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

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

April 1982
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, Alopeurus 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 Phleaeae 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 and 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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I also wish to thank Mrs G. Millar for typing my final manuscript.
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### Key to shading in Anatomical line drawings:

*(after Metcalf 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 specialised 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, Caucasus, Syria, Palestine, Iraq, Cyprus, Iran, Afghanistan, Arabia, Egypt and Baluchistan, was published by E. Boissier between 1867 and 1884, and after the author's death a Supplement was added by R. Burser (1888). Boissier himself visited Izmir, Aydin Da., Menderes valley, Manisa, Bozdog, Honas De. (Denizli) and Uludag (Bursa). In his 'Flora Orientalis' he cited his specimens from W. Anatolia as well as other collections by various botanists.

T. Kotshy's major period of exploration was undertaken during the preparation of 'Flora Orientalis'. Between 1844 and 1859 he set
out on long tiring journeys in E. Anatolia; he visited the Taurus
Mountains, Muğ, Varto (Singöl 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; G. Koch
(1844) N.E. Anatolia; Noë (1844-1846) Istanbul, Harput (Elazığ);
Heldreich (1845-1851) Antalya, Burdur, Isparta, Konya, İzmir; Tchihatcheoff
(1847, 1849, 1853, 1858, publ. 1860) W. and N. Anatolia; Clementi
(1849-1850) Istanbul, Uludag (Bursa); Huet de Pavillon (1853) Erzurum,
Bayburt, İspir; Balansa (1854, 1855, 1856, 1857, 1866, publ. 1874)
İzmir, S.E. Taurus Mountains, Ersoyas Da. (Kayseri), Uşak, Murat Da.
and N.E. Anatolia; Bourgeau (1860, 1863) Antalya, Elmalı, Gümüşhane,
Bayburt; Haussknecht (1865) Urfa, Gaziantep, Berit Da. (Maras), Harput
(Elazığ), Diyarbakır; F. Luehan (1881-1882) Muğla, Antalya (publ.
0. 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; Asnavour (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. Hayak 1914); Sintenis (1889-1890) N.E. Anatolia,
Gümüşhane, C. Anatolia, Çanakkale; Panther and Zederbauer (1902 publ.
1905) Ersoyas Da. (Kayseri); E.V.D. Post (1906, 1910, 1913, 1918, 1918)
Rize, Ararat Mountain, Konya, Istanbul, Bolu; G.E. Post (1906) S. and
E. Anatolia, particularly Hatay, Gaziantep, Maras, Mardin (publ.
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), İzmir, Manisa, Aydın, 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 Risa 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. Cseoczott (1925, publ. 1938-39) Istanbul, Hendek, Ankara, Çankiri, Ilgaz Da. (Kastamonu); K.0. Müller (1931-33) Ankara; W. Kotte (1931-33) Ankara; R. Görz and Werth (1931-33) Ankara; O. Schwarz (1932, publ. 1934) İzmir; E.K. Balls (1935, publ. 1935) N.E. Anatolia, Taurus Mountains,

Towards the end of this period K.H. Rechinger (1943) published his 'Flora Aegaea' 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. Aksan, T. Ekim, H. Pegman, O. Seqman 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 Roeder (1953) on the basis of its embryo type, as a result it was separated from the Chlorideae and placed with the Festucoideae (tribe Phleaeae).

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 Tsvelev (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, rachillas, lemmas, awns and caryopses.

The most recent work on internal vegetative morphology of grasses is that by Metcalfe (1960). *Alopecurus myosuroides*, *A. alpinus*, *A. caniculatus*, *A. pratensis*, *Helictotrichon pratense*, *H. planiculme*, *H. pubescens*, *Phleum alatum*, *P. arenarium*, *P. nodosum* and *P. pratense* are described anatomically in Metcalfe's work. St.-Yves (1934) examined a number of *Helictotrichon* species. Very few other species have been examined anatomically.
Phleum, Alopecurus and Heliotrichon 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. rendleii, A. glacialis, A. aucheri, A. laguroideas, A. aequalis, A. textilis, A. mysuroides, A. gerardii, A. arundinaceus, A. davisi, A. setarioides, A. utriculatus, A. lanatus and A. vaginatus.

For Heliotrichon 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. sedensae, H. desertorum, H. pubescens, H. versicolor, H. pratense, H. blavi, H. armeniacum, H. argaeum, H. compressum, H. marginata, H. albinervis, H. scellianum, H. praeusta, H. dahuricum, H. bromoides, H. cincinnata, H. planiculma and H. heckelii. At the same time I have tried to justify my inclusion of the perennial "Avenas" under a single genus Heliotrichon, instead of the two genera accepted by Holub (1977).

I have recognised thirty-eight genera in the tribes Avenae (incl. Agrostideae), Phleae, 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, 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; Lopholochloa cristata under Aira and Trisetum sibirica, Trisetum flavaccens, Arrhenatherum elatius,
Gaudinia fragilis and Helictotrichon pratensis under Avena. Since then many new genera based either on Linnaean 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 Forsk. (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), Helicotrichon Bess ex Roemer & Schultes (1827), Triplachne Link. (1833), Avellinia Parl. (1842), Mailea Parl. (1842), Rhizocephalus Boiss. (1844), Antinoria Parl. (1845), Molinierella Rouy (1913), Gaudinopsis Big (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 Helicotrichon 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 Helicotrichon Bess ex Roemer & Schultes (1827). The latter treatment has been accepted by many botanists, such as Potzstal (1951), Paunero (1959), Boz (1970), Tzvelev (1976) etc.

*Heliototrichon* (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 *Heliototrichon* 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 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 Tránius (1820). In his monograph of *Koeleria*, Domin recognised a number of subspecific as well as varistal 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. pilati*, *K. kurdica*), but so far his species treatment has not been adopted by other botanists.
Parlatore (1842) described a new genus, *Maiula* 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 *Deysuxia* was first described by Beauvois (*op. cit.*), following a manuscript name attributed to Clarion. A detailed historical review of the genus *Deysuxia* 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 rachilla 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 rachilla is not prolonged. *Deysuxia* has been distinguished by the presence of a distinct, usually hairy prolongation of the rachilla, and by the hairs on the callus usually not exceeding the lemma in length. Bentham and Hooker (1883) accepted *Deysuxia* and *Calamagrostis* as separate genera but admitted the presence of intermediate species between the two genera. Vickery (*op. cit.*) supports the acceptance of *Deysuxia* as an individual genus. Bor (*op. cit.*) also treated *Deysuxia* 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.
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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 μm, 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 HCl 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 solerenceyma types at the vascular bundles in the lemma (transverse section) of the representatives of the family Poaceae (after Vukolov, 1929)

Key to shading

Solerenceyma

Vascular bundles
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 & 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) Festuroid 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
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 Rhisoraphalus, 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
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 sclerenchyma (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 pressure. 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 solerenenchymatous fibres that extend outward from more centrally located solerenenchymatous 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 aequalis*).

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 *Cornuscopia* (*C. cuullatum*), *Alopecurus* (*A. setarioides*, *A. rendle*).

