subsp. longifolia																																																		x
subsp. pubescens																		x	x	x	x				x	x	x				x	x	x		x								x	x	x	x	x	x	x	x
versicolor																										x	x				x	x	x										x	x	x			x	x	x
Hierochloë odorata		x	x												x			x	x	x	x						x															x	x	x	x	x	x	x	x	x
Holcus																																																		
annuus																							x	x	x						x					x	x												x
lanatus		x																	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x		x	x	x	x	x	x	x	x
Koeleria																																																		
brevis																																	x											x			x				x
cristata						x	x	x	x	x			x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
eriostachya								x										x													x	x	x									x			x				x
lobata																										x	x	x	x	x	x	x	x		x	x							x			x	x			x
nitidula								x		x					x																	x	x			x	x						x			x				x
Lagurus ovatus													x									x	x	x	x	x	x	x	x	x	x	x		x	x	x					x				x				x
Milium																																																		
effusum		x	x												x	x	x	x	x	x	x						x	x		x	x	x	x	x	x							x	x	x	x	x		x	x	x	x
pedicellare								x			x																												x			x	x							x
schmidtianum								x										x	x	x	x																														x

APPENDIX I (continued)

			ASIA														CAUCASIA				MEDITERRANEAN																				C. EUR.								
Species	N. AMER.	E. ASIA	ARABIA	SINAI	KHORAS	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASUS	GEORGIA	AZERB.	ARMENIA	EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	ROMANIA,HU	GE,CZ,PO,SU	HE, AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
Milium																																																	
vernale																																																	
subsp. montianum									x		x																								x		x	x	x	x									x
subsp. vernale							x		x		x		x				x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x	x	x			x	x
Molineriella minuta																								x	x	x	x		x	x	x		x	x	x														x
Parvotrisetum myrianthum																													x	x			x	x															x
Phleum																																																	
alpinum		x												x		x	x	x	x	x					x	x	x	x	x	x	x	x	x	x	x		x				x	x	x		x	x	x	x	x
arenarium																						x	x												x	x	x		x									x	
bertolonii									x								x	x						x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x			x	x
boissieri	x						x	x	x	x	x			x																						x			x										x
crypsoides																																		x	x														
echinatum																												x	x	x			x	x	x														x
exeratum																																																	
subsp. aegaeum																																			x														
subsp. exeratum					x	x	x	x	x	x	x	x																	x	x	x			x	x	x			x										x
montanum																																																	
subsp. montanum							x							x			x	x			x									x	x		x	x			x				x			x					x
subsp. serrulatum																																				x	x												x
paniculatum																																																	
subsp. ciliatum						x	x	x						x			x	x	x	x																								x					x
phleoides						x	x	x	x		x					x	x	x	x	x	x		x	x					x	x	x	x	x		x		x	x	x		x	x	x	x	x	x	x	x	x
pratense	x	x				x	x	x	x	x						x	x					x	x	x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x			x	x	x
subulatum																																																	
subsp. ciliatum																														x				x	x														x
subsp. subulatum			x							x	x				x							x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x				x	x

APPENDIX I (continued)

Species		N. AMER.	E. ASIA	ASIA: ARABIA	SINAI	KHORAS	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASIA: CAUCASUS	GEORGIA	AZERB.	ARMENIA	MEDITERRANEAN: EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	C. EUR.: ROMANIA, HU	GE, CZ, PO, SL	HE, AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
Polyporon																																																		
maritimus																																																		
subsp. maritimus		x	x		x			x		x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x				x					x		x
subsp. subspathaceus																																				x													x
monspeliensis		x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x							x
viridis		x					x		x						x	x						x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x		x	x
Pseudophleum gibbum																																																	
Rhizocephalus orientalis								x	x			x	x																																				
																																				x	x	x	x								x
Rostraria																																																	
berythea								x				x																																					
cristata		x		x						x		x			x	x		x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							x
hispida																						x	x	x				x	x	x																			x
obtusiflora																						x	x	x				x	x	x																			x
subsp. amblyantha																																																	
subsp. obtusiflora								x			x	x			x							x														x	x	x	x	x								x
																																				x	x			x	x								x
Triglochne nitens																						x	x	x	x	x			x						x	x					x								x
Trisetaria																																																	
aurea																								x				x	x	x																			x
loeflingiana								x				x		x	x	x		x	x				x	x		x				x						x													x
Trisetum																																																	
flavescens		x	x	•			x	x	x					x			x	x	x	x	x		x	x											x													x	x
rigidum							x			x							x	x	x	x																							x	x	x			x	x
sibiricum																	x	x	x	x										x																		
thospiticum																																																x	x	x
turcicum																	x																																x

APPENDIX I (continued)

Species		N. AMER.	E. ASIA	ASIA: ARABIA	SINAI	KHORAS	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR.DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASIA: CAUCASUS	GEORGIA	AZERB.	ARMENIA	MEDITERRANEAN: EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DUBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	C. EUR.: ROMANIA	GREECE, HUNGARY	HE. AU	CRIMEA	S. RUSSIA	C. RUSSIA	N. EUR.	W. EUR.	TURKEY
Ventenata dubia																		x	x	x	x			x		x	x	x			x	x	x	x	x						x	x	x	x	x			x
eigii																																				x														x
subenervis																																																		x
Zingeria																																																		
pidisica																																																		
subsp. pisidica																		x	x	x	x																						x							x
subsp. poaeforme																																																		x
trichopoda																																																		
subsp. biebersteiniana																		x	x	x	x																									x	x			x
subsp. trichopoda								x		x	x	x	x				x	x	x																											x	x			x
verticillata																																																		x

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Index to Taxonomic Account (Chapter VII)

Taxa are listed alphabetically from Genus to species and infraspecific taxa. Only accepted names are underlined, the remainder being synonyms.

Fl. 7. In P. nigra subsp. pallasiana forest, 1250 m.

Typus: [Turkey C3 Isparta] "17 km E. of Egridir, 1250 m", [15 vii 1968], F. Sorger 68-36a-12! [Holo Hb. Sorger!]

Endemic. E. Mediterranean element.

4. G. huber-morathii M. Dogan in Notes R.B.G. Edinb. 40(1): 81, 85 (1982)

Annual. Stem 16-33 cm, slender, glabrous and smooth, slightly geniculate at nodes, 3-4-noded. Leaf blades 6-9.5 cm x 1-2 mm, linear, acuminate, convolute at later stage, hairy on upper surface, glabrous below; sheaths glabrous; ligule 2-6 mm, lacerate at maturity. Panicle 3-14 cm x 2-4.5 cm, lanceolate, rather lax; branches up to 3.5, patent; pedicels 1.5-13 mm, slightly scabrid. Spikelets 8-11 mm, lanceolate, with 6-7 florets. Glumes lanceolate; lower glume 4.5-6 mm; upper glume 6-6.5 mm. Lemma lanceolate, bifid, ± hairy on dorsal surface especially in lower half. Lowest lemma 5.5-6.4 mm, without a long dorsal awn, with a mucro (c. 1 mm) from sinus; lobes acute. Upper lemmas 4-7 mm, with a dorsal awn; lobes acuminate; awns 3-6 mm, geniculate and twisted below. Palea 5.5-6 mm, scabrid on keels, bifid. Anthers 3.5 mm. Fl. 5. Grows in macchie with P. brutia, 10-50 m.

Typus: [Turkey C3 Antalya] "Finike, Atbükü Körfezi, 10-50 m", [26 v 1950], A. Huber-Morath 12485! [Hb. Huber-Morath]

Endemic. E. Mediterranean element.

7. TRISETUM Pers., Syn. Pl. 1: 97 (1805)

Perennial. Leaf blades flat. Ligule membranous. Inflorescence a contracted or lax panicle. Spikelets laterally compressed, with 2-4 florets. Glumes unequal, lanceolate, keeled; lower glume 1-veined; upper glume 3-veined. Lemma 5-veined, awned from back, bifid at apex; awns often twisted in lower half, geniculate or straight; callus hairy. Palea 2-veined, keeled, bifid at apex, scabrid on keels. Rhachilla disarticulating above glumes and between florets, hairy. Lodicules 2. Stamens 3. Caryopsis elliptic, laterally compressed.

Type: T. pratense Pers. = T. flavescens (L.) Beauv.

Literature:

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Key to Species

1. Rhachilla hairs as long as lemma, protruding from open spikelet ..... 1. rigidum

1. Rhachilla hairs rather short or absent, when present not protruding from the spikelet

2. Panicle rather lax; branches usually longer than 3 cm

3. Awns geniculate; lowest sheaths hairy; spikelets 4-7.5 mm ..... 2. flavescens

3. Awns curved; lowest sheaths glabrous; spikelets 6.3-8.5 mm ..... 3. sibiricum

2. Panicle rather dense, spike-like; branches usually shorter than 3 cm

4. Spikelets with 2 florets; rhachilla hairs 0.6-0.8 mm; densely caespitose; leaf blades pilose ..... 4. thospiticum

4. Spikelets with 3 florets; rhachilla almost glabrous; laxly caespitose; leaf blades not pilose ..... 5. turcicum

1. T. rigidum (M. Bieb.) Roemer & Schultes, Syst. Veg. 2: 662 (1817).

Syn: Avena rigida M. Bieb., Fl. Taur.-Cauc. 1: 77 (1808);

Avena daenensis Boiss., Diagn. ser. 1 (7): 123 (1846).

Laxly caespitose perennial. Stem (16-) 30-45 cm, erect to geniculately ascending from base, slender and glabrous but sometimes slightly hairy below nodes. Leaf blades (2-) 4-6 cm x 2-4 mm, linear, acuminate, glaucous, usually glabrous and rigid; sheaths glabrous; ligule 1.6-3 mm, ± lacerate. Panicle 2.5-8 cm x 1.5-2.5 cm, oblong to narrowly elliptic, becoming silvery; branches erect, contracted; pedicel 2.5-7 mm, glabrous. Spikelets 8-11 mm. Lower glume 3.8-4.8 mm; upper glume 6-7.7 mm. Rhachilla hairs about as long as lemma. Lemma 5-7.5 mm, bifid at apex, purple like glumes; awn 4-8 mm. Palea 4-4.8 mm. Anthers 2.2-2.7 mm. Fl. 7-9. Dry alpine mountain slopes, 2300-2400 m.

Typus: [U.S.S.R.] "Hab. in Caucasi orientalis glareosis", M. Bieberstein [Iso LE!]

Mainly E. Anatolia.

A8 Erzurum: Kop Da. pass, 2400 m, K.P. Buttler 14276!

A9 Kars: Ardahan, Grossheim I: Map 185

B8 Erzurum: Palandöken, N.W. of Büyük Ejder Da., 2300 m, F. Holtz et al. 832!

C5 Nigde: Bulghar Maden, Bal. 29!

External distribution: N. and C. Iran, Caucasia to Siberia.

2. T. flavescens (L.) Beauv., Ess. Agrost.: 88, 180 (1812).

Syn: Avena flavescens L., Sp. Pl. 80 (1753).

Ic: Hubbard, Grasses 246 (1968);

Bor, Fl. Iraq 9: 360, t. 137 (1968).

Laxly caespitose perennial. Stem 30-70 cm, erect or geniculate, smooth and glabrous, sometimes hairy just below nodes. Leaf blades 3.5-12 cm x 2-5 mm, linear, acuminate, usually pubescent, especially on the upper surface, somewhat glabrous; basal sheaths always hairy, upper ones glabrous; ligule 6-7 mm. Panicle 6-10.5 cm x 1-2 cm, rather lax, ± golden coloured to purpurascent; pedicels 1-7 mm, slightly aculeolate. Spikelets 4-7.5 mm, oblong or finally wedge-shaped. Glumes broadly hyaline; lower glume 2.2-4.1 mm; upper glume 3.7-6.8 mm. Rhachilla segments slightly hairy. Lemma 4.2-7 mm, awned above the middle; callus hairy; awn 4.5-9.5 mm, geniculate, twisted in lower half. Palea 3.6-4.6 mm. Anthers 2-3 mm. Fl. 5-8. Meadows, mountain slopes, fallow fields, roadsides, 770-2896 m.

Typus: "Hab. in Germania, Anglia, Gallia", /Hb. Linn. 95/15!/

N.W. Turkey, Inner & N.E. Anatolia.

A1(E)Kirklareli: Demirköy to Igneada, A. Baytop (ISTE 5494)!

A2(A) Istanbul: Camlica, N. Tanker (ISTE 10583)!

A3 Ankara: Beypazari, Nahiye Tepe, 2000 m, Y. Akman (ISTE 21030)!

A6 Sivas: Yildiz Da., Sariyer, 1700 m, Tobey 2356!

A7 Giresun: below Tamdere, 1600 m, D.20638!

B8 Erzurum: 20 km from Erzurum to Pasinler, 1950 m, D.46282!

B9 Bitlis: Tatvan, 1750 m, D.22187!

C4 Konya: Ermenek, Peronin 214!

C9 Hakkari: Karadag, 2896 m, D.24393!

External distribution: N. Africa, W. and C. Europe, Aegean, Caucasia, N.W., W. and C. Iran, Turkestan, Siberia, E. Asia. Introduced in

N. America. Euro-Sib. element.

3. T. sibiricum Rupr. in Beitr. Pfl. Russ. Reich. 2: 65 (1845).

Laxly caespitose perennial. Stem up to 130 cm, erect, glabrous and smooth, 3-4-noded. Leaf blades 8-24 cm x 3-8 mm, linear, acuminate, hairy on the vein of upper surface, green; sheaths glabrous, somewhat with slightly appressed hairs; ligule 2.5-3.5 mm, lacerate. Panicle 8-16 cm x 2-4.5 cm, ovoid, lax; branches 3-5.5 cm; pedicels 0.8-4 mm, slightly scabrid. Spikelets 6.3-8.5 mm, brownish. Glumes broadly hyaline, scabridulous on veins; lower glume 3.5-4.5 mm; upper glume 5.5-7.2 mm. Rhachilla segments c. 1.8 mm, with hairs up to 1 mm. Lemma 4.5-6.6 mm; awn 5.5-9 mm, curved, twisted in lower half, scabrid; callus hairs minute. Palea 5.4-6 mm. Anthers 2-3 mm. Fl. 7. Edge of Pinus sylvestris forest, banks, 2150 m.

Typus: [U.S.S.R.] "Terra parva Samojedorum, fl. Belaja", Ruprecht.

E. Anatolia.

A9 Kars: 6 km from Sarikamiş to Karakurt, 2150 m, D.46563!

External distribution: C. Europe, Caucasia, C., N. and W. Russia.

4. T. thospiticum Chrtek in Bot. Not. 119: 489-490 (1960).

Densely caespitose perennial. Stem 21-50 cm, slender, erect, slightly hairy. Leaf blades 3.1-11 cm x 2.3-4 mm, linear, acuminate, pilose to subglabrous; sheaths like leaves but basal sheaths glabrous and papery; ligule 0.5-1 mm, obtuse, lacerate later. Panicle 3.6-10 cm x 1.3-3.5 cm, oblong contracted; branches 1-2.5 cm, erect; pedicels 1.5-4 mm, scabrid. Spikelets 5.5-9.5 mm, becoming purple-violet, usually with 2 florets and sometimes with a third rudiment. Glumes unequal, smooth, with hyaline margins; lower glume 3.5-6.3 mm; upper glume 5-8 mm. Rhachilla 1.5-2 mm, hairy unilaterally; hairs c. 0.6-0.8 mm.

Lemma 6-8 mm; awn 6-10 mm. Anthers 2.2-3.7 mm. Fl. 7-8. On basal and earthy slopes, 3200-3300 m.

Typus: [Turkey B9 Bitlis] "Suphan Da., 33300 m, 28 viii 1954", P.H. Davis 24763a [Holo E!]

Endemic.

5. T. turcicum Chrtek in Bot. Not. 119: 487-489 (1966).

Laxly caespitose perennial. Non-flowering shoots extravaginal. Stem 40-50 cm, ascending from base, hairy below nodes. Leaf blades 7.5-13 cm x 3-5 mm, linear, acuminate, usually glabrous all over, but scabrid only on veins; sheaths hairy; ligule 1.6-3 mm, obtuse, lacerate. Panicle 5.2-8.6 cm x 6-8 mm, dense, contracted; pedicels 2.5-4.5 mm, erect, scabrid. Spikelets 5.4-8 (-10) mm, usually with 3 florets. Glumes unequal, largely hyaline on margins; lower glume 4.5-6 mm; upper glume 6.3-6.5 (-8.5) mm. Rhachilla segments 1.5-2 mm, almost glabrous. Lemma 5.3-6.5 (-8) mm; awn 9.5-10 mm. Palea 5-7 mm. Anthers (2.5-) 3-4.5 mm. Fl. 7-8. Alpine meadows, 2000-2300 m.

Typus: [Turkey A8 Rize] "Cimil, 2000 m, viii 1866", Balansa 1551 [Iso E!]

External distribution: Caucasia (fide Tzvelev).

8. TRISETARIA Forsskal, Fl. Aeg.-Arab. 27 (1775)

Annual. Leaf blades flat. Ligule membranous. Inflorescence a rather dense, spike-like panicle. Spikelets small, with 2-3 florets, laterally compressed. Glumes unequal, lanceolate, keeled; lower glume 1-veined; upper glume 3-veined. Lemma 5-veined, terminating in 2 apical setae, dorsally awned; callus hairy. Palea 2-veined, keeled. Rhachilla disarticulating above glumes and between florets. Lodicules 2. Stamens 3. Caryopsis elongate, laterally compressed, trullate in side view. Embryo $\frac{1}{3}$ as long as caryopsis. Hilum punctiform.

Type: T. linearis Forsk.

Key to Species

1. Spikelets 2.6-3.3 mm; apical setae about 0.3 mm ..... 1. aurea

1. Spikelets 5-5.5 (6) mm; apical setae about 2.5-3.5 mm ..... 2. loeflingianum

1. T. aurea (Ten.) Pignatti in Archiv. Bot., Forli, 31: 51 (1955).

Syn: Trisetum aureum Ten., Fl. Nap. 2: 378 (1820);

T. noeanum Boiss., Diagn. Ser. 1 (13): 48 (1853).

Ic: Ic. Fl. Ital. 1: 28, f. 237 (1895); Zangheri, Fl. Ital. 2: 185, f. 6766-6767 (1976).

Annual. Stem 5.5-12 cm, erect to slightly geniculate, rather slender, tufted, glabrous. Leaf blades 1.5-3.5 cm x 1-2 mm, linear, acuminate, villous to somewhat subglabrous; sheaths glabrous, uppermost one often inflated, basal sheaths villous; ligule 1.5-3 mm, obtuse. Panicle 1.6-3 cm x 0.9-1.5 cm, pyramidal to ovoid, sometimes lobed; branches 1.4-2 cm, contracted; ledicels 0.6-1.6 mm, glabrous. Spikelets 2.6-3.3 mm, with 2 florets, brownish and shiny. Glumes broadly hyaline, smooth, acuminate; lower glume 2.4-2.6 mm; upper glume 2.8-3.2 mm,

enveloping florets. Rhachillasegments 0.3-0.4 mm, hairy. Lemmas 1.7-2.7 mm, hyaline on margins, glabrous; terminal setae 0.3 mm; awn dorsal 2.7-4.3 mm, slightly bent, twisted below. Palea 1.5 mm. Anthers 0.8-1.5 mm. Sandy places near sea, sea level.

Typus: Habitat in pratis siccis sabulosis; loco vulgo dicto Granatello, Tenore.

Rare, only recorded once from Istanbul.

A2 Istanbul: Istanbul, 1845, Noë 116!

External distribution: N.W. Africa, Italy, Sicily, Bulgaria, Greece. The province of some of Noë's specimens is open to doubt.

2. T. loeflingiana (L.) Paunero, in An. Jard. Bot. Madrid, 9: 527 (1949).

Syn: Avena loeflingiana L., Sp. Pl. 79 (1753);
Trisetum loeflingianum (L.) C. Presl, Fl. Sic. 3 (1820);
Trisetum cavanillesii Trin. in Mem. Acad. Sci. Petersb., Ser. 6, 1: 63 (1830);
Trisetum gaudinianum Boiss., Voy. Bot. Espagne 2: 653 '1841)!;
Lophochloa cavanillesii (Trin.) Bor, Grass. Burma, Ceyl. Ind. Pakist.: 445 (1960).

Ic: Fiori, Ic. Fl. Ital. 1: 28, f. 236 (1895) as Trisetum cavanillesii; Bor. Fl. Iraq 9: 359, t. 136 (1968).

Annual. Stem 9-25 cm, rather slender, tufted to solitary, simple or branched at base, usually erect, somewhat geniculate at base. Leaf blades 3-6.5 cm x 0.9-1.7 cm, narrowly linear, acuminate, somewhat ± involute, pubescent; sheaths loose, retrorse hairy; ligule 1.5-2 mm, hairy on dorsal side. Panicle 3.5-5 cm x 5-9 mm, narrowly oblong, dense, contracted. Spikelets 5-5.5 (-6) mm, with a hairy redument of third floret. Glumes largely hyaline, smooth; lower glume 3-4 mm; upper glume 4-5 mm. Lemma 4 mm, smooth nearly; terminal setea

2.5-3.5 mm; awn 10-12 mm. Anthers 0.3-0.6 mm. Fl. 5 Dry sandy places, Calligonum steppe, 850 m.

Typus: "Hab. in Hispania" [Hb. Linn. 95/5!]

E. Anatolia.

B10 Kars: 3-5 km E. of Aralik (Aras valley), 850 m, D.43672!

External distribution: C. Europe, Mediterranean, Caucasia, N. Iraq, W. Iran, Afghanistan, Turkestan, W. Pakistan, S. Russia.

9. PARVOTRISETUM Chrtek in Preslia 37: 201 (1965)

Annual. Leaf blades involute. Ligule membranous. Inflorescence a lax panicle. Spikelets very small, laterally compressed, usually with 2 florets. Glumes subequal, keeled, membranous, longer than florets; lower glume 1-veined; upper glume 3-veined. Lemma 5-veined, membranous, terminating in 2 short setae, with a dorsal awn; callus hairy. Palea 2-veined, 3-fid, shorter than lemma. Rhachilla disarticulating above glumes, glabrous to slightly hairy. Lodicules 2. Stamens 3. Caryopsis oblong. Monotypic.

Type: P. myriathum (Bertol.) Chrtek

P. myrianthum (Bertol.) Chrtek in Preslia 37: 201 (1965).

Syn: Avena myriantha Bertol., Fl. Ital. 1: 722-723 (1833);

Trisetum myrianthum (Bertol.) Parl., Fl. Ital. 1: 270 (1848).

Ic: Fiori, Ic. Fl. Ital. 1: 28, f. 240 (1895).

Annual. Stem (5-) 20-50 cm, solitary to numerous, glabrous and smooth, erect, sometimes geniculately ascending from base. Leaf blades 1.5-13.5 cm x 0.4-2 mm, involute, glabrous and shiny on lower side, scabrid on upper side; sheaths glabrous; ligule 0.9-4.2 mm, lanceolate, acute. Panicle 2.5-17 cm x 0.8-3 cm, oblong; branches 1-6 cm, patent; pedicels 0.6-1.5 mm, scabridulous. Spikelets 2-3 mm. Glumes lanceolate, scabridulous on keels. Rhachilla segments 0.7 mm. Lemmas 1.2-1.9 mm, lanceolate, pubescent to glabrous; awn 2-3.2 mm, slightly twisted below, dorsally attached, very slender, scabrid. Palea 1.4 mm, hyaline, 3-lobed at apex, midlobe longer than the two ones. Anthers 0.6-1 mm.

Type: [Italy] "Frequens in agris prope Mediolanum" Balsamo-Crivellius et De Notaris.

Turkey-in-Europe

A1(E) Edirne: Enez, Çataltepe, Grisebach.

External distribution: Italy, Jugoslavia, Albania, Greece.

Mediterranean element.

10. AVELLINIA Parl., Pl. Nov. 61 (1842)

Annual. Leaf blades flat or involute. Ligule membranous. Inflorescence a rather dense contracted panicle. Spikelets laterally compressed, with 2-4 florets. Glumes very unequal, persistent, membranous; lower glume 1-veined; upper glume 3-veined and equaling spikelet. Lemma 3-veined, membranous, 2-fid at apex, with a subterminal awn. Palea about $\frac{1}{2}$ as long as lemma, 2-veined, bifid at apex. Rhachilla disarticulating above glumes and between florets. Lodicules 2. Stamens 3. Caryopsis linear-lanceolate.

Type: A. michelii (Savi) Parlatore

A. michelii (Savi) Parl., Pl. Nov. 61 (1842).

Syn: Bromus michelii Savi, Bot. Etrusca 1: 78 (1808);

Vulpia michelii (Savi) Reichb., Fl. Germ. Excurs. Add. 234c (1833).

Ic: Fiori, Ic. Fl. Ital. 1: 33, f. 275 (1896); Zangheri, Fl. Ital. 2: 188, f. 6869-6870 (1976).

Annual. Stem 10-25 cm, usually tufted, erect or geniculately ascending from base, retrorsely puberulent, with 1-3 nodes. Leaf blades 1-4.5 cm x 0.8-2 mm, linear, acuminate, usually puberulent, sometimes involute; sheaths puberulent; ligules up to 1.2 mm, truncate. Panicle 3.1-8.5 cm x 1.2-2 (-3) cm, oblong to oblong-cylindrical; branches 1-3.3 cm; pedicel 1.2-3.7 mm, scabrid. Spikelets (3-) 3.7-6.4 mm. Glumes scabrid on keel; lower glume 1.3-1.6 mm, linear, acuminate; upper glume 3.7-6.4 mm, lanceolate, mucronate. Rhachilla segment 0.5-0.7 mm, slightly scabrid. Lemma 2-4.5 mm, linear-lanceolate; awn 2.9-3.5 mm, straight, slightly scabrid; callus scabrid. Palea 1.5-2.2 mm, scabrid on keels. Anthers 0.4-0.5 mm. Fl. 5. Dry open places near the sea.

Typus: "Hab. in collibus siccis, Cyprus prope Davlu" Sint. et Rigo.

N.W. & W. Anatolia, Islands.

A2(A) Istalbul: Heybeliada, 23 v 1897, Azn.! Büyükada, 9 v 1897, Azn.!

B1 Izmir: Inseln im Golf von Izmir, Bal.

External distribution: N.W Africa & S. Europe eastwards to Aegean.

Mediterranean element.

11. ROSTRARIA Trin., Fund. Agrost.: 149 (1820), s. str.

Syn: Lophochloa Reichb., Fl. Germ. Excurs. 42 (1830);

Trisetum b. Rostraria (Trin.) Trin. in Mem. Acad. Sci. Petersb., ser. 6, 1: 65 (1830);

Wilhelmsia C. Koch in Linnaea 21: 400 (1848).

Annual. Leaf blades flat. Ligule membranous. Inflorescence a spike-like panicle, ovate-oblong or cylindrical to pyramidal, ± dense, sometimes lobed. Spikelets laterally compressed, with 3-5 (11) florets, uppermost florets often reduced. Glumes unequal, keeled; lower glume 1-veined, lanceolate, acuminate; upper glume 3-veined, broader and longer than lower one, elliptic, acuminate to acute-subobtuse. Lemmas 5-veined, keeled, acute to obtuse, with or without subterminal awn. Palea as long as lemma or longer, 2-veined, bifid sometimes veins produced as short arista. Rhachilla disarticulating above glumes and between florets. Lodicules 2. Stamens 3. Caryopsis narrowly oblong, laterally compressed.

Type: R. pubescens Trin. (= R. cristata (L.) Tzvel.)

Literature:

Domin, K. 1907. Monographie der Gattung Koeleria. Bibl. Bot. 65: 1-354.

Key to Species

1. Lemmas obtuse at apex; veins of lemmas very prominent ..... 1. obtusiflora

1. Lemmas acute at apex; veins of lemmas not prominent

2. Palea terminating in 2 exserted setae ..... 2. berythea

2. Palea bifid, without setae

3. Panicle ovoid; awns3-5 mm; anthers 0.7-1 mm, oblong ..... 3. hispida

3. Panicle oblong; awns 0.5-2.3 (-3) mm; anthers 0.2-0.6 mm, oval ..... 4. cristata

1. R. obtusiflora (Boiss.) Holub in Folia Geobot. Phytotax. (Praha), 9: 271 (1974).

Annual. Stem 3-13 (-45) cm, geniculately ascending from base, fasciculate, glabrous and smooth. Leaf blades 1-3 (-12) cm x 1.2-2 (-4.2) mm, linear, acuminate, slightly hairy on upper surface, glabrous beneath; sheaths hairy, ± violet; ligule 0.6-0.8 (-1) mm, obliquely arranged around stem. Panicle 1.2-2.7 (-6) cm x 4-8 (-12) mm, cylindrical, dense. Spikelets 1.8-5 mm, with 3-5 florets. Glumes unequal; lower glume 1.8-2.5 mm, acuminate to acute; upper glume 2.4-3.5 mm, subobtuse to acute. Lemma glabrous, 2.5-4 mm, obovate-lanceolate, obtuse at apex, with a short subterminal awn or sometimes awnless. Palea nearly equaling lemma. Anthers 0.3-0.5 mm.

Key to subspecies

1. Spikelets 4-5 mm, with 3-5 florets ..... subsp. obtusiflora
1. Spikelets 1.2-2 mm, with 3-4 florets ..... subsp. amblyantha

subsp. obtusiflora

Syn: Koeleria obtusiflora Boiss., Diagn. ser. 1 (7): 121 (1846);
Koeleria phleoides var. obtusiflora Boiss., Fl. Or. 5: 573 (1884);
Koeleria obtusiflora var. typica Domin in Bibl. Bot. 65: 272 (1907);
Lophochloa obtusiflora (Boiss.) Gontsch., in Fl. USSR 2: 338 (1934).

Ic: Domin in Bibl. Bot. 65: t. 18 f. 8 (1907).

Fl. 5. Sandy flat riverbanks, 350 m.

Typus: [Iran] "Hab. prope pagum Radar provinceae Schiraz" [in vicinitate pag. Dalechi iii 1842] [Iso E!]

S.E. Anatolia.

C9 Mardin: Cizre, 350 m, D.42516!

External distribution: Cyprus, Egypt, W. Syria, Syrian Desert, N. Iraq, W. Iran, Afghanistan. Ir.-Tur. element.

subsp. amblyantha (Boiss.) M. Dogan (ined.)

Syn: Koeleria amblyantha E. Desv. ex Boiss. Diagn. ser. 2 (4): 134 (1859); Koeleria phleoides var. amblyantha Boiss., Diagn. ser. 2 (4): 134 (1859).

Ic: Domin in Bibl. Bot. 65: t. 18 f. 9; t. 19 f. 4 (1907).

Fl. 4. Sandy soil on the coast, 0-20 m.

Typus: [Lebanon] "Hab. in Syria littorali ad Sidonem et Berythum" (Gaillardot; Blanche)

S.W. Anatolia.

C1 Mugla d. Marmaris: E. of Datça, D.41359!

C3 Antalya: Kumköy, between Antalya and Serik, 20 m, D.25735!

External distribution: Cyprus, W. Syria. E. Mediterranean element.

2. R. berythea (Boiss. & Blanche) Holub in Folia Geobot. Phytotax. 9: 271 (1974).

Syn: Koeleria berythea Boiss. & Blanche, Diagn. ser. 2 (4): 135 (1859)!; Koeleria phleoides var. grandiflora Boiss., Fl. Or. 5: 575 (1884)!; Lophochloa berythea (Boiss. & Blanche) Bor in Taxon 16: 68 (1967).

Ic: Domin in Bibl. Bot. 65: t. 18 f. 6 (1907); Bor, Fl. Iraq 9: 350, t. 132 (1968).

Annual. Stem 8-36 cm, erect or slightly bent at base, slender, smooth and glabrous. Leaf blades 2-9 cm x 1.5-5.5 mm, linear, acuminate, ± pilose on upper surface especially on veins, glabrous beneath, scabrid towards apex; sheaths glabrous or pilose; ligule 1-1.5 mm, truncate, dentate. Panicle 2.5-6 cm x 0.5-1.8 cm, ovate-oblong. Spikelets 4.5-6.3 mm (excl. awn), with 3-5 florets, the last two florets rarely

unawned and thickened. Glumes unequal, glabrous to ciliate on keel; lower glume 3.2-4 mm, lanceolate; upper glume 4.5-5 mm, elliptic, acuminate. Rhachilla hairs 0.3-0.4 mm. Lemma 4.5-5 mm (excl. awn), with a straight subterminal awn, bidenticulate at apex, dorsally hairy; awn up to 1.2-2 mm. Palea slightly exceeding lemma, with 2 setae at apex. Anthers 0.5-0.7 mm. Fl. 4-5. Damp places, on rocky limestone slopes, roadside ditch, 0-600 m.

Typus: [Lebanon] "Hab. in Syria littorali circa Berythum et Sidonem" [4 iii-6 iv 1853], Blanche [Holo G!, Iso K!]

S. Anatolia.

C3 Antalya: Çatallar, T. Baytop (ISTE 11175)!

C5 Adana: Karataş, 9 km S. of Adana, Jones & Coode 239A!

C7 Urfa: 15 km E. of Birecik, 600 m, F. Sorger 80-15-45!

External distribution: Cyprus, W. Syria, N. Iraq, W. Iran.

3. R. hispida (Savi) M. Dogan

Syn: Festuca hispida Savi, Fl. Pis. 1: 117 (1798);
Koeleria hispida (Savi) DC., Hort. Monspel.: 119 (1813);
Lophochloa hispida (Savi) Jonsell in Bot. J. Linn. Soc. 76: 321 (1978).

Ic: Domin in Bibl. Bot. 65: t. 20 f. 5-6 (1907).

Annual. Stem 3-15 (-30) cm, usually erect, slightly bent at base, glabrous and smooth. Leaf blades 2-7.5 cm x 0.7-6 mm, lanceolate, acuminate, villous on upper surface, glabrous beneath; sheaths villous; ligule up to 0.8 mm. Panicle 0.7-2.5 cm x 0.6-1.5 cm, usually ovoid, sometimes oblong and very dense. Spikelets 4-5.3 mm (excl. awn) with 2-5 florets. Glumes acuminate, usually ciliate on keel, with hyaline margins; lower glume 2.2-3.1 mm; upper glume 3.2-4 mm. Rhachilla glabrous. Lemma 3.4-4.5 mm, ± ciliate, with a subterminal awn;

awn 1-3 mm, slightly curved especially in upper half. Palea equaling lemma. Anthers 0.8-1 mm. Fl. 4-6. Dry places on the coast, muddy places, 0-30 m.

Typus: [Italy] "L' no trovata fra i sassi nel Monte Pisano vicino a Calci" Savi.

N.W. Turkey and S. Anatolia.

A2(E) Istanbul: Yedikule, 7 vi 1898, Azn.!

A2(A) Istanbul: Tuzla, 31 v 1896, Azn.!

C3 Antalya: Serik to Manavgat, 30 m, E. Hennipman et al. 839!

C5 Adana: Tarsus, Alifeki, 25 iv 1955, K. Karamanoglu (ANK. 957)!

External distribution: N. Africa, Corsica, Italy, Sardinia, Sicily, Greece. Mediterranean element.