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. *Ononisoccus*, *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 aequalis (Fig. 9, b), Hierochloe odorata (Fig. 9, d), etc. Sometimes the leaf blades 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 maora (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 planiculm (Fig. 4, d), H. pratense (Fig. 5, a), H. pubescens (Fig. 5, d), H. schellianum (Fig. 6, c), H. marginata.
Fig. 4. Leaf blade sections (cross section) of Heliototrichon
   a) H. compressum (x 25)  (T. Ekim 932)
   b) H. argaesum (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
  Ep. Epidermis
  P. Parenchyma
  Ph. Phloem
  Sc. Sclerenchyma
  Xy. Xylem
Fig. 5. Leaf blade sections (cross section) of *Heliototrichon*

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. 6. Leaf blade sections (cross section) of Heliototrichon

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. praestata (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. 7. Leaf blade sections (cross section) of *Heliotricon*

a) *H. cinsinata* (x 25) (Todaro 307)

b) *H. filifolium* (x 25) (13 viii 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. 8. Leaf blade sections (cross section) of revised genera

a) Parvotrisetum myrianthemenum (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. Ofnas 58)
e) Anthoxanthum odoratum (x 25) (Feșmen & 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. 9. Leaf blade sections (cross section) of revised genera

a) Ammophila arenaria (x 25) (T. Ualu 3926)
b) Alopecurus ausheri (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) (Seqmen & Peqmen EGE 16357)
h) Alopecurus lanatus (x 25) (Coode & Jones 1352)
i) Alopecurus vaginatus (x 25) (D.21094)
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 Heliotrichon convolutum (Fig. 5, a), H. blavii (Fig. 5, b), Ventenata subenervis (Fig. 8, d), Triplachne nitens (Fig. 8, h), Ammophila arenaria (Fig. 9, a), Alopecurus davisi (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 (1953), De Wet (1958), etc. Metcalf (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. Agrostidioae), Milieae, Phleeae and Phalaridioae, and confirmed their 'festucoid' anatomy in which there is a well developed inner chlorenchymatous 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 Heliototrichon versicolor (Fig. 5, c), H. planiculme (Fig. 4, d), H. argaeum (Fig. 4, b), H. compressum (Fig. 4, a), Alopecurus aequilis (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 Heliototrichon haekelii (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), Heliototrichon pubesca (Fig. 5, d), H. sedensense (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 Heliototrichon blavii (Fig. 5, b), H. haekelii (Fig. 7, d), H. pubesca (Fig. 5, d), H. versicolor (Fig. 5, c), H. pratensis (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. Heliototrichon 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)
Fig. 10
(i.e. Alopecurus gerardi, A. aucheri, A. glacialis, Helicotrichon 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 Helicotrichon desertorum (Fig. 7, e), H. sedenense (Fig. 6, d), H. sempervirens (Fig. 7, g), H. setaceum (Fig. 6, e), 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 Helicotrichon pubescentum (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 Helicotrichon filifolium (Fig. 7, b) H. parlatorei (Fig. 7, f), H. convolutum (Fig. 5, e), Alopecurus, Phleum, Agrostis, Caudinopsis, Molinerella, Triplachne, etc.

It seems unreasonable to accept a new genus on the basis of bulliform cells alone, as was done in Helicotrichon by Holub in Flora Europaea vol. 5; subgeneric status seems sufficient. In the subgenus
Heliototrichon of the genus Heliototrichon, 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 Heliototrichon 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. blavid (Fig. 5, b), etc. Other species of Heliototrichon do not have any distinct midrib, as in Heliototrichon convolutum (Fig. 5, e), H. filifolium (Fig. 7, b), H. hackelia (Fig. 7, d), H. desertorum (Fig. 7, e), H. parlatorei (Fig. 7, f), H. sambivirena (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 craticus, 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 longitudinally '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 Triisetum. 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. planiculm (Fig. 4, d), H. compressum (Fig. 4, a), H. dahuricum (Fig. 6, f), H. ciminiata (Fig. 7, a), H. desertorum (Fig. 7, e), Alopecurus setaroides, Triisetum flavescens (Fig. 8, c), Zingeria tri-chopoda (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, IIIa), as in Alopecurus craticus, A. semiculatus, A. aequalis, A. aucubifolius (Fig. 9, b), A. textilis, A. myosuroides, etc. Sometimes the mid-vein has only an abaxial girder (Fig. 2, IVa), as in Helicotrichon armeniacum (Fig. 4, c), H. argaesum (Fig. 4, b), H. margiata (Fig. 6, a), H. albiermis (Fig. 6, b), H. blavii (Fig. 5, b), H. beckelii (Fig. 7, d), etc. Very often the mid-vein has adaxial and abaxial girders (Fig. 2, I), as in Helicotrichon schallianum (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. trudinaceus, 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 Helicotrichon planiculm (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, a), Gaudinopsis macra (Fig. 8, b), etc. The shape of 'girders' appears to be very often I-shaped (after Metcalfe op. cit.), as in Helicotrichon decorum (Fig. 7, h), Anthoxanthum odoratum (Fig. 8, a) Parvotrisetum myrianthemum (Fig. 8, a),
Hierochloë odorata (Fig. 9, d), Alopecurus acheri (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. parlatorii (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 Heliototrichon 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 Heliototrichon 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 com-
pletely surrounds the entire vascular bundle, as in *Heliototrichon
pubescens*. The second type is the commonest one, in which the outer
vascular bundle is interrupted below. This interruption is often
associated with a solerenshmatous girder or not, and is seen in some
species of *Heliototrichon*, such as *H. versicolor*, *H. pratense*, *H. armen-
iacum*, *H. planiculme*, *H. argaeum*, etc. In the third and final type,
the outer vascular bundle sheath is interrupted at both poles by
solerenshmatous girders, as in *H. filifolium*, *H. convolutum*, *H. parla-
torei*, 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 illus-
trated 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. heckelii* (Fig. 7, d), and protected their convolute leaf blades either by having a continuous sub-epidermal 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 interrupted 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, o). Later, in the more specialised species, this number increased greatly and many lines of bulliform cells evolved, but in some of the present *Helictotrichon* 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 solerenchyma. In the genera *Avena*, *Arrhenatherum*, *Vantnata*, 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, o), *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

Heliototrichon sedensense (x 400) (1882, Reuter)

List of Contractions

H. Hair
I.C. Interstomatal long cell
L.C. Long cell

S. Stomata
S.C. Short cell
De role Fig. 11b
Fig. 11b. Epidermal cell strips

a) Alopecurus davisii (x 150)  (Seqmen & Peşman EGE 16357)
b) Alopecurus lanatus (x 150)  (Coode & Jones 1352)
c) Alopecurus textilis (x 150)  (D.20619)
d) Heliototrichon pratense (x 150)  (A. Tatli ISTE 31299)
e) Heliototrichon argasum (x 150)  (D.20546)
f) Heliototrichon planiculms (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. Alman 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)
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 prickles-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 \( \mu \) to 500 \( \mu \) 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 endwalls 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 *Triplaxa 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 *Heliototrichon*. 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 *Triplaxa 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 *Heliototrichon planiculmos* (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*, *Cormueopia cucullatum*, *Rhizoccephalus orientalis*, or rounded as in
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 *Heliototrichon 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. planiculm* (Fig. 11, f), *H. convolutum* (Fig. 12, c), *H. blavi* (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 *Heliototrichon 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 *Heliototrichon pratense* (Fig. 11, d), *H. planiculm* (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, Alopeurus 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 Alopeurus davisi (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. Alopeurus davisi 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 Alopeurus davisi than in Alopeurus 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 Alopeurus and Helictotrichon leaves, three major types of short cells are scored. In the first type no short cells are observed, as in Alopeurus pratensis, A. creticus, A. rendlei, A. laguroidea, 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. planiculmis* (Fig. 11, f), *H. bromoides*, *H. hakalii*, *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 *Heliototrichon sedenense*, *H. decorum*, *H. setaceum*, *H. sempervirens*, *H. convolutum* (Fig. 12, o), etc.

2.7.17. Silica bodies

In the intercostal zone of *Alopecurus* leaves, no silica bodies have been observed, but in the other genus, *Heliototrichon*, 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 *et al.*). 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 *Heliototrichon planiculmis* (Fig. 11, f). In the second type, the silica bodies are ± equidimensional 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, o), 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...
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 Heliototrichon pubescens (Fig. 12, b), H. versicolor (Fig. 12, e), H. armeniacum, H. pratense (Fig. 11, d), Alopecurus davisi (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. planiculum (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. sampervirens, 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. huckelii, 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) \( \circ \)-shaped
   c) \( \wedge \) to \( \wedge \)-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 $3 \times$ as long as width or longer
   b) Length less than $3 \times$ 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
|   | 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 | b | a | f | g | a | b | b | a | b | a | a | a | n(b) | a | a | b | a | a | b | d |
| H. versicolor | a | b | e | a | a | b | a | a | h | b | a | b | a | f | a | b | a | b | a | a | a | a | a | n(b) | a | a | b | a | a | b | d |
| H. pratense | b | b | e | a | a | b | a | b | a | f | f | f | f | b | a | b | b | b | a | a | a | a | a | b | b | b | o-l | b | b | b | b | c |
| H. armoniacum | c | b | e | a | a | b | a | h | e | f | f | e | f | o(e) | f | b | a | b | b | b | a | a | a | n(b) | a | a | b | a | a | b | d |
| H. planicola | b | b | e | a | a | b | a | h | b | a | b | a | f | f | f | f | b | a | b | a | a | a | a | a | b | b | b | b | b | b | b |
| H. aryaem | a | b | e | a | a | b | a | b | a | e | f | o(a) | f | b | a | b | b | a | a | a | a | b | b | a | a | a | a | a | b | d |
| H. compressus | a | b | e | a | a | b | a | b | a | e | f | o(a) | f | b | a | b | b | a | a | a | a | b | b | a | a | a | a | a | b | d |
| H. margineata | b | b | b | a | a | b | a | a | e | f | f | f | f | b | a | b | a | b | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. albipennis | b | b | e | a | a | b | a | b | a | e | f | f | f | f | b | a | b | a | b | a | a | a | a | a | b | b | a | a | a | b | d |
| H. scabellum | b | b | e | a | a | b | a | b | a | f | d | a | a | a | a | a | a | a | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. praestans | b | b | e | a | a | b | a | b | a | f | f | f | f | c | a | b | a | b | a | a | a | a | a | b | b | o(h) | b | b | b | b | d |
| H. dabusirum | a | b | e | a | a | b | a | b | a | f | f | f | f | b | a | a | b | a | a | a | a | a | a | c | b | a | a | a | a | b | d |
| H. bromidae | b | b | e | a | a | b | a | b | a | f | f | f | f | c | a | a | a | a | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. cincinata | b | b | e | a | a | b | a | b | a | f | f | f | f | b | a | b | a | b | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. blavium | d | a | e | a | a | b | a | b | a | e | d | f | a(b) | b | b | b | b | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. hookelli | d | a | e | a | a | b | a | b | a | e | f | f | f | f | a | b | a | b | a | b | a | a | a | a | b | b | a | a | a | b | d |
| H. filifolium | d | a | f | b | a | b | a | b | a | f | f | f | f | c | a | b | a | b | a | a | a | a | a | b | b | a | a | a | a | b | d |
| H. sedemoum | d | a | f | a(b) | a | b | a | b | a | f | f | f | f | c | a | a | a | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. decorum | d | b | b | c | a | b | c | b | b | f | f | f | f | c | a | b | a | b | a | a | a | a | b | b | a | a | a | a | a | b | d |
| H. setaceum | d | a | f | c | a | b | c | b | a | f | e | e | e | e | c | a | b | a | b | a | a | a | a | a | b | b | a | a | a | b | d |
| H. aspermum | d(c) | b | f | c | b | b | b | a | b | f | f | f | f | e | c | a | b | a | b | a | a | a | a | a | b | b | a | a | a | b | d |
| H. parastomus | d | b | f | b | b | b | a | b | f | f | f | f | e | c | a | b | a | b | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. consolatam | d | b | f | b | b | b | a | b | f | f | f | f | e | c | a | b | a | b | a | a | a | a | a | a | b | b | a | a | a | b | d |
| H. desertorum | d | a | f | c | a | b | c | b | a | f | e | f | b | b | a | b | a | a | a | a | a | a | a | a | b | b | c | b | b | b | b |
| H. sedatina | d | a(b) | f | e | c | a | b | c | b | a | f | f | f | f | c | a | b | a | b | a | a | a | a | a | b | b | c | b | b | b | b |
Chapter III

3. Comparative Reproductive Morphology

3.1. Material and Methods

Investigating Reproductive Morphology:

Reproductive organs were studied by the use of x10 to x20 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 microscopical 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 microscopical 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. 100Å (10⁻⁶). 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, Aoneson 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 2μ 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.

* 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, Tritium, 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*, *Castridium*, *Pseudopheum*, *Polygono*, *Rostraria*, *Alopecurus*, *Phleum*, etc.) or it may be a dense head-like panicle, 1-2 times as long as broad (e.g. *Rhizopephalus*, *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. lasica* (Bal. 624)
f) *A. stolonifera* (D. 47278A)
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. Involucres

Only in the genus *Cornucopia* is there an involucre - a cup-shaped structure which envelopes almost half of the dense head-like panicle. Its occurrence 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 *Crepis* (*C. aculeata, C. schoenoides*), *Rhzoscephalus*, 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. *Lolaisa*). 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 Phleaeae. 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), Heliototrichon, Arrhenatherum, Gaudinia, Venenata, Gaudinopsis, Trietum, Trietaria, Parvitrisetum, Koeleria, Rostraria, Avellinia, Deschampsia, Antinoria, Molineriella, Aira, Corynephorus, Holcus, Calamagrostis, Ammophila, Apera, Lagurus, Agrostis (Fig. 14, Ia-Ib), x Agropyron, Polygogon, 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  P. Palea
L. Lemma  Sp. Spikelet
L.G. Lower glume  St. Stamens
L.O. Lodicule  U.G. Upper glume
O. Ovary
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 ereciformis
IVa  Phalaris minor
IVb  Alopecurus aequalis
IVc  Alopecurus vaginatus
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 *Cormocopia*.

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. bertoloni*, *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. textilia*, *A. rendleii*, etc.) or cuneate (i.e. *P. paniculatum*).

3.5.3. Glumes (Fig. 15-23)

Length: The relative length of the glumes is of great help for distinguishing species. Glumes can be equal, as in *Antinoria*, *Aira*, *Agropogon*, *Alopecurus*, *Cormocopia*, *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*, *Venantia*, *Trisetum*, *Avellinia michelii*, *Rostraria*, *Anthoxanthum*, *Pseudopheleum*, etc. The lower is sometimes longer than three-fourths of the upper one, as in *Helictotrichon*, *Gaudinopsis*, *Parvotrisetum*, *Deschampsia*, *Molinariella*, *Corynephorus*, *Holcus*, *Ammophila*, *Lagurus*, *Polypogon*, *Castridium*, *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. bysantina* (A. Baytop ISTE 33691)
d) *A. capillaris* (A. Baytop ISTE 33728)
e) *A. lazica* (Bal. 624)
f) *A. balansae* (Bal. 620)
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 Rhicocephalus, 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, Gadinopsie, 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. Hierochloe, Antinoria), ovate to elliptic (i.e. Zingeria, Milium, Anthoxanthum, Aire, Deschampsia), elliptic (i.e. x Agropogon), obovate (i.e. Beckmannia), navicular (i.e. Pseudophleum), uroelolate (i.e. Rhicocephalus) 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 viridias 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* (No8 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. Angin 2368)

i) *P. exsratum* (Paganen & Gainer 1311)

j) *P. boissieri* (D.28737)

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

l) *P. cryptoides* (12 vi 1870, Bourgeau)
Fig. 16. Spikeslets 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. Albo)
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. sucheri (Stn. & Hend. 5285)
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. Pegman 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* (Seqmen & Pegmen EGE 16357)

d) *A. lanatus* (Goode & Jones 1352)
Fig. 20. Spikelets of *Alopecurus*

a) *A. gerardii* (Coode & Jones 2714)

b) *A. vaginatus* (D.33372A)

c) *A. glacialis* (A. Güner 1029)
Fig. 21. Spikelets of the revised genera

a) Polypogon maritimus (x 10) (H. Birand ANK 1168)
b) Parvotrisetum myrianthemum (x 10) (20 vi 1885, Haldreich)
c) Ventenata dubia (x 5) (A. Baytop ISTE 5548)
d) Trisetaria loeflingiana (x 10) (Sint. 1584)
e) Trisetum flavescens (x 10) (D.46282)
f) Arrhenatherum elatius (x 5) (Shrend. 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. 22. Spikelets of the revised genera

a) Avellinia michelii (x 10) (23 v 1897, Azn.)
b) Beokmannia creuciformes (x 10) (R. Alava 7024)
c) Deschampsia caespitosa (x 10) (F. Holts 945)
d) Cormocopia cuvullatum (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, Asn.)
b) Ammophila arenaria (x 5) Seçmen & Leblebici 452a)
c) Rhizocephalus orientalis (x 10) (Coode & Jones 183)
d) Calamagrostis epigæos (x 10) (Duncan & Tait 215)
e) Milium effusum (x 10) (Pribler 252)
f) Zingeria trihopoda (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 macro, 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 cuscullatum 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 rachilla 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 1/2 or
less of their length (i.e. A. bulbosus, A. geniculatus, A. equalis, A. pratensis, A. arundineceus), but some other species have them connate for 1/3 to 4/5 (i.e. A. utriculatus, A. myosuroides, A. creticus, A. setaricoides, A. rendlei).