4. R. cristata (L.) Tzvelev, Poaceae:267 (1976).

Annual. Stem 3-50 cm, erect or geniculately ascending from base, smooth and glabrous, usually fasciculate, sometimes solitary. Leaf blades 2-13 cm x 1-7 mm, linear-lanceolate, acuminate, ± villous to pubescent; sheaths usually hairy; ligules 1-2 mm. Panicle 1-6 cm x 0.3-1.3 cm, oblong, narrowly oblong-cylindrical or ovate, dense to loose, pale green; pedicels scabridulous. Spikelets 2.2-5.5 mm, usually with 3-5 sometimes7-11 florets. Glumes unequal, acuminate, glabrous or with an irregular pubescent to hirsute; lower glume 1.4-2.8 mm; upper glume 2-4 mm. Rhachilla short hairy. Lemma 2.7-4.2 mm, glabrous or with an irregular pubescent, acute at apex in side view, with a subterminal awn 0.5-2.3 (-3) mm. Palea shorter than lemma, bifid. Anthers 0.2-0.6 mm, oval or rounded-oval. Fl. 4-7. Waste or open places, sandy plots, forested foothills, mountain slopes, 10-1200 m.

Key to varieties

1. Spikelets densely covered with hairs ..... var. cristata

1. Spikelets ± glabrous ..... var. glabriflora

var. cristata

Syn: Festuca cristata L., Sp. Pl.: 76 (1753);

Festuca phleoides Vill., Fl. Delph. 7 (1785);

Koeleria cristata (L.) Pers., Syn. Pl. 1: 97 (1805);

Koeleria phleoides var. typica Domin in Mag. Bot. Lap. 3: 333 (1904);

Trisetaria phleoides (Vill.) Nevski in Acta Inst. Bot. Acad. Sc. URSS, ser. 1, fasc. 4, 339 (1937);

Lophochloa cristata (L.) Hyl. in Bot. Not. 3: 355 (1953).

Typus: "Habitat in Lusitanae collibus sterilbus" [Hb. Linn. 92/24, photo!]

Mainly W. and S. Anatolia, Islands.

A1(A) Çanakkale: Erenköy, Sint. 19!

A2(A) Istanbul: Hunkar, Iskelesi, J. Ball 2599!

A7 Trabzon: 32 km from Trabzon to Erzurum, N. Jardine 4358!

B1 Izmir: Izmir, vi 1877, J. Ball 2513!

C1 Mugla: Bodrum, 0-10 m, D.40873!

C2 Mugla: Marmaris to Emecik, 200 m, D.25337!

C3 Antalya: on Korkuteli road from junction with Burdur road, Jackson 5023!

C5 Mersin: Tarsus, 20 m, D.26506!

Is. Tokmakia (N.E. of Lesvos): Barbalias, 0-50 m, J.R. Edmondson 2455!

Kos: around classical ruins, sea level, D.40551!

var. glabriflora (Trautv.) M. Dogan (ined.)

Syn: Koeleria phleoides var. glabriflora Trautv. in Acta Horti Petrop. 7 (2): 526 (1881);

Koeleria phleoides var. pseudolobulata Degen et Domin in Mag. Bot. Lap. 3: 335 (1904).

Typus: "Prope Lenkoran" Radde

Widespread.

A1(E) Edirne: Sarayici, A. Baytop (ISTE 6579)!

A2(E) Istanbul: Yedikule, 7 vi 1898, Azn.!

A3 Bilecik: 50 km N. of Bilecik, A. Baytop (ISTE 8823)!

A5 Amasya: Havza to Merzifon, T. Baytop (ISTE 15452)!

A6 Tokat: Erbaa, Kalekoy, 300 m, Tobey 691!

A7 Trabzon: 32 km from Trabzon to Maçka, N. Jardine 435B!

B1 Izmir: Çeşme, 10-50 m, D.41811A!

B2 Kütahya: 4 km N. of Abide to Simav, 700 m, Coode & Jones 2614!

B3 Eskişehir: Eskişehir to Mayislar, 800 m, A. & T. Baytop (ISTE 25284)!

B8 Siirt: 35 km from Siirt to Baykara, 800 m, D.43100!

B9 Bitlis: 65 km S. of Bitlis, J.G. Ross!

C1 Mugla d. Milas: Becir Köy above Gökdere, 150 m, E. Sezik (ISTE 7727)!

C2 Mugla: Marmaris to Emecik, 200 m, D.25337!

C3 Antalya: Kumköy between Antalya and Serik, 20 m, D.25735!

C4 Antalya: Alanya, A. Baytop (ISTE 8544)!

C5 Mersin: Tarsus, 20 m, D.26506!

C6 Maras d. Pazarcik: between Narli and Karabiyikli, 600-700 m, D.27835B!

C8 Mardin: 8 km from Mardin to Nusaybin, 850 m, D.28490!

C9 Mardin: Cizre, 350 m, D.42516!

Isl. Tokmakia (N.E. of Lesvos), Asproisos, 0-30 m, J.R. Edmondson 2500!

Rhodos: Rhodos, 4 v 1870, Bourgeau!

External distribution: Mediterranean, Crimea, Caucasia, N. Iraq, N. Iran, Arabia, Afghanistan, W. Pakistan. Introduced in N. America.

12. KOELERIA Pers., Syn. Pl. 1: 97 (1805)

Caespitose perennial, with short creeping rhizomes or bulbous at the base. Leaf blades flat to convolute. Sheaths glabrous to hairy. Ligule membranous, short. Inflorescence a spike-like panicle, rather dense or sometimes rather loose. Pedicels puberulent. Spikelets laterally compressed, with 2-3 (4) florets. Glumes lanceolate, acute to acuminate, subequal to unequal, glabrous to hairy, shorter than spikelets; lower glume 1-veined; upper glume 3-veined. Lemma 3-5-veined, lanceolate to ovate-lanceolate, acute to acuminate, sometimes with an aristate point, glabrous to hairy. Palea equalling lemma, 2-veined, keeled, bifid at apex. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis oblong-trullate in side view, laterally compressed.

Type: K. cristata (L.) Pers.

Literature:

Domin, K. 1907. Monographie der Gattung Koeleria. Bibl. Bot. 65: 1-354.

Ujhelyi, J. 1972. Evolutionary Problems of the European Koelerias in G. Vida (ed.), Evolution in Plants (Symposia Biologica Hungarica 12) 163-176 (1972).

Key to Species

1. Non-flowering shoots usually with 5-10 leaves; leaf blades shorter than 3 cm
   2. Lemma terminating in an aristate point (c. 1 mm); upper glume shorter than lowest lemma ..... 1. brevis
   2. Lemma without an aristate point at apex; upper glume as long as lowest lemma ..... 2. lobata

1. Non-flowering shoots usually with 2-4 leaves; leaf blades longer than 4 cm

3. Glumes subequal; upper glume as long as lowest lemma ..... 3. nitidula

3. Glumes unequal to subequal; upper glume shorter than lowest lemma

4. Glumes unequal; usually glabrous; leaf blades glabrous to scabridilous ..... 5. cristata

4. Glumes subequal, pilose; leaf blades pilose ..... 4. eriostachya

1. K. brevis Stev. in Bull. Soc. Nat. Mosc., 30, 3: 110 (1857).

Syn: K. lobata non (Bieb.) Roemer et Schultes, Syst. Veg. 2: 620 (1817); K. degenii Domin in Mag. Bot. Lap. 3: 275 (1904).

Ic: Domin in Bibl. Bot. 65: t. 3 f. 5 (1907); Kulczynski, Atlas Fl. Polsk. 4 (4): 458 (1936).

Densely caespitose perennial. Stem 20-36 cm, slender, erect to sometimes geniculate at base, slightly hairy below panicle, with a bulbous enlargement at base, usually 1-noded in lower half. Leaf blades 2-3 (-5) cm x 0.5-1 (-15) mm, convolute, mainly coming out from base of stem, scabrid on margins; sheaths persistent up to half way up the stem, upper ones scabrid, lower ones covered with pilose (c. 1-1.5 mm); ligule up to 1 mm, truncate, becoming lacerate. Panicle 2-2.7 cm x 0.7-1 cm, rather dense spike-like, ovate to oblong, pale yellow. Spikelets 4.8-7 mm, almost sessile, with 2-3 florets. Glumes unequal, shorter than florets; lower glume 2.8-3.5 mm, lanceolate, acuminate; upper glume 3.5-4 mm, oval, acuminate. Lemma 4.5-4.8 mm, lanceolate, acuminate, glabrous to slightly hairy, terminating in a short aristate point (up to c. 1 mm). Palea as long as lemma.

Anthers 2-2.5 mm. Fl. 5-7. Dry calcareous places, 0-1000 m.

Typus: /Crimea/ "Tauria, Sudak, 1832" Steven.

Turkey-in-Europe, W. Anatolia.

A1(E) Kirklareli d. Taştepe: 4 km N. of Kofçaz, N. Uluocak (ISTE 27160)!

A2(E) Istanbul: Halkali to Yarimburgaz, 27 v 1894, Azn.!

B3 Kütahya: 50 km N.W. of Afyon, 1000 m, F. Sorger 63-46-43!

B3 Eskişehir: Imşehir, tree plantation field, Kayacik 820!

External distribution: Bulgaria, Romania, Crimea, W. and E. Russia.

This species was first described by Steven as K. brevis in 1857, but later was again described by Domin as K. degenii. Recently this species has been [illegible] as K. lobata in Flora Europaea (5: 219). Certainly the earliest name, K. brevis, remains unchanged in this account. K. brevis differs from K. lobata in a number of characters, viz. lemmas terminating in an aristate point (c. 1 mm); upper glume shorter than the lowest lemma; glumes unequal.

2. K. lobata (Bieb.) Roemer & Schultes, Syst. Veg. 2: 620 (1817).

Syn: Dactylis lobata M. Bieb., Fl. Taur.-Cauc. 1: 67 (1808);

K. splendens C. Presl, Cyp. Gram. Sic. 34 (1820).

Ic: Domin in Bibl. Bot. 65: t. 5 f. 1 (1907).

Densely caespitose perennial. Stem 20-32 cm, erect, rather slender, glabrous and smooth, 1-noded, with a bulbous enlargement at base. Leaf blades 1.5-3 (-5.5) cm x 0.4-1 (-2.5) mm, convolute, mainly basal, with a fringe of cilia on margins, greyish-green; sheaths persistent, entire, glaucous, glabrous in upper, ciliate at basal ones; ligule up to 1 mm, truncate, denticulate. Panicle 2-3 cm x 0.7-1.7 cm, oblong to ovate, rather dense, somewhat lobed below, glossy and yellow. Spikelets 5-7.5 mm, with 2-3 florets. Glumes subequal, usually glabrous,

acute or finally acuminate; lower glume 3-5.5 mm; upper glume 4.5-6.8 mm. Lemma 5-6.8 mm, acuminate to shortly aristate. Palea equaling lemma. Anthers 2-3 mm. Dry stony places, especially on limestone, lowland-1200 m.

Typus: [Crimea] "Described from Tauria", M. Bieberstein. [Lectotype LE!]

Turkey-in-Europe, Islands.

A1(E) Tekirdag/Kirklareli: Saray to Vize, Hermann.

A1(E) Kirklareli: Pinarhisar, Sogucak, Hermann.

Is. Samos: M. Kerki, 1200 m, Rech. 2036.

External distribution: C. and S. Europe, Aegean, W. Russia, Crimea.

This species has been confused with other species and there has been a great problem over its earliest name and synonymy. It was first described by M. Bieberstein in his Fl. Taur.-Cauc. 1: 67 (1808) as Dactylis lobata. Later the same species was redescribed by C. Presl in his Cyp. Gram. Sic. 34 (1820) as K. splendens. K. splendens has been accepted as an earliest name for this species, since K. lobata was mistakenly put together with K. degenii and K. brevis.

The type material of K. lobata has been borrowed from Leningrad (LE) and detailed investigation has been undertaken to establish its affinities with other species. Finally K. lobata turned out to be the earliest name for this species.

So far I have cited only 3 literature records from Turkey and further confirmation is needed of its presence there.

3. K. nitidula Vel., Fl. Bulg. 1: 611 (1891).

Syn: K. gracilis Pers. var. obscura Vel. in Böhm. Ges. Wiss. 2, 28: 26 (1903);

K. gracilis Pers. var. glabrescens Domin in Mag. Bot. Lap. 3: 266 (1904);

K. nitidula var. obscura(Vel.) Domin in Bibl. Bot. 65: 167 (1907).

Ic: Domin in Bibl. Bot. 65: t. 11 f. 3 (1907).

Laxly caespitose perennial, with short creeping rhizomes. Stem 15-70 cm, erect, somewhat geniculate only at base, rather slender, 2-noded. Leaf blades 5-13 cm x 1-1.5 (-2) mm, slightly convolute, usually glabrous, sometimes slightly ciliate, mainly basal, green or greyish-green; sheaths usually glabrous, only basal sheaths pubescent, occasionally disintegrating into wide ribbons, innovation intravaginal. Panicle 2.5-10 cm x 0.7-1.5 cm, narrowly oblong or cylindrical and dense when young, ovoid-oblong, rather loose and strongly lobed at anthesis. Spikelets 4.1-5.2 mm, with 2-3 florets. Glumes subequal, narrowly lanceolate, acute, bright and largely membranous on margins; lower glume 3.3-4.2 mm; upper glume 3.8-4.7 mm. Lemma 3.5-4.4 mm, membranous, acute to aristate. Palea as long as lemma. Anthers 1.7-2 mm. Fl. 5-7. Steppe, igneous slopes, hillsides, 400-1800 m.

Typus: [Bulgaria] "In collinis calidis supra Belledihan" Skorpil [Holo PRM]

Mainly N. and E. Anatolia, rare in C. Anatolia.

A1(E) Kirklareli: Hasköy to Kizilcaamusellim, A. Baytop (ISTE 6619)!

A2(E) Istanbul: Halkali to Safraköy, 27 v 1894, Azn.!

A2(A) Istanbul: Soganlik to Kartal, 8 vi 1905, Azn.!

A9 Kars: Gölebert near Ardahan, 1800 m, D.30439!

B6 Sivas: Gürün to Pinarbaşi, 35 km from Gürün, 1700 m, Stn. & Hend. 5705!

B10 Van: 3-4 km N.E. of Başkale, 2300 m, D.44520!

C6 Adana d. Saimbeyli: Doganbeyli to Akçal, 1300 m, D.19900!

External distribution: C. Europe, Jugoslavia, Bulgaria, Greece, Aegean, N. and W. Iran, Afghanistan.

4. K. eriostachya Pancic in Verh. Zool.-Bot. Ges. Wien 6: 591 (1856).

Syn: K. cristata var. hirsuta Griseb. ex Trautv. in Acta Horti Petrop. 7, 2: 596 (1881);

K. albovii Domin in Mag. Bot. Lap. 3: 344 (1904);

K. caucasica Trin. ex Domin in Bibl. Bot. 65: 161 (1907);

K. eriostachya subsp. caucasica Domin in Bibl. Bot. 65: 161 (1907);

K. eriostachya subsp. albovii (Domin) Domin in Bibl. Bot. 65: 164 (1907).

Ic: Domin in Bibl. Bot. 65: t. 15 f. 1 (1907);

Fl. Grusii 1: t. 20 (1941).

Caespitose perennial, with short creeping rhizomes. Stem 15-70 cm, rather slender, usually erect somewhat slightly geniculate at base, glabrous and smooth, sometimes hairy below panicle and nodes, with 1-2 nodes. Leaf blades 5-20 cm x 1-3 mm, convolute, linear, acuminate when opened up, covered by pubescent but rather hairless in early stages; upper sheaths glabrous, lower one pubescent; ligule 0.5-1 mm, truncate. Panicle 2-8 cm x 6-15 mm, oblong-cylindrical, often lobed below. Spikelets 4.5-6.5 mm, with 2-3 florets, lanceolate. Glumes subequal, acuminate, usually pubescent green to purple; lower glume 2.9-4.8 mm; upper glume 3.3-5.2 mm. Lemma 3.8-5.8 mm, lanceolate, acuminate, pubescent. Palea almost as long as lemma. Anthers 2.5-4 mm.

Fl. 6-7. Alpine and subalpine meadows, 2360-2500 m.

Typus: /Jugoslavia/ "An den Kämmen des M. Kapaonik bei Kruševac, Serbien" Pančić

E. Anatolia.

A9 Kars: SW slope of Kisir Da., 2500 m, D.30567!

A9 Kars: Digor, N. of Susuz Köy, 2360 m, A. Yürül (EGE 16354)!

External distribution: C. Europe, Italy, Bulgaria, Jugoslavia, Caucasia, W. Iran.

5. K. cristata (L.) Pers., Syn. Pl. 1: 97 (1805).

Syn: Aira cristata L., Sp. Pl. 63 (1753);

Poa cristata (L.) L., Syst. Nat., ed. 12, 2: 94 (1767)!;

Koeleria gracilis Pers., Syn. Pl. 1: 97 (1805);

Dactylis cristata (L.) Bieb., Fl. Taur.-Cauc. 1: 67 (1808)!;

Aira macrantha Ledeb. in Mem. Acad. Sci. Petersb. 5: 515 (1812);

K. macrantha (Ledeb) Schultes in Schultes & Schultes fil.,
Mantissa 2: 345 (1824);

K. cristata var. tenuifolia Boiss., Fl. Or. 5: 575 (1884)!;

K. glaucovirens Domin in Mag. Bot. Lap. 3: 273 (1904);

K. kurdica Ujhelyi in Ann. Hist.-Nat. Mus. Hung. 60: 91 (1968);

K. pilati Ujhelyi in Ann. Hist.-Nat. Mus. Hung. 62: 86 (1970).

Ic: Bor, Fl. Iraq 9: 347, t. 131 (1968);
Hubbard, Grasses 242 (1968).