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

Compression: As illustrated diagramatically in Fig. 14, glumes are usually keeled (i.e. Avena, Helictotrichon, Phleum, Alopeurus, Triplechne, etc.), but in two genera, Milium, Zingeria, they are rounded on the back. In Polypogon (P. maritimus, P. monapellinensis) and Gastrodium, 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 Alopeurus (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 Alopeurus 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 Alopeurus 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 Agropyron, Polypogon, Gastridium and Triplachne. In the second group, glumes are 1- to 3-veined, as in Arrhenatherum, Trisetum, Triestaria, Pervotrisetum, Avellinia, Rostraria, Koeleria, Deschampsia, Molineriella, Antinoria, Aira, Holcus, Corynephorus, Calamagrostis, Ammophila, Zingera, Milium and Anthoxanthum. In the third group, both glumes are 3-veined, as in Hierochloë, Alopecurus, Cornucopia, Beckmannia, Phleum, Pseudophleum and Rhizoccephalus. In the fourth group, a number of other genera are placed in which glumes are usually at least 3-veined, as in Avena, Heliottrichon, 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 braacts (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, there is 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 Agropyron, Anthoxanthum, Gaudinia, Hierochloë, etc).
In the second type, cells are short or long but cell walls are more or less sinuous (i.e. Alra, Ammophila, Avellinia, Calamagrostis, Gastridium, Helictotrichon, Rostraria, etc.). It is also possible to recognize further subgrouping in this type. For example in Alopecurus, A. rendlel, A. creaticus and A. bulbosus, epidermal cells are squidimensional 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 rachilla segments is also quite a valuable taxonomic character. In *Avena sativa*, rachilla segments break up at their apex and eventually fall attached to the lower floret, but in *Avena bysantina*, rachilla segments break up at their base and fall attached to the upper florets.

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

**Hairiness:** The hairiness of rachilla segments has great taxonomic value. Rachilla 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 *Trietum rigidum* in which the long rachilla hairs more or less equal the spikelets. Among the species of *Helictotrichon* in Turkey, only *H. compressum* does not have any hairs on the rachilla segments.
Presence or absence of second rhachilla segment: Particularly in genera belonging to the formerly accepted tribe Agrostidea, the presence or absence of the second rhachilla segment has been carefully investigated, and much used in infra-generic grouping. In the genus *Calamagrostis*, *C. arundinacea* and *C. persa*, belonging to Sect. Deueuxia, 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 *Agropyron*, but is often present in a number of other genera, such as *Gaetridium*, *Ammophila*, *Lagurus*, *Trisetum*, *Coryne-putnum*, *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 Agrostidea, spikelets consist of one floret, as in *Phleum*, *Corynephorus*, *Alopecurus*, *Triplachne*, *Rhizoccephalus*, *Agrostis*, *Calamagrostis*, *Apera*, *Lagurus*, *Ammophila*, *Polypogon*, *Gaetridium*, *Milium*, *Zingeria*, etc. In some other genera the spikelets have 2 florets, like *Beckmannia*, *Holcus*, *Coryne-\_phorus*, *Aira*, *Molinieriella*, *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 Rhizoccephalus, Pseudopheum, 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, Heliotrichon, Arrhenatherum, Ventenata, Gaudinia, Gaudinopsis, Trisetum, Parvotrisetum, Rostraria,
Beckmannia, etc. Lemmas are sometimes elliptical, as in Polypogon, Gastridium, Alopecurus, Hierochloë, Milium, Zingemia, etc., or ovate as in Triplachne, Cornucopia and Phleum. Lemmas are oblong in some genera, such as Pseudophleum, Rhizoscephales, 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, Agropyron, 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, Zingemia, Alopecurus, Phleum, etc. In Anthoxanthum and Hierochloë, the uppermost lemma is also obtuse at the apex. In Rhizoscephales 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 Avenae, at least some of the lemmas are usually bifid at the apex, viz. Avena, Helictotrichon, Arrhenatherum, Caudinopsis, Trisetum, Avellinia, Rostraria, Aire, 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 Alopeurus 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 Alopeurus.

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 Zingelia. 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 Agropyron, or dorsal to sub-basal, as in Avena, Helictotrichon, Gaudinia, Gaudinopsis, Triisetum, Trisetaria, Parvotriquetum, Deschampsia, Molineriella, Aira, Corynephorus, Triplachne, Alopeurus, 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 Heliotrichon

a) H. compressum (A. Baytop ISTE 4001)
b) H. argaeum (Stn. & Hand. 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)
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 *Heliototrichon* 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 *Heliototrichon* (*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 *Heliototrichon*, 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.)
lumina are always large. As a general rule in the species of Heliototrichon 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, Heliototrichon (Pl. 4, a), etc. but in the second type cell walls are sinuate, as in Agrostis (Pl. 4, b), Rhizosephalus (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* (Duncun & Tait 34)
   b) *P. pratense* (D.47587)
   c) *P. bertoloni* (Aytug & Yalt. 3309)
   d) *P. echinatum* (Noë 1486)
   e) *P. subulatum subsp. ciliatum* (W. Greuter 10849)
   f) *P. crypsoides* (12 vii 1870, Bourgeau)
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. Alcman 6622)

f) *P. boissieri* (D.28744)
have only slightly different hairs, which are oblong-acute in *P. panici-
ulatum* (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. gibbon*), the hairs
resemble those of *Phleum boissieri* but they are extremely long and
rather pointed at apex (Pl. 4, a). In another similar genus, *Rhizoce-
phalus* (*R. orientalis*), the hairs are clavate, c. 106-120 µ long (Pl. 4, c).
Lemma hairs are extremely useful in distinguishing *Zingeria* (clavate)
from *Mdlum* (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 sub-
species *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) Tripletum flavescens (x 220) (D. 20638)
e) Anthoxanthum odoratum (x 220) (Peşmem & Güner 1312)
f) Triplachne nitens (x 400) (iv 1883, G. Ruhmer)
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 *Phleaeae* 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/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 *Phleaeae*, *Milieae* and *Phalarideae* is the callus either glabrous or missing completely (because of disarticulation of rachilla 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. lasica*, *A. stolonifera*, *A. canina* and *A. gigantea*. In four other species callus hairs are at

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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 (MoNeil 697)
e) A. capillaris (A. Baytop ISTE 33728)
f) A. lazica (Bal. 624)
Plate 8. Length of Palea in *Agrostis*

a) *A. gigantea* (MoNeil 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)
least 150 μ long \( \tilde{A}_s \) olympica (hairs equaling spikelet), \( A_s \) planifolia (280-500 μ ), \( A_s \) castellana subsp. byzantina (150-270 μ ) and \( A_s \) 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 \( A_s \) planifolia and \( A_s \) 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, (\( A_s \) sericeus, \( A_s \) glacialis, \( A_s \) ponticus), turned out to be the same polymorphic species \( \tilde{A}_s \) 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 \( A_s \) arundinaceus from Turkey (B6 Sivas, Tobey 1679) also supports this idea, because though typical \( A_s \) 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 Cormoidea from the tribe Phлеaе (Tsvelev 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)
da) H. pratense (D.37401)
e) H. blavii K.F.J. Maly 234)
f) H. convolutum (Y. Akman ISTE 12238)
Apex: The palea apex is bifid in most of the genera, but in *Anthoxanthum, Phalaris, Hierochloe* 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 *Heliototrichon, 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 *Heliototrichon*, two types of palea surface appearance were discovered. In the first type the palea is completely glabrous (i.e. *H. argaeum, H. armeniacum, H. planiculm, 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 & Josifova (1968). Stebbins (1956) recognised four types of lodicules, viz. fastucoid, 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, Heliototrichon, 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 Rhizosepalus 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, but in Rostraria hiapida anthers are 0.7-1 mm. 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. **Gynoecium**

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 gynoecium has arisen from 2 to 3 carpels intergrown at their edges and presents a modified form of syncarpic 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.) Phalaridinae (*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 exerted 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 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; "Centotheooid", "Eragrostoid", "Crysooid-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 Kings (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 chloridooid cereals. All the revised genera fall within the festucoid type in King's system.

Caryopsis

Length: The size of 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, Helicostachyon 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 michalii, 23 v 1897, Amn.)

f) Trullate (Rostraria cristata, F. Chesler & T. Deaver 144)
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, Agra 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 Cornucoopia).

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 Cornucoopia). 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 bertoloni). 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. Gäner 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. crypsoidea (22 vi 1870, Bourgeau)
f) P. arenarium (v 1872, J. Ball)
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, Polygono*, *Gastridion, Triplachne, Milium, Anthoxantum* and *Hierochloë*, caryopsis shape is elliptical. Caryopsis shape is occasionally ovate, as in *Pseudophium* (Pl. 10, c) and *Rhizosephalus* (Pl. 10, d). In *Antinoria, Phalaris, Alopecurus* and *Cormocopia*, caryopsis shape is obovate.

In *Alopecurus* and *Cormocopia* the caryopsis is rather rounded on the ventral side and sometimes defined as obliquely-ovoblate. 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, 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 Farz (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"), festuroid ("Chesnut-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 festuroid 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. orypsoide*, *P. pandulatum*, *P. arenarium*, *P. exeratum* and *P. boissieri*. These two major types of caryopsis surface appearance clearly distinguish perennial species from annual ones.
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 Carnoy'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 pretreated 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:

<table>
<thead>
<tr>
<th>Species</th>
<th>Collector numbers</th>
<th>2n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrostis canina</td>
<td>A. Baytop (ISTE 33691)</td>
<td>14</td>
</tr>
<tr>
<td>Aira elegansis</td>
<td>A. Baytop (ISTE 15437)</td>
<td>14</td>
</tr>
<tr>
<td>Apera baytopiana</td>
<td>Leblebiçi, Seqmen &amp; Bekat 2857</td>
<td>14</td>
</tr>
<tr>
<td>Apera spica-venti</td>
<td>A. Baytop (ISTE 13501)</td>
<td>14</td>
</tr>
<tr>
<td>Arrhenatherus elatius</td>
<td>A. Baytop (ISTE 20789)</td>
<td>28</td>
</tr>
<tr>
<td>Alopecurus aequalis</td>
<td>Tobey 774</td>
<td>14</td>
</tr>
<tr>
<td>Alopecurus gerardii</td>
<td>Pasmukqugolu &amp; Quezel (NIB)</td>
<td>14</td>
</tr>
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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 Avenaeae (incl. Agrostidées), Milieae, Phalaridées and Phleeae in Turkey on the basis of their overall similarities and dissimilarities. 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, Rhizoccephalus, 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. Mailea).

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 interconneced 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 myosuroideas* var. *lataelatus*).

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

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*, *Deserti-colae* and *Tianshanicae* 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
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two subgenera, Pubavenastrum and Avenula. He went further and distinguished two sections, Avenula and Seleravenastrum in the latter subgenus.

Various treatments of the genus Helictotrichon \textit{a}l. over a 92 year period are briefly summarized in Table III and all the species previously placed under each infrageneric \textit{taxon} by Boissier (1884), St.-Yves (1931), Komarov (1953), 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 solerendyma 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 solerendyma present below the abaxial epidermis.

Type: \textit{H. sempervirens} (Vill.) Pilger

**Sect. 2. Unistrata M. Dogan**

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

Type: \textit{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(-4)-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* (Ascheron & 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. baokelii (Henrig) Henrard

Discussion

All the perennial species of Avena s.l. are retained here under one genus, Helicotriohon. 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, Helicotriohon and Avenula, are not separate genera but 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 Helicotriohon or to section Helicotriohon 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 Helicotriohon. In the other subgenus, Avenula a new monotypic section Blavia (based on H. blavi) 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 *Flora Rossica*, recognised two sections, *Colobachne* and *Eualopecurus* in this genus. Boissier (1884) distinguished two groups, Annu and Perennes, and did not consider the previous work. Later Grisebach's infrageneric grouping was accepted in the work of Ascherson and Graebner (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*, *Alopecourium* 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 ½ 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 ¼ - ¾ of their length above the base, usually with a rather narrow wing on the keel. Epidermal cells of glumes rather deeply sinuous, each
<table>
<thead>
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<th>Table IV</th>
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<tbody>
<tr>
<td>Sect. Colobachne</td>
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<tr>
<td>Sect. Euclopecurus</td>
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<tr>
<td>Sect. Alpines</td>
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<tr>
<td>Sect. Annum</td>
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<tr>
<td>Sect. Pseudephalaris</td>
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</tbody>
</table>

| Group Annul | A. agritici | A. creticus | A. utriculatus | A. agritici | A. creticus | A. utriculatus |
| Group Porennes | A. geniculatus | A. fulvus | A. geniculatus | A. fulvus | A. geniculatus | A. fulvus |
| Sect. Annual | A. agnatus | A. tiflilanium | A. geniculatus | A. agnatus | A. tiflilanium | A. geniculatus |
| Sect. Pseudephalaris | A. myosuroides | A. tiflilanium | A. geniculatus | A. myosuroides | A. tiflilanium | A. geniculatus |
| Sect. Alpines | A. leuc | A. sarcochaenius | A. dagipiaus | A. longiaristatus | A. dagipiaus | A. longiaristatus |
| Sect. Annum | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |
| Sect. Pseudephalaris | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |

| Sect. Colohechno | A. ponticius | A. vaginatus | A. vaginatus | A. vaginatus | A. vaginatus | A. vaginatus |
| Sect. Euclopecurus | A. macronatus | A. geniculatus | A. macronatus | A. geniculatus | A. macronatus | A. geniculatus |
| Sect. Alpines | A. leuc | A. sarcochaenius | A. dagipiaus | A. longiaristatus | A. dagipiaus | A. longiaristatus |
| Sect. Annum | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |
| Sect. Pseudephalaris | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |

| Sect. Colohechno | A. ponticius | A. vaginatus | A. vaginatus | A. vaginatus | A. vaginatus | A. vaginatus |
| Sect. Euclopecurus | A. macronatus | A. geniculatus | A. macronatus | A. geniculatus | A. macronatus | A. geniculatus |
| Sect. Alpines | A. leuc | A. sarcochaenius | A. dagipiaus | A. longiaristatus | A. dagipiaus | A. longiaristatus |
| Sect. Annum | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |
| Sect. Pseudephalaris | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |

| Sect. Colohechno | A. ponticius | A. vaginatus | A. vaginatus | A. vaginatus | A. vaginatus | A. vaginatus |
| Sect. Euclopecurus | A. macronatus | A. geniculatus | A. macronatus | A. geniculatus | A. macronatus | A. geniculatus |
| Sect. Alpines | A. leuc | A. sarcochaenius | A. dagipiaus | A. longiaristatus | A. dagipiaus | A. longiaristatus |
| Sect. Annum | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |
| Sect. Pseudephalaris | A. myosuroides | A. longiaristatus | A. nepalensis | A. nepalensis | A. nepalensis | A. nepalensis |
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 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 (Wild.) Boiss.