Densely caespitose perennial. Stem 8-40 (-65) cm, glabrous or slightly hairy, usually erect, sometimes geniculate at base, 2-3-noded. Leaf blades 2-10 (-20) cm x 1-2 mm, flat or involute, green to glaucous, hairy or glabrous, mainly basal; sheaths persistent, glabrous to hairy; ligules up to 2 mm, truncate. Panicle 3.5-9 (-14) cm x 0.5-2 (-4.3) cm, cylindrical to oblong or occasionally lanceolate, rather dense, sometimes interrupted below, silvery-green or yellow. Spikelets 4-6.5 (-7.3) mm, with 2-3 (-4) florets. Glumes unequal, lanceolate, acute to acuminate; lower glume 2-4 mm; upper glume 3-4.7 mm. Lemma 3.3-6.3 mm, lanceolate, acute to acuminate, glabrous. Palea equalling lemma. Anthers 1.7-2 (-3) mm. Fl. 6-7. Steppes, open stony places, meadows, mountain slopes, 0-2400 m.

Typus: "Habitat in Angliae, Galliae, Helvetiae siccioribus"
[Linn. Hb. 85/17!]

Widespread.

A1(E) Kirklareli: Hasköy to Kizilcamüsellim, A. Baytop (ISTE 6619)!

A2(E) Istanbul: Halkali, 4 v 1939, Post!

A3 Bolu: Abant G., 17 vii 1940, Post!

A4 Ankara: Beynam Forest, 1430 m, Y. Akman 8275!

A5 Çorum: Osmancik to Kargi, 600 m, Tobey 2687!

A6 Tokat d. Erbaa: near Kale Köy, 300 m, Tobey 684!

A7 Trabzon: Zigana Da., 2300-2400 m, T. Baytop (ISTE 14289a)!

A9 Kars: 34 km N. of Dogubayazit, 1650 m, D. Spencer 301!

B1 Balikesir: Kaz Da., Sint. 642!

B2 Izmir: Boz Da., 1500 m, E. Erben & K.P. Buttler 17429!

B3 Eskişehir: Turkmen Da., 790 m, T. Ekim 2260!

B4 Ankara: nr. Tuz G. 25 km N. of Koçhisar, 925 m, McNeill 338!

B5 Nigde: Nevsehir, 1200 m, D.19089!

B6 Sivas: 10 km S. of Gürün, Gökpinar, 1800 m, F. Sorger 71-50-27!

B7 Tunceli: Munzur Da., above Ovacik, 2300 m, D.31308!

B8 Erzurum: above the Ataturk Univ. Campus, 1940-1980 m, A. Tatli 1522!

B9 Bitlis d. Tatvan: Nemrut Da., 2220 m, H. Birand & K. Karamanoglu 234!

C2 Denizli: Honaz Da., 2300 m, E. Tuzlaci (ISTE 26509)!

C3 Isparta: Egrioir, Yaka Köy, 1600-1980 m, H. Peşmen & A. Güner 1617!

C4 Konya: Bozkir, Küçüksu, 1800 m, R. Çetik et al. 269!

C5 Nigde: 22 km E. of Ulukişla, 1200 m, F. Sorger 62-66-7!

C6 Adana: Karsanti, Sogukoluk, 1420 m, E. Yurdakulol 10239!

C8 Mardin: 2 km E. of Mardin, 1150 m, D.28440!

C10 Hakkari: Zap river, 1.7 km from turning to Yüksekova, J. Trelawny 1306!

External distribution: N., W., and C. Europe, Mediterranean (except N. Africa), Crimea, Caucasia, Iran, Transcaspia, Turkestan, S. Russia, Siberia, Afghanistan, W. Pakistan.

13. DESCHAMPSIA P. Beauv., Ess. Agrost.: 91 (1812)

Densely or laxly caespitose perennial. Leaf blades flat or setaceous. Ligule membranous. Inflorescence a lax panicle. Spikelets with 2 (-3) hermaphrodite florets. Glumes subequal, acute, persistent; lower glume 1-veined; upper glume 3-veined. Lemma 5-veined, truncate-denticulate at apex, surrounded by short callus hairs at base, awned from dorsal; awn straight or geniculate, sometimes twisted in lower half. Palea 2-veined, keeled, scabrid on keels, bidentate at apex. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis elliptic-oblong, glabrous, dorsally compressed.
Typa: D. caespitosa (L.) Beauv.

Key to Species

1. Awns of lemmas 5.5-8 mm, geniculate and twisted in lower half; leaf blades 0.3-0.8 mm wide ..... 1. flexuosa
1. Awns of lemmas 1.7-4.5 mm, straight or slightly bent, not twisted in lower half; leaf blades 2-5 mm wide ..... 2. caespitosa

1. D. flexuosa (L.) Trin. in Bull. Acad. Petersb. 1: 66 (1836).
Syn: Aira flexuosa L., Sp. Pl. 65 (1753).
Ic: Trin., Sp. Gram. 3 (2): 258 (1836);
Hubbard, Grasses 250 (1968).

Laxly or densely caespitose perennial, with short creeping rhizomes. Stem 40-60 cm, erect or bent at base, slender, smooth. Leaf blades up to 15 cm x 0.7-0.8 mm, setaceous, green, glabrous; ligule 1-3 mm, obtuse. Panicle 6-15 cm x 3-5 cm, open, lax; branches 3-9 cm, usually patent; pedicels 3.5-8 (-17) mm, smooth or sparsely aculeolate. Spikelets 4.5-6.5 (-7) mm, usually oblong, somewhat slightly wedgeshaped,

purplish or silvery, with 2 florets. Glumes smooth, keeled; lower glume 4.1-6 mm, ovate; upper glume 4.5-7 mm, elliptic-ovate. Lemma 4.5-6 mm, ovate-oblong, rounded on back, awned above base; callus hairs c. 1.3-1.5 mm; awn 5.5-8 mm, geniculate and twisted in lower half. Palea ± equalling lemma. Rhachilla prolonged by less than ¼ of upper floret. Anthers 2.2-3.4 mm. Grains enclosed by the slightly hardened lemma and palea. Fl. 6-8. Dry edge of Pinus sylvestris forest, rocky igneous slopes, 1097-2150 m.

Typus: "Habitat in Europae petris, rupibus" [Hb. Linn. 85/11!]

W. & N. Anatolia.

A6 Ordu: Erbaş above Çambaşi, 2000 m, C. Tobey 1407!

A7 Giresun: Balaban Da. above Tamdere, 1700-1800 m, D.20652!

Gümüshane: Argyri Da. (12.5 km S.W. of Gümüshane, Sint. 1894: 6259!

A8 Trabzon: Soganli Pass, 2134 m, P. Furse 4037!

A9 Kars: 6 km from Sarikamiş to Karakurt, 2150 m, D.46557!

B1 Balikesir: Kaz Da., 1097 m, E. Anglia Exped. B.26!

External distribution: N.W. Africa, W. and N. Europe, Aegean, Caucasia, Siberia.

2. D. caespitosa (L.) Beauv., Ess. Agrost.: 91 (1812).

Syn: Aira caespitosa L., Sp. Pl. 64 (1753);

D. caespitosa var. colorata Griseb., Spic. 2: 457 (1844).

Ic: Trin.,Sp. Gram. 3 (22): 253 (1836);

Hubbard, Grasses 252 (1968).

Densely caespitose perennial. Stem 28-110 cm, erect or slightly bent at base, smooth. Leaf blades 9-30 cm x 2-5 mm, linear, acuminate, sometimes convolute, green or glaucous, ribbed above, aculeolate on margins and ribs, smooth beneath; ligule 3-15 mm, acute. Panicle 10-30 cm x 1.5-29 cm, open, lax, ovate to oblong; branches 2-13 cm, very slender, rough, spreading; pedicels 1-9 mm, smooth or aculeolate.

Spikelets 3-6 mm, silvery, purplish or stramineous, lanceolate to narrowly oblong. Glumes equaling spikelet or slightly shorter; lower glume 3-4.2 mm; upper glume 3.5-5 mm. Lemma 3.1-4.6 mm, enclosed in glumes or their tips protruding, rounded on back, oblong, with a fine straight awn from just above the base; awn 2-4.5 mm, not twisted. Palea slightly shorter than lemma. Anthers 1.5-2 mm. Rhachilla prolonged by up to $\frac{1}{2}$ of upper floret. Grani enclosed by the firm lemma and palea. Fl. 6-8. Alpine and subalpine water meadows and near stream, 1000-3000 m.

Typus: "Hab. in Europae partis cultis et fertilibus" [Hb. Linn. 85/8!]

Widespread in Anatolia.

A2(A) Istanbul: Beykoz, 4 vi 1900, Azn.!

A3 Bolu: Abant Göl, 1350 m, A. & T. Baytop (ISTE 1840)!

A4 Kastamonu: N. of Ilgaz Da., 2100 m, D.38361!

A7 Trabzon d. Maçka: Hamsiköy, Balahor Y., 1650 m, R. Ansin 533!

A8 Rize: Çamlihemşin, Amlakit Y., 2200-2720 m, A. Güner 1069!

A9 Kars: Yalnizçam, 1900 m, D.29662!

B5 Yozgat: 5 km N.W. of Bogaz Kale, 1000 m, E. Hennipman et al. 1961!

B6 Maraş: Çardak Kandil Da., 1800 m, D.20259!

B7 Erzincan: 48 km from Erzincan to Sivas, M. Tanker (ISTE 5624)!

B8 Erzurum: Büyük Ejder Da nr. Sütlüce, 2300 m, F. Holtz et al. 945!

B9 Van d. Hoşap: Kepir Da., 2900 m, D.23333!

C5 Adana: Karanfil Da., F.A. Bisby 98!

C10 Hakkari: Sat Da. (above Yüksekova), 2700 m, Duncan & Tait 114!

External distribution: W., N. and C. Europe, Mediterranean (except E. Mediterranean), Caucasia, Turkistan, E. Asia, N. America.

14. MOLINERIELLA Rouy, Fl. Fr. 14: 102 (1913)

Annual. Leaf blades flat to folded. Ligule membranous. Inflorescence a rather lax panicle. Spikelets with 2 florets, rather small, laterally compressed. Glumes subequal, keeled, shorter than spikelet; lower glume 1-veined; upper glume 3-veined. Lemma 5-7-veined, obtuse at apex, somewhat truncate, awnless or dorsally awned. Palea slightly shorter than lemma, 2-veined, bifid at apex. Rhachilla disarticulating above glumes. Stamens 3. Caryopsis elliptic-oblong.

Type: M. minuta (L.) Rouy

M. minuta (L.) Rouy, Fl. Fr. 14: 102 (1913).

Syn: Aira minuta L., Sp. Pl. 64 (1753);

Airopsis minuta (L.) Desv. in J. Bot. (Paris) 1: 201 (1808);

Molineria minuta Parl., Fl. Ital. 1: 237 (1848);

Periballia minuta (L.) Aschers. & Graebn., Syn. Mitteleur. Fl. 298 (1898-1902).

Ic: Fiori, Ic. Fl. Ital. 1: 26, f. 223 (1895);

Zangheri, Fl. Ital. 2: 185, f. 6753-6754 (1976).

Annual. Stem 3-20 cm, usually erect or sometimes geniculate at base, slender, smooth, tufted or solitary. Leaf blades 1-4 cm x 1-2 mm, linear, acuminate, scabrid on margin; sheaths smooth, somewhat inflated; ligule 2-2.5 mm, elongate, sometimes lacerate. Panicle 1.5-4 cm x 1.2-4 cm, ovate; branches 1.5-3 cm; pedicels 2-7.5 mm, glabrous, clavate. Spikelets 1.5-2 mm, usually purplish, shiny. Glumes ovate-lanceolate, subobtuse to acute; lower glume 1.3-1.6 mm; upper glume 1.5-1.7 mm. Rhachilla segment c. 0.7 mm. Lemma 1.3-1.8 mm, ovate scarious at apex, awnless, shortly hairy at base. Anthers 0.1-0.3 mm. Fl. 3-4. Dry open places, on metamorphic rock, with Quercus coccifera, up to 300 m.

Typus: [Spain] "Hab. in Hispania", Loefling. [Hb. Linn. 85/4!]

N.W. Turkey, W. Anatolia.

A1(E) Edirne: Keşan to Ipsala, 20 km from Keşan, A. Baytop (ISTE 17654)!

Tekirdag: 2 km from Corlu to Seymen, A. Baytop (ISTE 17637)!

A2(E) Istanbul: Şişli to Kagithane, 30 iii 1891, Azn.!

A2(A) Istanbul: Çamlica, 26 iv 1919, Azn.!

B1 Çanakkale: Kaz Da., Sint. 1883: 1231!

C2 Aydin: Çine to Yatagan, 300 m, D.25218!

External distribution: S. Europe.

15. ANTINORIA Parl., Fl. Palerm. 1: 94 (1845)

Annual. Leaf blades flat. Ligule membranous. Inflorescence a lax panicle. Spikelets laterally compressed, with 2 florets, very small, upper floret stipitate. Glumes nearly equal, keeled, longer than florets; lower glume 1-veined; upper glume 3-veined. Lemmas shorter than glumes, hyaline, 3-veined, widest near apex, not completely truncate, with three-lobed apex, middle lobe longer and larger than others, awnless. Palea 2-veined, hyaline. Rhachilla disarticulating above glumes, not prolonged. Lodicules 2. Stamens 3. Caryopsis obovoid, rounded on abaxial side, flat on adaxial.

Type: A. agrostidea (A.P. de Candolle) Parlatore

A. insularis Parl., Fl. Palerm. 1: 94 (1845).

Syn: Airopsis insularis (Parl.) Nyman, Syll. Fl. Europaea 411 (1854-1855);

Aira insularis (Parl.) Boiss., Fl. Or. 5: 528 (1884).

Ic: Fiori, Ic. Fl. Ital. 1: 26, f. 222 (1895) as Aira insularis.

Annual. Stem 5-30 cm, slender, erect or ± geniculately ascending from base, glabrous, shiny. Leaf blades 2-12 cm x 1-2.5 mm, linear, acuminate, scabrid on upper surface and margin; uppermost sheath sometimes inflated; ligule 1.5-3 mm, elongate. Panicle 2-10 cm x 0.5-7 cm, ovate; branches patent 1.5-4 cm; pedicels 1.5-3.8 mm, clavate, glabrous. Spikelets 1.3-1.6 mm, green to shiny. Glumes ovate, obtuse, scabridulous on keel. Lemma 0.8-1 mm, hyaline, glabrous. Palea linear, as long as lemma. Anthers 0.5-0.7 mm. Fl. 4-6. Damp places on mountains.

Syntypes: [Sicily] "Piano de'Greci al gurgo di Ddingoli. Cotrano al gurgo lo Drago e al gurgo Lungo", Gussone.

W. Anatolia.

B1 Izmir: Mont. Pagus, iv 1866, Bal. 705!

External distribution: Corsica, Sardinia, Italy, Sicily, Greece, Aegean. Mediterranean element.

16. AIRA L., Sp. Pl. 63 (1753)

Annual. Leaf blades usually convolute. Ligule membranous. Inflorescence a very lax to dense spike-like panicle. Spikelets very small, with 2 hermaphrodite florets, laterally compressed. Glumes equal, membranous, persistent, usually longer than florets; lower glume 1-veined; upper glume 3-veined. Lemma 5-veined, bifid at apex, with a dorsal geniculate awn from below the middle, or sometimes lower floret awnless. Palea 2-veined, shorter than lemma, bifid at apex. Rhachilla not prolonged, disarticulating above glumes and between florets. Lodicules 2, lanceolate. Stamens 3. Caryopsis oblong-elliptic, longitudinally sulcate on adaxial face, glabrous.

Type: A. caryophylle L.

Key to Species

1. Panicle rather dense, spike-like; branches up to 1 cm ..... 1. praecox

1. Panicle very lax; branches 2-5 cm

  2. Spikelets 1.5-2.5 mm; pedicels more than twice as long as spikelet ..... 2. elegantissima

  2. Spikelets 2.5-3.5 mm; pedicels less than twice as long as spikelets ..... 3. caryophyllea

1. A. praecox L., Sp. Pl. 65 (1753).

Ic: Lowe, Nat. Hist. Brit. Grasses t. 23 (1891); Hubbard, Grasses 260 (1968).

Annual. Stem 2-9 cm, slender, erect to procumbent, 2-3 noded. Leaf blades 1-4 cm x 0.5-1.5 mm, convolute, glabrous; sheaths smooth, slightly inflated; ligule 1-3 mm, obtuse at apex. Panicle 5-20 mm x 1.5-6.5 mm, narrowly oblong, very dense; branches patent, up to 1 cm;

pedicels 1-4.2 mm. Spikelets 2.5-3.5 mm, oblong. Glumes lanceolate, acute, shiny, slightly scabridulous on keel. Lemma nearly equaling glumes or slightly shorter, scabridulous on upper half, with short hairs at base; awn 3.5-4.1 mm, twisted in lower half, geniculate, arising lower $\frac{1}{3}$ of lemma. Anthers 0.2-0.3 mm. Fl. 5. Sea level.

Described from: "In Europae australioris campis arenosis inundatis" /Hb. Linn. 85/20!/

N.W. Anatolia.

A2(A) Istanbul: Çatal Da., v. 1865, Rene du Parquet (BM)!

External distribution: N., W. & C. Europe, Spain, Portugal, S. France, Italy, Crimea. Introduced into N. America.

A new record for Turkey, and presumably adventive.