Sect. 4. Tozzettia (Savi) Endl.

Annual. Panicle ovate to broadly cylindrical. Glumes acute, connate for 3/4-1/2 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, Pseudoephalaria, 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 davisi 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, Chilochoa and Euphleum in Phleum. Boissier (1884) divided the genus into two groups, Annuum and Perennia, on the basis of habit. Boissier also recognised another monotypic genus, Mailea, next to Phleum. In the works of Asoherson and Graebner (1902), the previously recognised sections, Euphleum and Chilochoa, were recognised and Mailea 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, Chilochoa 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. Mailea, 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.
|---------|------------------|------------------|-------------------------|----------------|-------------|---------------------|----------|
| Sect. Achnodon | P. tenu

*Note: The table is a botanical classification table showing different sections and species within the family of plants.*
Sect. 2. *Chilochoa* (Beauv.) Peterm.


Type: *Chilochoa boehmeri* Beauv. \(= P. \text{phleoides} \text{ (L.) Karsten}\)

Sect. 3. *Maillea* (Parl.) Horn af Rantzen


Type: *Maillea crypsoides* (D'Urv.) Boiss. \(= P. \text{crypsoides} \text{ (D'Urv.) Hackel}\)

Sect. 4. *Achnodon* (Link) Griseb.


Type: *Achnodon bellardii* (Willd.) Link \(= P. \text{subulatum} \text{ (Savi)}

Ascherson & Graebner

Discussion

The previously recognised four sections, *Phleum*, *Chilochoa*, *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 microcharacters show that it belongs to section *Chilochoa*. Section *Achnodon*, based on *Phleum tenue* (= *P. subulatum*), includes another two species, *P. exeratum* and *P. boissieri*, which were previously placed in section *Chilochoa* 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 Chilochoa.
CHAPTER VII

7. Revision of Turkish Avenaeae Dum. (incl. Agrostideaee Dum.).

Milieae End!, Phalarideaee Benth., and Phleeae Dum.

7.1. Introduction

In the area covered by the Flora of Turkey and East Aegean Islands (Davis, 1965-), the tribes Avenaeae (incl. Agrostideaee), Milieae, Phalarideaee and Phleeae are represented by 36 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 Akmam, Y., Asnavour, C.V., Bagda, H., Balansa, B., Balls, E.K., Baytop, A. & T., Biram, H., Bouquet, G., Boissier, P.E.E., Bormulller, J.f.N., Buttler, K.P., Cooks, M.J.E. & Jones, B.M.C., Gotik, R., Davis, E.H., Demiriz, H., Ehrendorfer, F., Ekim, T., Huber-Morath, A., Karamanoglu (Bilger), K., Kasapligil, B., Krause, K., Leblebioi, E., Pem, H., Post, B. & G., Sengen, O., Sorger, F., Tobey, C., Yaltirik, F. and Yurdakulol, N. 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, ISZE, NGE, MUB) were examined, and some of the collections were borrowed for further examination. Two trips were made to major herbaria in London and all the relevant 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. Intra-generic classifications for the genera Heliotrocho, Alopecurus and Phleum are given in Chapter VII. A synopsis of the sections occurring 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 F.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

5. Lemma glabrous and shiny .............................. 28. Milium

3. Spikelets laterally compressed

5. Rachilla disarticulating below glumes; spikelets falling entire ..................................... 24. Polygono

5. Rachilla 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 nutlet

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

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

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

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

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

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-ovulate; panicle ovate in outline

16. Glumes glabrous; panicle oblong to elliptic in outline

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

17. Both glumes 3-veined; lemma awnless or dorsally awned
18. Lemmas 3-veined, keeled, with an awn (usually); rhachilla disarticulating below glumes ........ 32. Alopaeurus
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. Ventsenata
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

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

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

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

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

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

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

33. Lemmas with 2 setae at apex

33. Lemmas shortly bifid at apex

*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 2 x as long as lemma .......... 10. Avellinia
34. Lower glume 1/2 to 2 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. Heliototriodon
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 second, 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
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, dorsallyawned; 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 ⅓ of its length; hilum basal and punctiform.

Type: A. sativa L.

Literature:

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. glauca

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

Syn: Trisetum pilosum Roem. et Schults, Syst. Veg. ed. 15, 2: 662 (1817);
Ho: 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, subsessile; 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. Rachilla 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 mêmes lieux que A. olunda", Durieu /&so. Kit/ W. and C. Anatolia.

A2(A) Bursa: Uludag, Sint. 1883: 67!
B1 Manisa: Manisa Da., A. Baytop (ISTE 6371a)!

Izmir: Izmir, 30 iv 1854, Bel.!

C5 Iğel: Iğel, 18 iv 1855, Bel.!

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

Mares d. Pazarcık: between Narel and Karabıyıkli, 600-700 m, D.27803!

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

C9 Siirt: Sırnak to Gire, 14 km from Sırnak, 610 m, D.42688!


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


Like A. eriantha Durieu, but spikelets with 3-5 florets; Rachilla 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.\(^7\)

W. & S. Anatolia.

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

C5 Iğal: Iğal, 27 iv 1855, Bal.\(!\)

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


Annual. Stem 25-120 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, subscand, 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. atheranthia

subsp. barbata

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

Typus: \[\text{Portugal}\] "Ex cult. mee 1796, hab. in Lusitania", Herb. Pott \[\text{Lm}\]

Widespread, but rare in N. and Inner Anatolia.

A1(E) Edirne: Karaağaç to Edirne, A. Baytop (ISTE 6611)
A2(E) İstanbul: Belgrad forest, Kayacık 46
A3 Bilecik: between Osmanyeli and Bilecik, A. Baytop (ISTE 9309)
B1 Izmir: Kargıyaka to Bornova, T. Gölzler (ISTE 19862)
B3 Eskişehir: Sındırgan Da., Gölçayakapa dam, T. Erkin 516
B9 Bitlis: Kermet Köy, 65 km S. of Bitlis, 4 vi 1967, J. C. Ross
C2 Mucia: 13 km S. of Fethiye, O. Polunin 13995
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. Rhodes: M. Profeta, 600 m, Rocch. 7100

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

subsp. atheranthera (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) İstanbul: Yıldız parkı, A. Baytop (ISTE 764,5)

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


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


Lo: 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 40 mm, geniculate, twisted below. Palea 9.5-10.5 mm, ciliate on keel. Rachilla disarticulating above glumes and between florets. Fl. 4-6. Stony field, sandy soil, sea level-1250 m.

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

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

A2(A) Istanbul: Yakasik, 6 v 1894, Ann.!


B1 Izmir: Büyük Yamanlar, S., Orfas 55!

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

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

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

C2 Muğla: Marmaris, D. 4422!

C3 Antalya: Bahceli Evler, 30 m, F., Hanniman et al. 533!

C4 Konya: Ermenek, 1250 m, M., Degan 129
C5 Adana: Adana to Karatas, 9 km S. of Adana, Coode & Jones 2191

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


Annual. Stem 45-80 (-150) cm, erect to geniculately ascending, glabrous. Leaf blades 43-26 cm x 4-10 mm, linear, acute, scabridulous 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, bidenticate to almost bifid, dorsally awned, hairy in lower half; awn 20-35 mm, geniculate, twisted below. Palea 13-16 mm, ciliate on keel. Rachilla 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
2. Lemmas completely glabrous ............................... var. glabrata

var. fatua

Io: Sib, Fl. Iraq 9: 335, t. 124 (1968);
Typus: "Hab. in Europae agris inter segetes" Fl. Linn. 9/95

Inner & N.E. Anatolia.
A8 Coruh: Hapa, D. 29829
B6 Sivas: 55 km S.W. of Sugahri, 1510 m, D. Spencer 4021
C5 Nigde: 3 km N.W. of Ulukila, 1400 m, F. Holtz et al. 634.