2. A. elegantissima Schur in Verh. Mitt. Siebenb. Ver. Naturw. 4 (Sert. Fl. Transs.): 85 (1853).

Annual. Stem 5-40 cm, solitary to fasciculate, erect or decumbent, somewhat geniculately ascending, 1-4-noded, slender, smooth. Leaf blades 0.4-8 cm x 0.2-1 mm, narrowly linear, acute, usually convolute, glabrous; sheaths scabrid; ligule 1.5-3.5 mm, lanceolate, acute. Panicle 3-10 cm x 1-7 cm, ovate, rather lax; branches 2-5 cm; pedicels 2-7.5 mm, scabrid, clavate. Spikelets 1.5-2.5 mm. Glumes ovate-lanceolate, acuminate, scabridulous on keel, shiny. Lemma $\frac{2}{3}$ x as long as glumes, brownish, scabrid, with short hairs at base; awn of upper floret 2.5 mm, arising below the middle. Lower floret usually awnless, or rarely awned. Anthers 0.3-0.5 mm.

Key to subspecies

1. Only the upper lemma with a dorsal awn; lower lemma acute ..... subsp. elegantissima

1. Both lemmas with a dorsal awn; lemmas bifid .... subsp. ambigua

. subsp. elegantissima

Syn: A. elegans Willd. ex Gaudin, illegit.;

A. capillaris Host, Gram. Austr. 4: 20 (1809).

Ic: Reichb., Ic. Fl. Germ. 1: t. 94 f. 181 (1850).

Fl. 4-5. On sand dunes, in open forest, on volcanic conglomerate, 3-30 m.

Described from: Transsilvania, Turkey-in-Europe, N. & S. Anatolia, Islands.

A2(E) Istanbul: Sariyer, Belgrad Forest, F. Yaltirik 2433!

A3 Bolu: Düzce, Kühne 2523!

A5 Sinop: Inceburun, 30 m, Tobey 1627!

C3 Antalya: Manavgat, Kara point, 3 m, D.25833!

Is: Psara: 'Ahladhokambos', 20 m, W. Greuter 10 820!

External distribution: S. & C. Europe, N.W. Africa, Cyrenaica, Crimea. Introduced into N. America.

subsp. ambigua (De Notaris) M. Dogan (ined.)

Syn: A. ambigua De Notaris in Ann. Sci. Nat. Ser. 3, 5: 365 (1846);

A. capillaris Host subsp. ambigua (De Not.) Arcangeli Compend. Fl. Ital. 775 (Torino 1882);

A. elegans subsp. ambigua (Arcangeli) Holub in Preslia 36, 3: 251 (1964);

A. byzantina Albers in Willdenowia 9: 283 (1979)!

Ic: De Notaris in Mem. Accad. Sci. Torino, Ser. 2, 21: 382, t. 3 (1864).

Fl. 4-6. Along dry stream beds, dry slopes and grassland, open places caused by fire, sandy soil, 0-1400 m.

Typus: [Italy] "Habui semina specimenaque in pascuis secus Ticinum lecta a cl. inventore".

N. & W. Anatolia, Islands.

A8 Rize: Rize, v 1866, Bal. 706!

B1 Balikesir: Kaz Da., Sint. 1883: 103!

B1 Izmir: Selçuk, Belevi, S. Oflas 29!

B2 Kütahya: Simav, Kiçir to Akdag, 1100 m, Coode & Jones 2682!

B3 Eskisehir: Kara Kütük, 1300-1400 m, T. Ekim 340!

Is. Lesvos: Angliki Skala, 9 km S.E. of Kalloni, at mouth of Kalami river, 1 m, J.R. Edmondson 2297!

Tokmakia island (N.E. of Lesvos) Barbalias, 0-50 m, J.R. Edmondson 2548!

External distribution: Aegean, Caucasia, N. & N.W. Iran.

3. A. caryophyllea L., Sp. Pl. 66 (1753).

Ic: Lowe, Nat. Hist. Brit. Grasses t. 21 (1858);
Hubbard, Grasses 258 (1968).

Annual. Stem 18-25 cm, fasciculate or solitary, erect to geniculately ascending, slender, glabrous. Leaf blades 0.5-3 cm x 0.2-0.3 mm, convolute, glabrous, greyish-green; sheaths retrorsely scabridulous; ligule up to 5 mm, lanceolate, acute. Panicle 4-6 cm x 3-5 cm, rather lax; branches 2-4 cm, erecto-patent, bearing spikelets only at ends; pedicels 2-4 mm, glabrous, clavate. Spikelets 2.5-3.5 mm, ovate to oblong, silvery or tinged with purple. Glumes ovate-elliptic, acute at apex, scabridulous on keel, shiny. Lemma $\frac{3}{4}$ x as long as glumes, narrowly ovate, scabridulous especially in upper half, with short hairs at base, brownish in colour; awn 3-3.3 mm, geniculate and twisted in lower half, arising lower $\frac{1}{3}$ of lemma. Anthers 0.3-0.6 mm. Fl. 4-6. Dry sandy places, 0-150 m.

Described from: "In Angliae, Germaniae, Galliae glareosis"

[Hb. Linn. 85/22!]

Turkey-in-Europe, W. Anatolia, Islands.

A1(E) Edirne: Keşan, Griseb.!

B1 Izmir: Izmir, sea shore, iv 1827, Fleischer!

Is. Rhodos: Santo Elia Montagne de Salakos, 4 vi 1870, Bourgeau!

External distribution: N., C.& W. Europe, Mediterranean, Crimea, S. & C. Russia. Introduced into N. America.

17. CORYNEPHORUS P. Beauv., Ess. Agrost. 90, t. 18 f. 2 (1812)

Annual. Leaf blades convolute. Ligule membranous. Inflorescence a lax panicle. Spikelets laterally compressed, with 2 hermaphrodite florets. Glumes subequal, longer than florets; lower glume 1-veined; upper glume 3-veined. Lemma 1-veined, scarious, with jointed subdorsal awn; callus hairy. Awn articulated near the middle, with a ring of scabrid hairs at the joint; lower part of awn dark brown in colour, twisted; upper part white, clavate. Palea slightly shorter than lemma, 2-veined. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis elliptic.

Type: C. canescens (L.) Beauv.

C. divaricatus (Pourret) Breistr. in Proc.-Verb. Soc. Dauph. Etudes Biol. (Grenoble) ser. 3, 17: 3 (1950).

Syn: Aira divaricata Pourret in Mem. Acad. Sci. Toulouse 3: 307 (1788); Corynephorus articulatus (Desf.) Beauv., Ess. Agrost. 159 (1812); Anachortus articulatus (Desf.) Jiras. et Chrlek in Preslia 34: 383 (1962).

Ic: Fiori, Ic. Fl. Ital. 1: 27, f. 225 (1895) as Aira articulatus Zangheri, Fl. Ital. 2: 185, f. 6757 (1976).

Annual, growing in clusters. Stem 7-42 cm, glabrous, smooth, slender, with 3 nodes. Leaf blades up to 4.5 cm x 0.5 mm, scabrid; sheaths often purplish; ligule up to 8 mm, subacute. Panicle 2-10 cm x 0.5-7 cm, rather open; branches patent or erecto-patent, 3-6 cm, bearing spikelets only in upper half; pedicels 1.2-3 mm, slightly scabrid. Spikelets 4-4.5 mm, usually purplish. Glumes lanceolate, acute, scabrid on keel; upper glume 3.7-4.3 mm; lower glume 3.1-3.9 mm. Lemma 1.5-2 mm, shortly bifid at apex; subdorsal awn 2.5 mm; callus hairs $\frac{1}{4}$-$\frac{2}{3}$ as long as lemma. Anthers 0.4-0.5 mm. Fl. 4-6. On sandy coastline, sea level - 1100 m.

Typus: /France/ A Narbonne, aux environs de Fontlaurier, Pourret.

Outer Anatolia, Islands.

A2(E) Istanbul: Florya, 10 vi 1894, Azn.!

A7 Trabzon: 20 km W. of Trabzon, 2 m, E. Hennipman et al. 1749!

B2 Izmir: Boz Da., 1100 m, E. Wall 156!

C1 Aydin: Dilek peninsula, Dipburun Kumulu, 2 m, T. Uslu 3542!

C3 Antalya: 6 km W. of Antalya, 10 m, T.A. Tengwall 415!

C5 Mersin: 3 km E. of Mersin, 2 m, E. Hennipman et al. 1178a!

Is. Kos: N. of the island, sea level, K.P. Buttler 18034!

External distribution: N. Africa, S. Europe, Caucasia, Transcaspia.

18. HOLCUS L., Sp. Pl. 1047 (1753)

Annual or perennial. Leaf blades flat. Ligule hyaline. Inflorescence a rather dense panicle. Spikelets with 2 florets, laterally compressed, lower floret hermaphrodite and awnless, upper one usually male with a subterminal awn. Glumes subequal, membranous, longer than florets, strongly keeled; lower glume 1-veined, with a seta or not; upper glume 3-veined, always with an apical seta. Lemma 5(-3)-veined, awnless in the lower floret, shortly awned from below the top in the upper floret, coriaceous, shiny. Palea membranous, 2-keeled, equaling lower lemma, shorter than upper lemma. Rhachilla shortly prolonged, disarticulating below the glumes. Lodicules 2. Stamens 3. Caryopsis laterally compressed, elliptic in side view.

Type: H. lanatus L.

Key to Species

1. Perennial with non-flowering shoots; only the upper glume with an apical seta ..... 1. lanatus
1. Annual without non-flowering shoots; both glumes with an apical seta ..... 1. annuus

1. H. lanatus L., Sp. Pl. 1048 (1753).

Ic: Kulczyński, Atlas Fl. Polsk. 4 (3): 419 (1936); Hubbard, Grasses 262 (1968).

Perennial, caespitose. Stem 20-110 cm, erect to geniculately ascending from base, slender to rather stout, pubescent at nodes and below them. Leaf blades 4-20 cm x 3-10 mm, linear, acuminate, pubescent on both surfaces; ligule up to 4 mm, truncate, denticulate. Panicle 5-15 cm x 2-4 cm, oblong; branches 2.5-4.5 cm, patent; pedicel 1-4 mm, aculeolate. Spikelets 3-5 (-6) mm, oblong to lanceolate. Glumes lanceolate, obtuse, ciliate on keel and veins, scabrid or puberulent

to villous on upper part of keel; upper glume equaling spikelet, with an arista from sinus (up to 1 mm). Rhachilla segments 0.5-0.7 mm, glabrous. Lemma 1.5-2 mm, enclosed by glumes, shiny, usually glabrous, somewhat slightly scabrid on middle vein, truncate at apex; lower lemma without an awn, with a few long hairs at base (c. 1 mm) equaling palea; upper lemma with a c. 2 mm awn arising from just below apex, usually recurved, shortly hairy at base. Palea $\frac{2}{3}$ as long as lemma. Anthers 1.5-1.7 (-2) mm. Fl. 5-8. Sandy soil near sea and damp high mountain slopes, 1-2000 m.

Typus: "Hab. in Europae pascius arenosis" [Hb. Linn. 1212/10!]

Turkey-in-Europe, N. & W. Anatolia.

A1(E) Tekirdag: 7 km from Çorlu to Seymen, A. Baytop (ISTE 22381)!

A1(A) Balikesir: Avsa adaşi, Araplar köyü, T. Aveigil (ISTE 6810)!

A2(E) Istanbul: Alibey Köy, 17 vi 1894, Azn.!

A3 Bolu: Koru Motel, 850 m, P. Uotila 20132!

A5 Amasya: Suluova, Karakilise köy, 1500 m, K. Alpinar (ISTE 38 388)!

A6 Samsun: Kirazlik, 1 m, C. Tobey 805!

A6 Ordu: 8 km from Ünye to Fatsa, 160-180 m, Hub.-Mor. 16431!

A7 Trabzon: N. slope of Soganli Da., above Çaykara, 1300 m, D.32073!

A8 Rize: 5 km from Ikizdere to Ispir, 2000 m, Stn. & Hend. 6229!

B1 Izmir: Bozdag köy towards Göloük, G. Regel (ISTE 12347)!

B2 Izmir: d. Ödemiş: between Alem gedigi and Bey Da., T. Uslu 5743!

External distribution: Europe and most of Mediterranean, Georgie. Introduced into N. America.

2. H. annuus Salzm. ex C.A. Mey., Verz. Pfl. Cauc.: 17 (1831).

Syn: H. setiglumis Boiss. & Reuter, Diagn. Pl. Nov. Hisp. 27 (1842).

Ic: Zangheri, Fl. Ital. 2: 185, f. 6740-6741 (1976).

Annual. Stem 13-86 cm, erect or slightly geniculate at base, tufted

or solitary, with 3-4 villous nodes. Leaf baldes 3-14 cm x 2-6 mm, linear, acuminate, puberulent; sheaths puberulent like leaves; ligule 3-6 mm, oblong, lacerate. Panicle 2.5-6 cm x 1-1.5 cm, oblong-elliptic, rather dense, somewhat lobed; branches 0.8-1.5 cm, patent; pedicels 1-4 mm, aculeolate. Spikelets 3-3.9 mm (excl. seta), lanceolate. Glumes dorsally ciliate, terminating in an aristate point; lower glume 2.5-2.8 mm, aristate point 1.1-1.5 mm; upper glume 3.2-3.9 mm, wider, aristate point 2.2-2.5 mm. Rhachilla segments 0.5-0.7 mm, glabrous. Lower floret awnless; palea equaling lemma; upper floret subterminal awn 2-2.3 mm, and its palea half as long as its lemma. Anthers 0.5-0.7 mm. Fl. 4. On the coast and in P. nigra forest, 0-690 m.

Typus: "In insula Sara" C.A. Meyer.

W. and S. Anatolia, Islands.

A2(A) Istanbul: Maltepe, 1 v 1898, Azn.!

B1 Izmir: Karaburun, G. Bocquet 2063

C1 Aydin: Koçarli, between Mersinbelen and Yigintaş, 690 m, T. Uslu 5144!

C2 Aydin: Çine, 310 m, T. Uslu 5151!

C3 Antalya: Kumköy, between Antalya and Serik, 5 m, D.25703!

C4 Icel: Anamur, v 1872, Peronin 100!

Is. Kos: Tybaki, A. Hansen et al. 831!

External distribution: Mediterranean area. Mediterranean element.

19. CALAMAGROSTIS Adans., Fam. Pl. 2: 31 (1763)

Perennial. Leaf blades flat or convolute. Ligule membranous. Inflorescence usually lax, occasionally rather dense panicle. Spikelet with 1 floret. Glumes ± lanceolate, acuminate or shortly aristate; lower glume 1-veined; upper glume (1-) 3-veined. Lemma shorter than glume, hyaline or membranous, 3-5-veined, with dorsal or subterminal awn; callus hairs usually as long as lemma or longer, sometimes up to ½ as long as lemma. Palea hyaline, 2-veined, keeled. Rhachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis elliptic to oblong.

Type: Arundo calamagrostis L. = C. lanceolata Roth. = C. canescens (Web.) Roth.

Literature:

Nygren, A. 1946. The genesis of some Scandinavian species of Calamagrostis. Hereditas 32: 131-262.

Nygren, A. 1962. Artificial and Natural Hybridization in European Calamagrostis. Symb. Bot. Upsal. 17 (3): 1-105.

Key to Species

1. Lemma at least ¾ x as long as glumes; callus hairs shorter than lemma; rhachilla prolonged into a hairy stipe
   2. Glumes acute to acuminate; leaf blades with short shiny hairs at base, covered by fine hairs ..... 4. arundinacea
   2. Glumes shortly aristate; leaf blades without any hairs at base, glabrous ..... 5. parsana
1. Lemma ½-⅔ as long as glumes; callus hairs longer than lemma; rhachilla not prolonged beyong floret
   3. Lemma 5-veined; glumes lanceolate ..... 1. canescens
   3. Lemma 3-veined; glumes linear-lanceolate

4. Glumes equal, 4.5-6 mm; lemma usually dorsally awned somewhat above the dorsal ..... 2. epigejos

4. Glumes unequal, 4-4.5 (-6) mm; lemma awned near summit ..... 3. pseudophragmites

1. C. canescens (Weber) Roth, Tent. Fl. Germ. 2 (1): 93 (1789).

Syn: Arundo canescens Weber in Wigg., Prim. Fl. Hols.: 10 (1780);
C. lanceolata Roth, Tent. Fl. Germ. 1: 34 (1788).

Ic: Hubbard, Grasses 282 (1968);
Kulczynski, Atlas Fl. Polsk. 4 (2): 409 (1932).

Laxly caespitose, rhizomatus perennial. Stem 50-120 cm, erect or slightly spreading, slender and smooth. Leaf blades 6-20 cm x 3-6 (-8) mm, linear, acuminate, flat to convolute, usually shortly hairy on upper surface and rough on margins, closely veined; sheaths smooth; ligule 1-7 mm, obtuse, usually lacerate at maturity. Panicle 5-23 cm x 1.5-6 cm, lanceolate-oblong, rather lax, flexuous or finally nodding; pedicels 0.7-3 mm. Spikelets 4.5-6 (-7) mm, usually purplish-brown or somewhat greenish-yellow. Glumes subequal, narrowly lanceolate, acuminate, 1-veined, slightly scabrid. Lemma broadly lanceolate, 5-veined, with 2 teeth at apex, with a very short subterminal awn; awn sometimes arising from sinus, up to 1 mm; callus hairs longer than lemma. Palea $\frac{2}{3}$ x as long as lemma. Anthers about 1.5 mm, purple, with well developed pollen.

Typus: /Germany/ "R. in tortolis prope Pagum Stifel"

E. Anatolia.

B8/B9 Mus: Nur im Hochlande auf Trachyt, bei Ssurp Garabied im Pascbalik Musch..... 1372 m, C. Koch

External distribution: Europe, Crimea, Caucasia, C. and S. Russia.

The record needs confirmation.

2. C. epigejos (L.) Roth, Tent. Fl. Germ. 1: 34 (1788).

Syn: Arundo epigejos L., Sp. Pl. 81 (1753).

Ic: Lowe, Nat. Hist. Brit. Grasses t. 15 (1891);

Hubbard, Grasses 284 (1968).

Caespitose perennial, with creeping rhizomes. Stem 60-100 (-200) cm, erect, rather stout, smooth and glabrous. Leaf blades 11-40 cm x 4-9 mm, linear, acuminate, flat, glabrous, scabrid on margins, closely veined; sheaths smooth; ligule 4-10 (-12) mm, membranous, becoming lacerate. Panicle 8-30 cm x 1.5-6 cm, lanceolate-oblong, dense; branches up to 11 cm, aculeolate, patent. Spikelets 5-6 (-7) mm, densely clustered, purplish-brown or green. Glumes ± equal, lanceolate, acuminate; lower glume 1-veined; upper glume 3-veined. Lemma about ½ as long as glumes, membranous, 3-veined, bifid, with a dorsal or subterminal awn (c. 1-2.5 mm); callus hairs much exceeding lemma. Palea up to ⅔ as long as lemma. Anthers 1.6-2.2 mm.

Fl. 6-7. Water meadows, mountain slopes, forests, 1000-3048 m.

Typus: "Hab. in Europe collibus aridis", [Hb. Linn. 97/11!]

Turkey-in-Europe, N.W. Anatolia, W. & E. Anatolia.

A1(E) Tekirdag: between Saray and Midye, T. Baytop (ISTE 11830)!

A2(E) Istanbul: Paşabahce, 19 vii 1939, Azn.!

A3 Bolu: Abant Göl, 1350 m, A. Baytop (ISTE 33663)!

A9 Kars: Yagmurlu Da., above Sarikamiş, 2300 m, D.32606!

B9 Bitlis: Nemrut Da. N.W. of Büyük Göl, 2500 m, A. Tatli 1592!

C1 Aydin: Soke, Kayaş nr. TRT antenna, 465 m, T. Uslu 3454!

C10 Hakkari: Yüksekova, 1950 m, Duncan & Tait 215!

External distribution: Europe, Crimea, Caucasia, Iran, Transcaucasia, Turkestan, Afghanistan, C. and S. Russia, E. Asia.

Introduced into N. America.

3. C. pseudophragmites (Haller fil.) Koeler, Descr. Gram. Gall. Germ. 106 (1802).

Syn: Arundo pseudophragmites Hall. fil. in Arch. Bot. (Roemer) 1 (2): 11 (1797);

Arundo glauca M. Bieb., Fl. Taur.-Cauc. 1: 79 (1808);

C. persica Boiss., Diagn. ser. 1 (7): 120 (1846);

C. littorea (Schrad.) Beauv. var. persica Boiss., Fl. Or. 5: 525 (1884).

Ic: Reichb., Ic. Fl. Germ. 1: t. 83, f. 152 (1850);

Bor, Fl. Iraq 9: 301, t. 108 (1968).

Caespitose perennial, with creeping rhizomes. Stem 50-120 cm, erect, rather stout, smooth and glabrous. Leaf blades 7-35 cm x 2-8 mm, linear, acuminate, usually flat, somewhat convolute, rather scabrid on margins, glaucous; sheaths glabrous; ligule 4-10 mm, acute, lacerate. Panicle 5-26 cm x 1-8 cm, usually lax, somewhat dense, nodding; branches aculeolate. Spikelets 4-4.5 (-6) mm, usually brownish-purple. Glumes unequal; upper glume 3.1-5 mm; lower glume 3.7-6.5 mm. Lemma 2.1-3.2 mm, 3-veined, bifid, with a subterminal 1.3-2 mm awn. Anthers 1.3-2 mm. Fl. 6-8. Wet places, sandy river terrace, mountain forests, on volcanic ash, 790-2000 m.

Typus: [Switzerland] "Legi primum ad aggerem areae, inqua ligna Civitatis Bernensis congerunter, in Marzihli dein Morellius a ripa fluminis Schwarzwasser", Haller f.

Widespread.

A1(E) Edirne: nr. Meriç River, A. Baytop (ISTE 13998)!

A2(A) Kocaeli: Gölcük, C. Regel (ISTE 14852)!

A4 Bolu: Gerede, Aktaş Ormani, 1150 m, O. Ketenoglu 346!

A5 Amasya: Kirazli dere, M. Tanker (ISTE 4562)!

A9 Artvin: Hopa, Grossheim I: Map 96

B2 Kütahya: Murat Da., 1400 m, D.36670!

B3 Eskişehir: Türkmen Da., Ilica cayir, 900 m. T. Ekim 2230!

B4 Ankara: E. of Lalahan, R. Çetik 183!

B5 Nevşehir: Ürgüp, 1200-1300 m, D. 19121!

B6 Maraş: Çardak, Kandil Da., 1800 m, D.20257!

B7 Erzincan: 12 km from Erzincan to Trabzon, M. Tanker (ISTE 5589)!

B8 Bingöl: between Muş and Solhan, T. Gözler (ISTE 15835)!

B9 Van: Gürpinar, 1750 m, D.44686!

B10 Kars: nr. Taşlica, 10 vii 1906, Azn.!

C2 Denizli: Çukurköy, 790 m, E. Tuslaci (ISTE 22703)!

C3 Isparta: Egridir, Yaka köy, 1700-1900 m, H. Peşmen & A. Güner 1489!

C9 Hakkari: Zab gorge, 22 km from Hakkari to Van, 1300 m, D.44872!

C10 Hakkari: 12 km from Yüksekova, 2000 m, Duncan & Tait 158!

External distribution: Europe, Caucasia, Iran, Transcaspia, Turkestan, C. and S. Russia, Siberia, E. Asia.

4. C. arundinacea (L.) Roth, Tent. Fl. Germ. 2 (1): 89 (1798).

Syn: Agrostis arundinacea L., Sp. Pl. 61 (1753);

C. silvatica Schrd., Fl. Germ. 1: 218 (1806);

Deyeuxia arundinace (L.) Beauv., Ess. Agrost. 160 (1812).

Ic: Reichb., Ic. Fl. Germ. 1: t. 79, f. 143 (1850).

Caespitose perennial, with short creeping rhizomes. Stem 60-100 cm, usually erect, rather stout, smooth. Leaf blades 8-50 cm x 1.8-10 mm, linear, acuminate, flat, hairy at junction of blades scabrous, with fine raised hairs on upper surface; sheath glabrous; ligule 2-4 mm, obtuse or truncate. Panicle 8-18 cm x 1-4 cm, rather dense or ± lax, somewhat interrupted, branches scabrous to aculeolate. Spikelets 4-6 mm, purplish-brown. Glumes subequal, lanceolate, acuminate, keeled, scabridulous; lower glume 1-veined, upper glume 3-veined. Lemma 4-4.5 mm, lanceolate, bifid, awned from below dorsal; awn twice as long as lemma, geniculate and twisted; callus hairs 1/5-1/4 x as

long as lemma. Anthers 2.4-2.7 mm. Fl. 7-8. High mountain slopes and in Rhododendron-Pinus nigra forest, 1530-2350 m.

Typus: "Hab. in Europae monticulis, silvatis glareosis juniperetis" [Hb. Linn. 84/7!]

Mainly N. Anatolia.

A2(A) Bursa: Uludag, Cennet Kaya, M. Heilbrom 129!

A4 Kastamonu: 69 km from Çankiri to Kastamonu, 1800 m, K.P. Buttler 15615!

A5 Kastamonu: Tosya, Sint. 1892: 4733!

A7 Trabzon: Maryemana, nr. Altindere Köy, 1400 m, R. Angin 768!

A8 Trabzon: N. slope of Soganli Da., above Çaykara, 1700 m, D.32192!

A9 Kars: Göle, 2000 m, A. Tatli 1341!

B1 Canakkale: Kaz Da., Sint. 1883: 537!

External distribution: Europe, Caucasia, C. and S. Russia.

5. C. parsana (Bor) M. Dogan in Notes R.B.G. Edinb. 40(1): 86 (1982)

Syn: Deyeuxia parsana Bor in Kew Bull. 3: 42 (1948);

Agrostis parsana (Bor) Beetle in Bull. Torrey Club 76: 290 (1949).

Ic: Bor, Fl. Iranica (Gramineae) 70 t. 41 (1970).

Perennial with fibrous roots at base. Stem 15-31 (-50) cm, erect to geniculately ascending from base, glabrous. Leaf blades 4-16 (-20) cm x 1.2-2.8 mm, linear, acuminate, glabrous to scarcely scabrid, green, flat; sheaths glabrous; ligule up to 3 mm, denticulate at apex, lacerate at later stage. Panicle 2-6 (-8) cm x 0.5-1 cm, oblong-cylindrical; pedicels 0.6-2 mm. Spikelets 5-5.5 mm, purple at maturity. Glumes unequal, keeled, lanceolate, terminating in a short aristate point; lower glume 4-4.5 mm, 1-veined; upper glume 5-5.5 mm, 3-veined; aristate points 1-1.5 mm. Lemma 3.5-4.5 mm, 5-veined, denticulate at apex, with a sub-basal awn; awn up to 5.5-7.5 mm, scabrid; callus hairs extending half way up lemma. Anthers up to 2.2 mm.

Fl. 8. Mountain valley near spring, 2700 m.

Typus: [Iran] "Shah Zadeh Kuh", Parsa, recte Gauba, [K!]

S. E. Anatolia.

C10 Hakkari: Sat Da. (above Yüksekova), N. of lake, 2700 m,

Duncan & Tait 109!

External distribution: N. Iran.

20. AMMOPHILA Host, Gram. Austr. 4: 24, t. 41 (1809)

Perennial, forming compact tufts, with far-creeping vertical rhizomes. Leaf blades convolute. Inflorescence a spike-like panicle. Spikelets with 1 floret, large, laterally compressed. Glumes ± equaling lemma; lower glume 1-veined, sometimes shorter than upper; upper glume 3-veined. Lemma coriaceous, 3-5-veined, shortly bifid at apex, with a very short stout subterminal awn; callus hairy. Palea as long as lemma, subcoriaceous, 2-keeled. Rhachilla prolonged beyond floret, disarticulating above glumes. Lodicules 2, long-acuminate. Stamens 3. Ovary glabrous. Caryopsis obovoid-oblong.

Type: A. arundinacea Host. = A. arenaria (L.) Link.

A. arenaria (L.) Link in Host. Bot. Berol. 1: 105 (1827).

Syn: Arundo arenaria L., Sp. Pl. 82 (1753);

Psamma arenaria (L.) Roemer et Schultes, Syst. Veg. 2: 845 (1817).

subsp. arundinacea H. Lindb. fil. in Acta Soc. Sci. Fenn. Ser. nov., B, 1 (2): 10 (1932).

Syn: Psamma australis Mabille in Rech., Pl. Corse 1: 33 (1867);

A. arenaria var. australis (Mabille) Hayek, Prodr. Fl. Balc. 3: 331 (1933).

Perennial. Stem 60-120 cm, erect, stout, glabrous, smooth. Leaf blades narrowly linear, up to 60 cm, sharp-pointed, tightly inrolled, up to 6 mm wide when opened out, closely ribbed above, ribs minutely hairy, smooth and shiny beneath; sheaths ribbed; ligule 10-30 mm, ± lacerate. Panicle 12-20 cm x 1.5-2 cm, oblong to cylindrical. Spikelets 10-14 mm, pale to straw yellow. Glumes narrowly lanceolate, acute to acuminate, keeled, rather firm; lower glume 10.5-12 mm; upper glume 11-13 mm. Lemma 10.5-12 mm, lanceolate, surrounded at base

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CONTRIBUTIONS TO THE STUDY OF TURKISH GRASSES, I

MUSA DOĞAN*

ABSTRACT. A new monotypic genus, *Pseudophleum* M. Doğan, is described to accommodate *Phleum gibbum* Boiss. Four new species, *Apera baytopiana* M. Doğan, *Apera triaristata* M. Doğan, *Gaudinopsis huber-morathii* M. Doğan, and *Gaudinopsis sorgerae* M. Doğan, are described and illustrated. A count of 2n = 14 was obtained from root-tips of *Apera baytopiana*. New combinations are published in *Alopecurus*, *Calamagrostis*, *Gaudinopsis*, *Helictotrichon*, *Phleum* and *Zingeria*. In addition, records of five other species new to Turkey (*Aira praecox* L., *Alopecurus davisii* Bor, *Anthoxanthum aristatum* Boiss., *Arrhenatherum kotschyi* Boiss., and *Trisetum sibiricum* Rupr.) are listed.

PSEUDOPHLEUM: A NEW GENUS FROM TURKEY

Phleum gibbum Boiss. is endemic to a rather small distribution area in W and adjacent C Anatolia. It was first described by Boissier in his *Diagnoses Pl. Orient. Nov. Ser.* 1(5): 69 (1844), and although he suggested that it might belong to a new genus (*Phalarella*, nomen), he evidently realised that any resemblance to *Phalaris* was purely superficial. He accepted it as a species of *Phleum*, both in his *Diagnoses* and in *Flora Orientalis*. Since then no work has been published on the generic position and relationships of this plant.

Comparative studies have persuaded me that *Phleum gibbum* Boiss. should be treated as a new monotypic genus: *Pseudophleum* M. Doğan. As shown in Table 1, it holds a somewhat intermediate position between *Phleum* L. and the monotypic genus *Rhizocephalus* Boiss. However, it also possesses differences from both the latter genera — notably the convolute leaves, more or less unequal glumes, a keeled lemma bearing setulose hairs, and a terminal awn. To combine both *Rhizocephalus* and *Phleum gibbum* in *Phleum* would be to destroy the morphological coherence of the latter genus, which contains a total of 16 species. To combine *Phleum gibbum* with *Rhizocephalus* would result in a heterogeneous ditypic group. The only acceptable procedure is to treat *Phleum gibbum* as a separate monotypic genus, *Pseudophleum,* showing affinities with both the other genera.

Pseudophleum M. Doğan, **gen. nov.** Fig. 1.

Genus affinis *Phleo* L. et *Rhizocephalo* Boiss. A *Phleo* L. glumis spicula brevioribus inaequalibus superne lateraliter gibbosis versus apicem acutis, lemmate glumis longiore ad tertiam partem superiorem dorsaliter carinato coriaceo venis et marginibus setulosis differt. A *Rhizocephalo* Boiss. panicula cylindrica haud involucrata glumis plus minusve inaequalibus venis ad apicem liberis, lemmate dorsaliter setuloso, staminibus tribus, lodiculis duobus recedit.

Herba annua. Lamina foliorum convoluta. Ligula membranacea. Panicula spiciformis. Spicula uniflosculosa, lateraliter compressa, hermaphrodita. Glumae lemmate breviores inaequales, cuneato-naviculares, lateraliter compressae, ad margines superne rectae, superne lateraliter gibbosae, breviter rostratae, ad basin brevissime connatae. Lemma oblongum, ad tertiam partem

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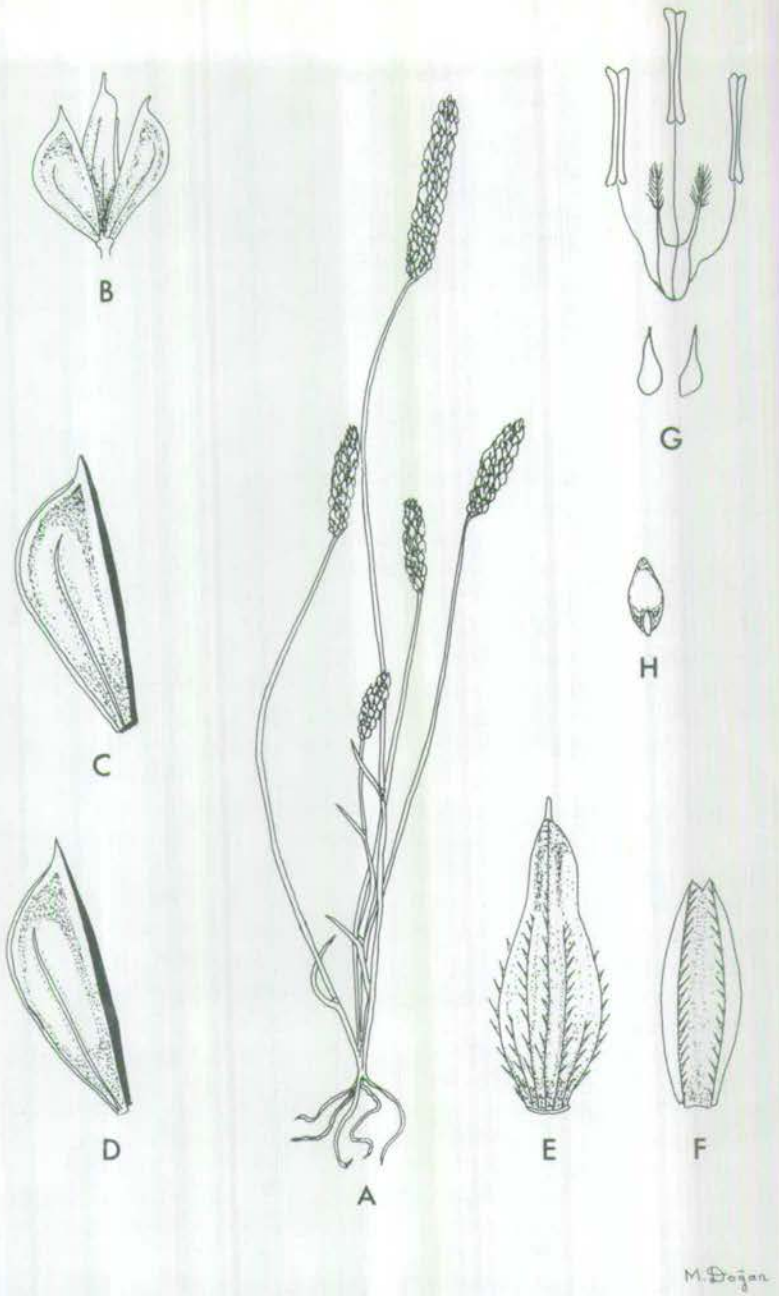

FIG. 1. *Pseudophleum gibbum*: A, habit; B, spikelet; C, lower glume; D, upper glume; E, lemma from dorsal view; F, palea; G, flower; H, caryopsis. A × ⅓, B × 6, C–H × 13.