Typus varietatis: Ignotus.

N.E. and N.W. Anatolia.

A2(A) Bursa: Bursa, Thirke

A8 Rize: Ciniil, Balansa

Is. Imros, Forsk.

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


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 3-6 mm, obtuse. Panicle 6-30 cm x 4-12 cm, pyramidal, equilateral to subsessile; 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 ①, dorsally awned; awn 5-7 cm, geniculate and twisted in lower half. Palea 16-25 mm, ciliate on keels. Rachilla 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 Paolotti, *In. Pl. Ital.* 1: 29 (1895);

Fl. 3-8. Limestone slopes, cultivated land, pebble beach, 50-1800 m.
Typus: Regio Mediterranea. Fl. Linn. 12/957
Mainly W. and S. Anatolia, Islands.

A2(E) Istanbul: Yildiz Parki, A. Bayton (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, Caucasus, S.W. Asia eastwards to E. Asia.

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" Fl. Linn. 12/957, Durieu /Iso KI7
Mainly S. and E. Anatolia, rare in W. Anatolia.
A8 Rise: Gündoğdu, 40 m, M. Dogan 320
A9 Kars: between Kars and Susus, 1800 m, D. 30648
B2 Manisa: Demirci, 700 m, Coode & Jones 2759
B8 Siirt: Silvan to Kurtalan, D. 22125

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


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


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, bidenticate, 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, Ann.

A2(E) Istanbul: Meydakiske to Catalca, A. Bayton (ISTE 13091)

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

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

C3 Konya: nr. Seydieshir, J. Bordaz 9

C5 Igel: Bolkar Da., Gölpinar, 10 km S.W. of Arslanköy, 1900 m,

Peat et al. 218-11-76


Syn: A. sterilis subsp. byzantina (C. Koch) Thell. in Vierteljahrs.


An 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 sub-equal; 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. Rachilla 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.
Typos: [Turkey] "Konstantinopel", C. Koch

N.W. Anatolia.

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

A2(A) Bursa: Bursa, Thirka

A8 Rize: Gündoğdu, 0.40 m, M. Dogan 326!

2. *HELIOTOTRICHON* 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, Sesn. Rostl. Kvet. Ceske: 20 (1852);

*Avenula* (Dumort.) Dumort, in Bull. Soc. Bot. Belgique 68 (1868);


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 conuplicate 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. Rachilla disarticulating above glumes and below florets. Lodicules 2. Stamens 3. Caryopsis hairy at apex, oblong.

Type: *H. planiculme* (Schrader) Pilger

(Avena planiculmis Schrader).

Literature:


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

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

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


Cavanilles 17 (1): 257-375.


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

Syn: Avena convoluta C. Presl, Gram. et Cyp. Sic. 31 (1820);
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 0.5-0.5 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. Fls. 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 681, 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 (IST 12235!)

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


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

Avencchloa compressa (Heuffel) Holub in Acta Horti Bot. Prag. 34 (1962);


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, glaucous-cosecent; cauline leaf blades 0.8-6 cm long, appressed to stem; sheath glabrous; 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.


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

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

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

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

A2(A) Istanbul: Yakacik to Aydos, A. Baytop (ISTE 9655)!

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

B3 Eskisehir: Sundiken Da., Kusucuk göl, 1500 m, T. Ekin 932!

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


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


Laxly cespitose 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 1-3.5 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. Rachilla 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, in regione alpina montis Argaei Cappadociae, 1280 m, 9 VII 1857, (Balansa 847, sub A. pratenai) Holotype N. and E. Anatolia.

A7 Giresun: Balaban Da. (Kiliq Tepe) above Tandere, 2900 m, D 20546!
A8 Rize: Rize to Ispir, 3000 m, Stn. & Hand. 6274!
Artvin: Magara Y. Savval tepe, Murgul, 2400 m, Stn. & Hand. 6030!
A9 Erzurum: Kop Da. pass, 2743 m, D. Furse 3803!
A9 Artvin: Yalnizcam Da. W. side of pass between Ardahan and Artvin, 2400 m, D 32537!

Endemic. Ir.-Tur. element.

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

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

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, 2.5-4.6 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. Rachillaa 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. Pl. 7. High mountain slopes, 2000-
2170 m.

Type: [Turkey A9 Karz] "Hab. Armenia, in pratis prope opp. Sarikamiş,
alt. 2170 m", [vii 1915] Saposhnikov. [Flora L] Caucasie
External distribution: Euro-Sib, element.

Syn: Avena pratensis L., Sp. Pl.: 30 (1753);
Avenastrum pratense (L.) Opiz, Seznam Rostl. Kr. Ceske: 20 (1852);
H. pratense (L.) Pilger in Feddes Rep. 45: 6 (1938);
Loc: Reichb., In. Fl. Germ. 1: t. 102 f. 207 (1850);

Densely caespitose perennial. Stem 30-85 (-100) cm, erect,
slender, glabrous, smooth, with 1-2-nodes in lower part. Leaf blades
6-25 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.
Rachilla 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 pasquiis siccis apricis" \( \sqrt{\text{Hb. Linn. 95/171}} \)

Inner and S. Anatolia.

B6 Sivas: Sarıküla, N. slope of Göläde Da., 2000 m, T. Ekim & A. Düzenlı 3850!

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

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


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.

Rachilla hairs 3-5 mm. Lemma 9-20 mm, oblong-lanceolate, 2-fid, dorsally awned; callus hairs 2-3 mm; awn ca. 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

2. Spikelets 20-26 mm; lower glume 14-16 mm
   Subsp. longifolia

Subsp. pubescens

Syn: Avena pubescens Hudson, Fl. Angl. 42 (1762);
Avenastrum pubescens (Hudson) Opiz, Sesam Rostl. Květ. Česká: 20 (1852);
Avenula pubescens (Hudson) Dumort. in Bull. Soc. Bot. Belg. 7: 68 (1868);

Loc: Reichb., Fl. Germ. 1: t. 213 (1850);
Hubbard, Grasses 230 (1968).

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

Type: England "Hab. in pratis et pastuis sicciolis, supra Banstead Downs copioso", Hudson.

N. and W. Anatolia.

A2(A) Bursa: Uludag, 1300 m, Bornm. 5648!
A3 Ankara: Baypasari, Egriova to Benli road, 1400 m, Y. Akman 8729!
A4 Cankiri: Ilgas Da., 1630-1680 m, Hub.-Mor. 14096!
A5 Amasya d. Mersifon: Bogha armut Y., 1000 m, G. Alpay 374!
A8 Rize: Cemil, 2000 m, 18 vii 1866, Bel.!
A9 Kara: Yagmurlu Da. between Sarikamış and Karaman, 2300 m, D.30812!
B2 Kütahya: Gediz, Murtat Da., between hamam and Cukuruken köy, 1500 m,
B3 Konya: Aksahir, Sultan Da. above Tekke, 1940 m, A. Baytop (ISTE 374,33);

C6 Hatay: Amanos Mount., 800 m, Y. Akman 5015!

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

Euro-Sib. element.


Syn: Avana hirtifolia Boiss., Diagn. Ser. 1 (4): 126 (1859);

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

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

Pl. 5-7. Mountain alone.

Typus: [Turkey] B2 Kittahya "Neb. in monte Tchabandagh prope Guedis Phrygise " Belange /Falo Gi/

Central (western part) Anatolia.

B2 Kittahya: Gudis, Fighena Da., 19 vii 1897, Bal.!

B3 Konya: Aksahir, nr. Tekke koy, G. Dökücü (ISTE 28777)

Endemic.


Syn: Avana versicolor Vill., Prosp. Fl. Dauph., 17 (1779);

Heuffalia achenheeri Schur, Rauw./Trans.: 763 (1866);

Avanastrum versicolor (Vill.) Fritsch, Expulsionfl. Gesterr.: 53 (1897);


Loxly 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, glaucous, with 3-4 lateral veins on each side of mid-vein, linear, acuminate, connuplicate; 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. Rhaebelia 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.