TABLE 1

	Phleum	**Pseudophleum**	**Rhizocephalus**
Life form	Annual/perennial	Annual	Annual
Leaf blade	Flat	Convolute	Flat
Glumes	Equalling spikelet Equal Shortly acuminate to aristate Veins free at apex	Shorter than spikelet ± Unequal Acute Veins free at apex	Shorter than spikelet Equal Acute Veins united at apex
Lemma	Rounded dorsally Hyaline Apex obtuse to truncate Clavate & short acuminate hairs on dorsal surface, or glabrous	Keeled in upper half Coriaceous Terminally awned Long acuminate hairs (tapering to a point) on dorsal surface	Rounded dorsally Coriaceous Terminally mucronate Clavate hairs on dorsal surface
Lodicules	2	2	0
Stamens	3 (rarely 2)	3	2
Caryopsis	Subacute at apex	Subacute at apex	Long-acuminate at apex

superiorem sensim angustatum et carinatum, dorsaliter 5-nervosum, terminaliter breviaristatum, praecipque in duobus partibus inferioribus secus nervos et ad marginem setulis instructum. Palea bicarinata, emarginata, ad marginem setulifera, lemmatem aequans. Rhachilla supra glumas disarticulans. Lodiculae 2. Staminae 3. Ovarium glabrum. Caryopsis ovoidea, hilo lenticulare minuto. Genus monotypicum.
Type: *Pseudophleum gibbum* (Boiss.) M. Doğan.

Pseudophleum gibbum (Boiss.) M. Doğan, **comb. nov.** Fig. 1.
Syn.: *Phleum gibbum* Boiss., Diagn. ser. 1 (5): 69 (1844).

Annual. *Stem* 5–20 cm, often solitary, somewhat tufted, usually erect, sometimes slightly geniculate in lower part, reddish, slender, glabrous and smooth, 3–4 noded in lower part. *Leaf-blades* 0.8–5 cm × 0.8–1.5 mm, linear-acute when opened-up, usually ± convolute, scabrid on the margins; sheaths glabrous; ligule 2.5–4 mm, acute. *Panicle* 0.7–4.3 cm × 0.4–0.5 mm, cylindrical. *Spikelets* 2.5–3 mm, cuneate-obovate, rather pale greenish. *Glumes* navicular, very narrow at the base, rather coriaceous; lower glume 1.8–2.2 mm, upper glume 2.4–2.6 mm. *Lemma* 2.7–3 mm (incl. aristate point), coriaceous, oblong, dorsally covered by setules; terminal aristate point up to 0.6 mm. *Palea* 2.6 mm, bifid, ciliate on the nerves. *Caryopsis* 1.3 × 0.5–0.6 mm. Hilum elliptical. *Fl.* June-July.
Type. [Turkey C1 Aydin]: in arenosis regionis superioris Mesogis (Aydin Da.) supra Tralles (Aydin) in consortio *Saponariae mesogitanae*, etc., *Boissier* (holo. G).
TURKEY. B2 Manisa: Boz Da., 22 vii 1854, *Balansa*. B2 Uşak: near Kaya Ağil Köy, SW of Uşak, 7 vii 1857, *Balansa*; Kara Göl Köy, 7 vii 1857, *Balansa*. B2/C2 Burdur: between Beyşehir and Şarkikaraağaç, 11 km E of Şarkikaraağaç, 1250 m, 24 v 1975, *R. Çetik* (ISTE 33840). B2 Denizli: Yayla Gölü near Buldan, meadows, 29 vi 1965, *G. Regel* (ISTE 12329).
Endemic to Turkey. E Mediterranean element.

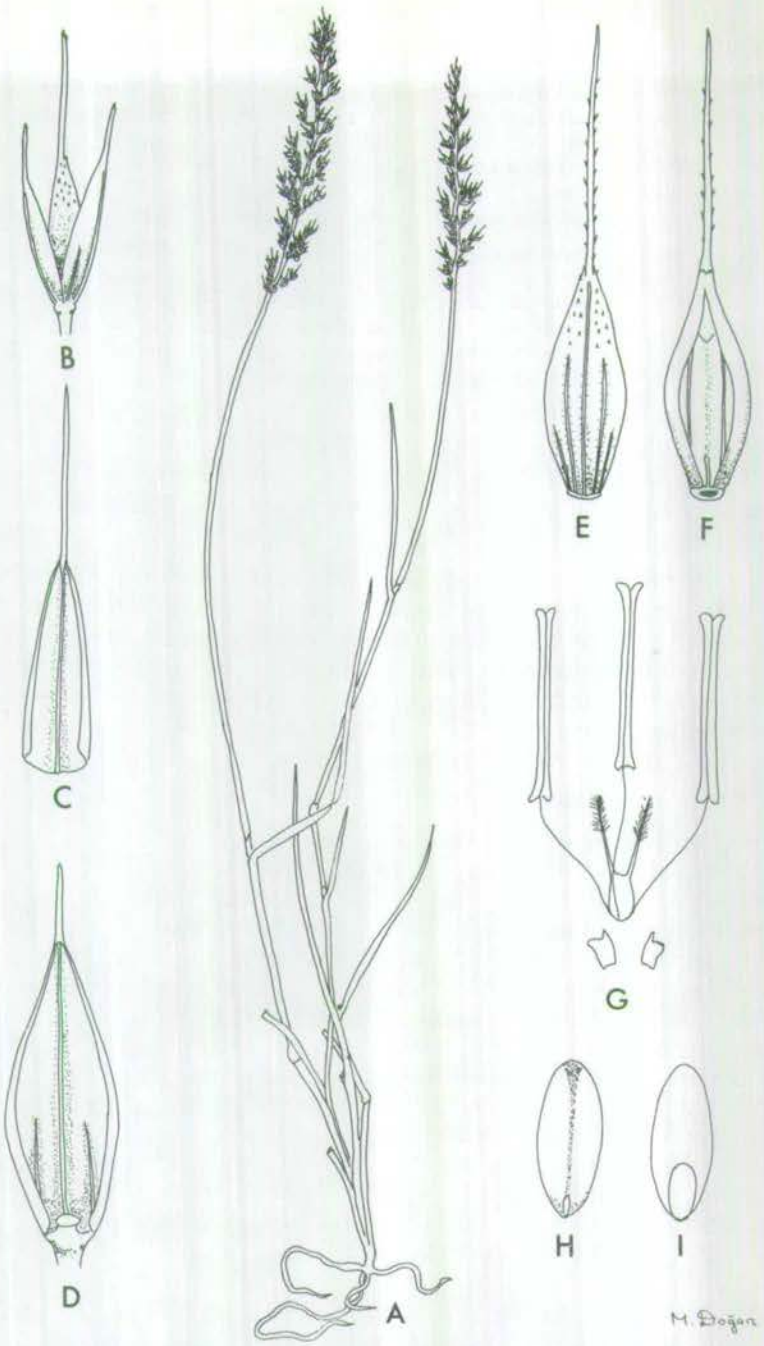

FIG. 2. *Apera baytopiana*: A, habit; B, spikelet; C, lower glume; D, upper glume; E, lemma from dorsal view; F, lemma from ventral view; G, flower; H, caryopsis from ventral view; I, longitudinal section of caryopsis. A × ⅔, B × 6, C–I × 13.

Apera baytopiana M. Doğan, **sp. nov.** Fig. 2.

Affinis *A. triaristatae* M. Doğan sed panicula angustiore minus ramulosa, aristis glumarum magis inaequalibus, arista lemmatis fere terminali 1.2–2.3 mm longa recedit.

Herba annua, viridis. Culmi 16–41 cm longi, plerumque erecti, inferne plus minusve geniculati, solitarii vel fasciculati, aliquantum tenues, glabri, laeves, plerumque 3–4-nodatis. Lamina 2–5.7 cm × 0.7–1.5 mm, sensim lineari-acuminata, in pagina superiore scabridula, facie inferiore demum glabra; ligula 1.2–3.7 mm, membranacea, acuminata, posterius lacerata. Panicula anguste oblonga, 2.2–6.2 cm longa, 5–17 mm lata, aliquantum densa sed paulo interrupta; rami subverticillati 4.5–15 mm longi, 2–3-plo ramulosi; pedicelli 0.3–1.1 mm, plus minusve scabri. Spiculae 2.4–2.8 mm longae (aristae exclusae), uniflorae, lateraliter compressae. Glumae marginibus albo-membranaceis, teminaliter aristatae; gluma inferior 1-nervosa, 1.9–2 mm longa, lanceolata, arista 0.8–1.5 mm recta scabridula; gluma superior 3-nervosa, 2.5–2.7 mm, elliptico-lanceolata, arista 0.4–0.7 mm. Lemma 3(–5)-nervosum, dorsaliter rotundatum, 1.5–2.1 mm longum, aliquantum firmum, superne scaberulum; arista fere terminalis, 1–2.3 mm longa, recta et plus minusve scabra. Palea elliptica, binervosa, 1.4–1.6 mm longa. Rhachilla supra glumam disarticulans. Stamina 3. Antherae 1.4–1.8 mm longae. Caryopsis 1.2–1.5 mm longa, elliptica; hilum ellipticum minutum. 2n = 14. Fl. Jun. *Riversides*.

Typus. [Turkey C2 Muğla]: Köyceğiz to Gökova, Karaböğurtlen, 30 vi 1979, *E. Leblebici, Ö. Seçmen & L. Bekat* 2857 (holo. EGE; iso. ISTE 43921, E).

Cultivated specimen from seed of holotype grown at RBG Edinb., C13584 (E).

This species was collected from SW Anatolia (C2 Muğla) in 1979 by a group of Turkish botanists from Ege University (Izmir). When first examined it was thought to belong to a new genus since it differed from *Apera* in two important characters: a) both glumes were terminally awned; and, b) the awn of the lemma was attached at the apex instead of below. However, later examination of specimens grown in cultivation from seed revealed some spikelets with subterminal lemma awns, and it appears the awn position varies slightly from specimen to specimen, and even according to age within a single specimen. Ideas on the taxonomic significance of terminal awns on the glumes were also modified by the discovery of *Apera triaristata* M. Doğan which has such awns well-developed — previously the concept of the genus was based solely on three species, of which only *Apera intermedia* Hack. with a short awn on the upper glume showed any sign of this character. Thus it was realised that the new species is correctly accommodated in *Apera* rather than a new genus.

Apera baytopiana resembles *Apera triaristata* M. Doğan and *Apera intermedia* Hack. in the glabrous callus of its lemma and its aristate glumes, but in *A. intermedia* only the upper glume has a terminal awn (c. 0.4–0.6 mm). It differs from *Apera triaristata* in having shorter awns on the glumes (see Table 2).

A chromosome count of 2n = 14 was obtained from seedling root-tips.

The species has been named after Prof. Dr Asuman Baytop of Istanbul University, Pharmacy Faculty, who sent this specimen to me together with part of her rich Turkish grass collections, and to whom I am greatly indebted for her co-operation and kindness.

TABLE 2

Spikelet and floral characters distinguishing all known species of *Apera*

Species	Spikelet mm	Lower Glume			Upper Glume			Lemma			Anther mm
		Length mm	Apex	Awn mm	Length mm	Apex	Awn mm	Length mm	Awn mm	Callus	
A. spica-venti	2.5–3.6	2.2–2.8	Acute	Absent	2.5–3.1	Acute	Absent	2.1–2.8	Clearly subterminal 5.4–8.4	Minutely hairy	1–1.5
A. interrupta	2–2.8	2–2.2	Acute	Absent	2.5–2.8	Acute	Absent	2–2.4	Clearly subterminal 4–8	Minutely hairy	0.2–0.4
A. intermedia	2.5–3	2.5–2.7	Acuminate	Absent	2.6–2.8	Terminal awn	0.4–0.6	2.2–2.5	Clearly subterminal 9–9.5	Glabrous	1.2–1.5
A. baytopiana	2.4–2.8	1.9–2	Terminal awn	0.8–1.5	2.5–2.7	Terminal awn	0.4–0.7	1.5–2.1	Terminal or almost terminal 1–2.3	Glabrous	1.4–1.8
A. triaristata	2.6–2.9	1.9–2.1	Terminal awn	2.2–2.9	2.4–2.6	Terminal awn	1.5–1.7	2–2.4	Clearly subterminal 6.5–10	Glabrous	1.5–1.6

Apera triaristata M. Doğan, **sp. nov.** Fig. 3.

Affinis *A. baytopianae* M. Doğan sed panicula latiore magis ramosa, aristis glumarum minus inaequalibus, arista lemmatis longissima 6.5–10 mm longa differt.

Herba annua. Culmi 15–23 cm longi, erecti vel nodis plus minusve geniculatis, laeves et glabri, solitarii vel caespitosi, 3-nodati. Lamina 4.5–8 cm × 1.5–2.5 mm, lineari-acuminata, scabridiuscula; vagina glabra. Ligula 4–5 mm, hyalina, acuta. Panicula 2–10 cm longa, 8–25 mm lata, lanceolata vel oblonga; rami 1–2.5 cm, erecti vel patentes ramulosa; pedicelli 0.3–0.8 mm longi, leviter scabridi. Spiculae 2.6–2.9 mm longae (aristae exclusae), lateraliter compressae, uniflorae. Glumae subaequales, terminaliter aristatae; gluma inferior 1.9–2.1 mm longa, lanceolata, 1-nervosa, arista 2.2–2.9 mm longa; gluma superior 2.4–2.6 mm longa, lanceolato-elliptica, acuminata, 3-nervosa, chartacea, arista 1.5–1.7 mm. Lemma 2–2.4 mm longum, 5-nervosum, dorsaliter rotundatum, dorso superne scaberulum, infra apicem aristatum, arista 6.5–10 mm longa, stricta, scabra. Callus glabra. Palea lemmati aequilonga, 2-nervosa, hyalina. Rhachilla supra glumam disarticulans et brevissime producta. Lodiculi 2. Stamina 3. Antherae 1.5–1.7 mm.

Typus. |Turkey C2 Denizli|: 39 km from Denizli to Acipayam, 1000 m, 16 vi 1954, *A. Huber-Morath* 12496 (holo. Hb. Huber-Morath).

This species was collected by Dr A. Huber-Morath in SW Anatolia in 1954 and is known only from the original gathering. It was first studied by the collector himself and provisionally determined as '*Polypogon* Desf. ?'. It certainly resembles *Polypogon* superficially, because both glumes have long awns which, with the long-awned lemma, give a bristly appearance to the panicle. However, when its spikelets are examined carefully, it can easily be recognized as another species of *Apera*. It has all the floral and vegetative characters of *Apera*, such as glumes 1–3-veined, rhachilla disarticulating above the glumes, lemma acute and chartaceous.

In Table 2 *A. triaristata* is compared with the other four species of *Apera*. *A. triaristata* resembles *A. baytopiana* and *A. intermedia* in having terminally aristate glumes and a glabrous callus. *A. intermedia* has only one awn, which is at the apex of the upper glume. *A. triaristata* is certainly morphologically closer to *A. baytopiana* than to *A. intermedia*.

Gaudinopsis huber-morathii M. Doğan, **sp. nov.** Fig. 4.

Affinis *G. quercetoro* (Boiss.) M. Doğan sed panicula laxa, lemmate flosculi infimi mucro ad 1 mm longo e sinu instructo differt.

Herba annua. Culmi 16–33 cm longi, erecti, tenues, glabri et laeves; nodi 3–4, plus minusve geniculati. Lamina 6–9.5 cm × 1–2 mm, lineari-acuminata, plerumque convoluta, in pagina superiore pilosa, facie inferiore demum glabra; vagina glabra; ligula 2–6 mm longa, hyalina, posterius lacerata. Panicula 3–14 cm longa, 2–4.5 cm lata, lanceolata, laxa, contentus 4–40 spiculata; rami usque ad 3.5 cm, patentes; pedicelli 1.5–13 mm, dorsaliter compressi, leviter scabridi. Spicula 8–11 mm longae, lanceolatae, flosculis 6–7. Glumae ellipticolanceolatae, acutae, 3-nervosae; gluma inferior 4.5–6 mm; gluma superior 6–6.5 mm. Lemma lanceolatum, bifidum, 5-nervosum, in dimidio inferiore adpresse pubescens. Lemma flosculi infimi 5.5–6.4 mm longum, exaristatum, sed mucrone ad 1 mm longo e sinu exoriens, lobis acutis; lemmata flosculorum superiorum 4–7 mm longa, dorsaliter aristata, arista 5.5–6 mm. Palea

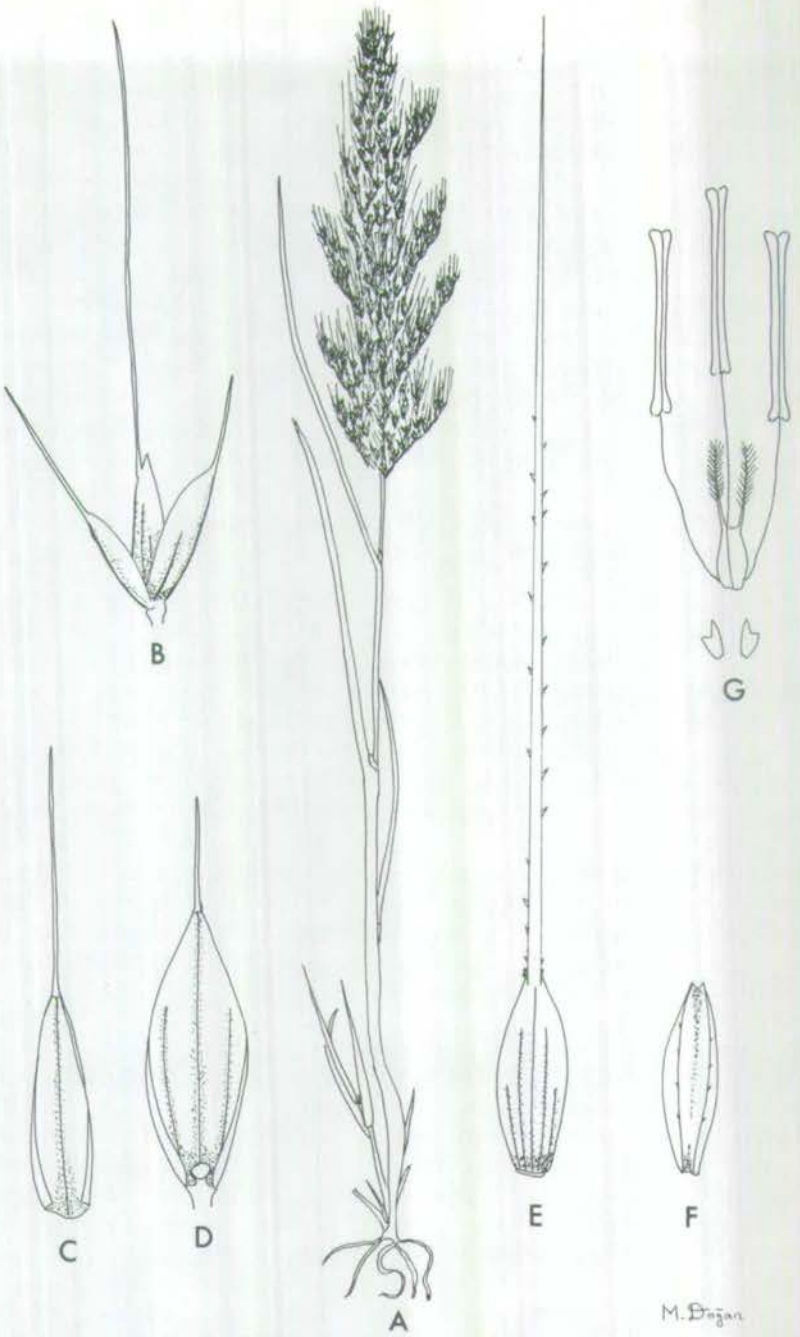

FIG. 3. *Apera triaristata*: A, habit; B, spikelet; C, lower glume; D, upper glume; E, lemma; F, palea; G, flower. A × ⅔, B–G × 13.

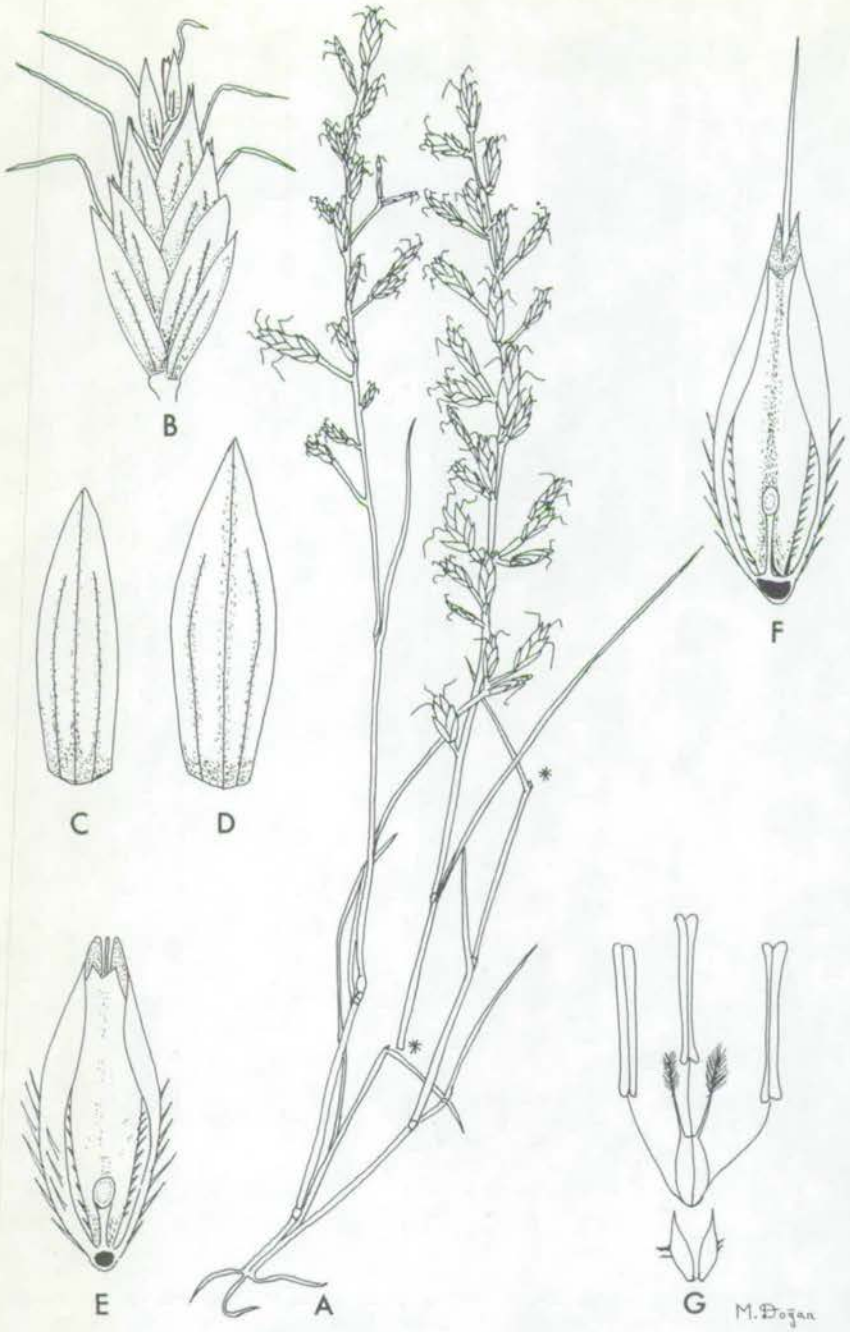

FIG. 4. *Gaudinopsis huber-morathii:* A, habit; B, spikelet; C, lower glume; D, upper glume; E, lowest floret; F, upper floret; G, flower. A × ⅓, B × 3, D–C × 6.

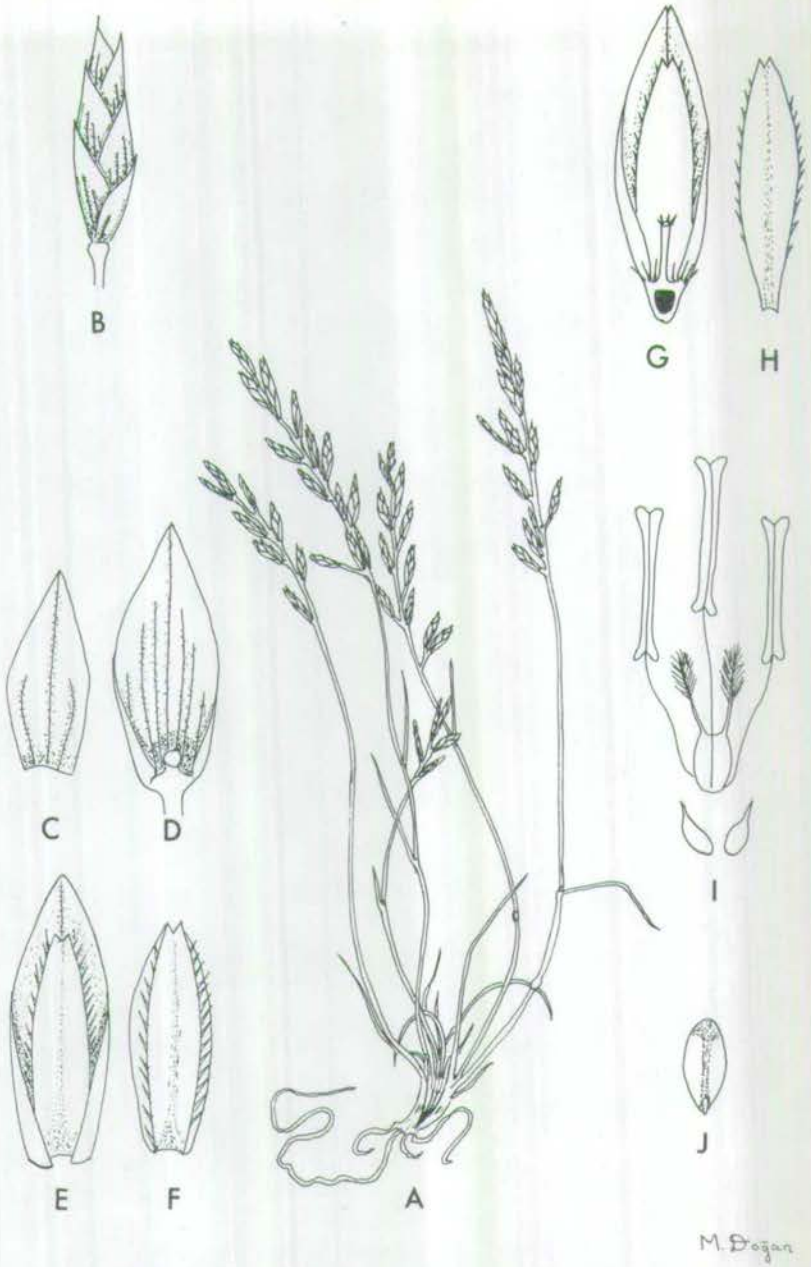

FIG. 5. *Gaudinopsis sorgerae*: A, habit; B, spikelet; C, lower glume; D, upper glume; E, lowest floret; F, palea of the lowest floret; G, upper floret; H, palea of upper floret; I, flower; J, caryopsis. A × ⅓, B × 3, C–J × 6.

2-nervosa, scabrida ad apicem bifida. Rhachilla supra glumas et inter flosculos disarticulans. Lodiculae 2. Stamina 3. Antherae 3.5 mm. Caryopsis ignota.
Typus. [Turkey C3 Antalya]: d. Finike, Bucht von Atbükü, Macchie, *Pinus brutia* Wald, 0–50 m, 26 v 1950, *A. Huber-Morath* 12485 (holo. Hb. Huber-Morath, iso. E).

This new species from SW Anatolia has a rather lax panicle and is closely related to *Gaudinopsis quercetorum* (Boiss.) M. Doğan (see p. 83). The lowest lemma is without an awn but bears a mucro (c. ½ mm) from its sinus.

In Table 3, *G. huber-morathii* and the other three species of *Gaudinopsis*, *G. macra*, *G. quercetorum* and *G. sorgerae*, are compared on the basis of floral characters.

I have named this species after its collector, Dr A. Huber-Morath (Basel), who kindly sent it to me together with other Turkish grass collections.

TABLE 3

Spikelet and floral characters distinguishing all known species of *Gaudinopsis*

	macra	quercetorum	huber-morathii	sorgerae
Spikelet (mm)	6–17	8.5–10	8–11	4.5–10
Floret number	5–7	4–5	6–7	3–8
Lower glume (mm)	4–6.5	4.5	4.5–6	3–4
Upper glume (mm)	5–7	6	6–6.5	3.7–4.8
Lowest lemma (mm)	4.5–7.5	7	5.5–6.4	4.2–5.5
Apex of lowest lemma	Acute	Acuminate	Bifid, with a terminal mucro	Acute to minutely bifid
Awn of lemma (mm)	3.5–10	8	3–6	Absent
Palea (mm)	4.5–5	4.5–5	5.5–6	3.8–4.8
Anthers (mm)	1.5–2.5	2.4–3.1	3.5	2.1–3

Gaudinopsis sorgerae M. Doğan, **sp. nov.** Fig. 5.

Ab omnibus ceteris speciebus generis lemmatibus haud aristatis facile distinguenda.

Herba annua. Culmi 7.5–16 cm longi, erecti, tenues, glabri et laeves, infra paniculam et ad nodos puberuli, 2–3-nodati, purpurascentes. Lamina 1.2–3 cm × 0.6–1.2 mm, convoluta, utrimque in pagina superiore scabridula, in pagina inferiore demum glabra; ligula 1.5–3.5 mm longa, membranacea, acuta. Panicula 2.5–5 cm longa, 0.8–1.7 cm lata, rigida, oblongo-lanceolata, 6–15-spiculata, interrupta. Pedicellis 2–8.5 mm, dorsaliter compressi, scabridi. Spiculae 4.5–10 mm longae, lateraliter compressae, lanceolatae, flosculis 3–8. Glumae lanceolato-acutae; gluma inferior 3–4 mm longa, 3-nervosa; gluma superior 3.7–4.8 mm longa, 3(–5)-nervosa. Lemma 4.2–5.5 mm longum, lanceolatum, acutum vel ad apicem bidenticulatum, haud aristatum, dorso rotundatum, rigidum, dorsaliter inferne minutissime scabridulum; callus pilis ad 0.5 mm. Palea 3.8–4.8 mm, apice bifida, 2-nervosa, setulosa. Rhachilla supra glumas et inter flosculos disarticulans. Lodiculae 2. Stamina 3. Antherae 2.1–3 mm. Ovarium glabriusculum. Stigmata 2. Caryopsis 1.7 mm longa, elliptica ex dorsaliter. Fl. Jul.
Typus. [Turkey C3 Isparta]: 17 km E of Eğridir (Anamas), *Pinus nigra* subsp. *pallasiana* Wald, 1250 m, 15 vii 1968, *F. Sorger*: 68-36a-12 (holo. Hb. F. Sorger).

This species is apparently a local endemic in Turkey, known only from the type gathering which was collected in SW Anatolia in 1968 by Dr F. Sorger (Vienna). At first glance it is a rather puzzling plant because awns are completely lacking. However, except for this anomaly it certainly has all the floral and vegetative characters of *Gaudinopsis*, though it is impossible to key it out to that genus in present Floras, since the keys are all concerned with the floral characters of *G. macra*, such as the presence of an awn on the lowest lemma.

In Table 3 *G. sorgerae* and the other species of *Gaudinopsis* are compared on a number of taxonomically useful floral characters.

The new species has been named after its collector, Dr F. Sorger, who kindly sent it to me for determination.

NEW COMBINATIONS

Alopecurus utriculatus Banks & Sol. subsp. **anthoxanthoides** (Boiss.) M. Doğan, **comb. et stat. nov.**
Syn.: *Alopecurus anthoxanthoides* Boiss., Diagn. ser. 1(13):42(1853).

Calamagrostis parsana (Bor) M. Doğan, **comb. nov.**
Syn.: *Deyeuxia parsana* Bor in Kew Bull. 3:42(1948).

Gaudinopsis quercetorum (Boiss. & Bal.) M. Doğan, **comb. nov.**
Syn.: *Ventenata quercetorum* Boiss. & Bal. in Boiss., Diagn. ser. 2(4):130(1859).

Helictotrichon pubescens (Huds.) Pilger subsp. **longifolia** (Boiss.) M. Doğan, **comb. et stat. nov.**
Syn.: *Avena pubescens* Huds. var. *longifolia* Boiss., Fl. Or. 5:545(1884).

Phleum montanum C. Koch subsp. **serrulatum** (Boiss.) M. Doğan, **comb. et stat. nov.**
Syn.: *Phleum serrulatum* Boiss., Diagn. ser. 2(4):125(1859).

Phleum paniculatum Huds. subsp. **ciliatum** (Boiss.) M. Doğan, **comb. et stat. nov.**
Syn.: *Phleum asperum* Vill. var. *ciliatum* Boiss., Fl. Or. 5:482(1884).

Zingeria pisidica (Boiss.) Tutin subsp. **poaeforme** (Boiss.) M. Doğan, **comb. et stat. nov.**
Syn.: *Milium trichopodum* Boiss. var. *poaeforme* Boiss., Fl. Or. 5:511(1884).

Zingeria trichopoda (Boiss.) P. Smirn. subsp. **biebersteiniana** (Claus) M. Doğan, **comb. et stat. nov.**
Syn.: *Agrostis biebersteiniana* Claus in Beitr. Pfl. Russ. Reich. 8:264(1851).

NEW RECORDS FOR TURKEY

Aira praecox L., Sp. Pl. 65(1753).
A2(A) Instanbul: Çatal Da., v 1865, *René du Parquet* (BM).

Alopecurus davisii Bor in Notes RBG Edinb. 25:63(1963).
B1 Izmir: Kemalpasa, Nif Da., 1500 m, 25 v 1971, *H. Peşmen & Ö. Seçmen* (EGE 16357).
Previously only known from the type collected on the island of Samos.

Anthoxanthum aristatum Boiss., Voy. Bot. Midi. Esp. 2:638(1842).
Is. Gökçeada: near Kuzulimani, *E. Leblebici & Ö. Seçmen* 1348 (EGE).

Arrhenatherum kotschyi Boiss., Diagn. ser. 1(7):122(1846).
B7 Sivas: d. Divriği, Dumluca Da., 30 v 1968, *T. Baytop* (ISTE 12878).

Trisetum sibiricum Rupr. in Beitr. Pfl. Russ. Reich. 2:65(1848).
A9 Kars: 6 km from Sarikamiş to Karakurt, 2150 m, 15 vii 1966, *P. H. Davis* 46563 (E).

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