A8 Rize: Buzdogan Da., 2659 m, viii 1866, Bel.!

Rize: Iksidere to Isipir, 2400 m, Ehrenl. et al. 787-157-14!
B5 Nigde a. Aksaray: Hasan Da., 2500 m, A. Duzenli 444!

element.


Syn: Avena planiculmia Schrader, Fl. Germ. 1: 381 (1806);

Avenastrum planiculm (Schrader) Opiz, Sesnam Rostl. Květ.
České: 20 (1852);

Avenochloa planiculmia (Schrader) Holub in Acta Horti Bot. Prag:
84 (1962);

Avenula planiculmia (Schrader) Holub in Folia Geobot. Phytotax.
(Praha) 11: 30 (1976).

Ia: Reichh., Ia. Fl. Germ. 1: t. 104 f. 211 (1850);


Cespitose 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. Rachilla 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 Gümüşhane: Soganli pass between Caykara and Bayburt, 2250 m,

F. Holts 1129!

External distribution: C. Europe, Jugoslavia, Bulgaria, S. Russia.
3. **ARRHENATHERNUM** 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. Rachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis oblong, terete, hairy; embryo 1/6 x as long as caryopsis. Hilum linear, 1/2 x as long as caryopsis.

Type: *A. aveneum* (Scop.) Beauv. = *A. elatius* (L.) J. et C. Presl.

Literature:


**Key to Species**

1. Second rachilla segment 0.5-1 mm; awn of lower floret 10-20 mm, arising in lower 1/3 of lemma; upper floret glabrous to slightly hairy

   1. *elatius*

1. Second rachilla 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*


*subsp. elatius*

**Syn:** *Arena elation* L., Sp. Pl. 79 (1753).

**Io:** 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. Rhaehilla segment 0.5-1 mm. Lemmas 6.5-10 mm, oblong-lanceolate, 2-dentate at apex, glabrous to slightly pilose (0. 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., Linna. 95/217

N.W., W. S. and Inner Anatolia.

A2(A) Istanbul: Tunkar Iskelesi, nr. Anadolu Hisar, 29 vi 1895, Aam.

A3 Ankara: Beypazari above Karasar, 1 vii 1972, X. 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: Kazisman, Grossheim I: Map 196
The presence of *A. elatius* subsp. *bulbosum* (Willd.) Schübler & Martens in the East Aegean Islands (Kalymnos), 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.


Syn: *A. elatius* var. *palaestinum* Boiss., Fl. Gr. 5: 550 (1884).

Gasaspitose 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 (-6) 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, acuminate. 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: "Tab. in Palaestina loco non notato", Boissier

Widespread except N. and easternmost Anatolia.

A2(A) Bilecik: nr. Gümüşbe, A. Baytop (ISTE 9321)!

B1 Balıkesir: Kaz Da., Menderes Dere, Sint. 1883: 104!

B2 Kütahya: 12 km from Kütahya to Bozüyük, 900 m, Hub.-Mor. 12488!

B5 Kayseri: Ali Da., 1350 m, A. Baytop (ISTE 37635)!

B7 Tunceli: between Pertek and Elazığ, 7 km S.W. of Pertek, 1200 m, E. Hannipman et al. 1550!

C2 Aydın: between Bozdogan to Cine, nr. Topcahaba forest fire tower, 1485 m, T. Uslu 5748!

C3 Isparta: Devrek Da., above Sou Köy, A. Baytop (ISTE 964,5)!

C4 Konya: Beşkira, Haydar Da., 2000 m, R. Getik 145!

C5 Iğal d. Tarsus: Gülük Bogaz, 820 m, Hub.-Mor. 14097!

C6 Hatay: Nur Da., Belen pass, 700-850 m, K.P. Butler 13020!

C7 Urfa: Birecik, Sint. 1888: 541!

C8 Mardin: 24 km from Mardin to Diyarbakır, 1000 m, D.23854!

Is. Lesvos: Mt. Ordianos, at Ipsilon Monastery, 500 m, J.R. Edmondson 2626!


Io: 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, sayng. Glumes lanceolate, acuminate; lower glume 6.5-9 mm; upper glume 12-13.5 mm. Rachilla 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: \( \text{Iran}^7 \) "Hab. in rupestribus et glareosis propus ruinas Persepolis", \( \text{iv 1847}^7 \); Kotsch. 272 \( \text{E}^7 \); Iso \( \text{E}^7 \)

Rare in E. Anatolia.

B7 Sivas: Divrigi, Dumlucu Da., T. Baytop (ISTE 12578);

External distribution: Caucasus, W. Syria, Syrian Desert, N. Iraq, Iran, Afghanistan.
4. **GAUDINTA** P. Beauv., Ess. Agrost. 95 (1812)


Type: *G. fragilis* (L.) Beauv.

**G. fragilis** (L.) Beauv., Ess. Agrost. 164 (1812).


Loc: Sibth. & Sm., Fl. Graeca 1, t. 88 (1808); Reichb., In. 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 1.5 mm, arising in upper 1/2 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, 0-14.85 m.

Described: "in Lusitania, Hispania" Loebling f. Linn. 95/161.
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, Asm.!

A7 Trabzon: Soguksu, 550 m, E. K. Balls 403!

B1 Izmir: Göztepe, 7 v 1906, Forum 10187!

B2 Balikesir: Kertil near Sindirgi, A. Baytop (ISTE 10105)!

B4 Nevsehir: 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

5. *VENTRINATA* Koel., *Descr. Gram.*: 272 (1802)


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. Lodicles 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 \( \frac{3}{4} \)-4/5 x as long as the upper one,
   5-7-veined; upper glume 7-9-veined ............................ 1. *dubia*

2. Lower glume \( \frac{1}{2} \) x as long as the upper one, 3-veined;
   upper glume 5-veined ........................................ 2. *subenervis*


Loc: *Fiori, Io.* *Fl. Ital.* 1: 28, f. 241 (1895);


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.


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, Asm.!
A3 Ankara: Beypasari, Egriova, 1550 m, Y. Akman 8727!
A4 Ankara: Çamkoru, 1300 m, O. Alpay 86!
B1 Izmir: Yamanlar Da., Karagöl, E. Alava & G. Beauchet 5072!
B3 Eskişehir: Türkmen Da., Belece district, T. Akın 2314!
B6 Adana: Saimbeyli to Göksun, 56 km E. of Saimbeyli, 1520 m,

Hub.-Kor. 11622!

External distribution: Mediterranean (except E. Mediterranean), C. Europe, Crimea, Caucasus, S. Russia.


Annual. Stem 7-43 cm, slender, erect. Leaf blades up to 4-5 cm, narrow; linear, hairy on upper surface, involute; ligule up to 4 mm, acute, somewhat lacerate. Panicles 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. sets), 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", v 1853, Balansa [Iso El7]

W. Anatolia.

B1 Izmir: Cesme, 50 m, K.P. Buttler 12327!

B1 Manisa: Manisa Da., T. Baytop (ISTE 6392)!

B2 Uşak: Kara Göl Dere, 700 m, Bal. 1336!

Is. Lesbos: Udja, Plati, Candarly

Endemic to Turkey and the East Aegean Islands. E. Mediterranean element.

3. V. eidi (H. Scholz) M. Dogan (ined.)


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 westlich Bongöl, 14 vii 1981, Raus 4014 [B7]

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. Rachilla disarticulating above glumes and between florets. Lodicles 2. Stamens 3. Caryopsis elliptic-oblance.

Type: G. macra (Stev. ex H. 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 macro from sinus (c. 1 mm) ............ 4. humer-morathi

2. Panicle rather dense; lowest lemma in each spikelet without a macro from sinus

3. Glumes and lowest lemma in each spikelet acuminate; upper lemmas and rachilla segments hairy

.............................. 2. quercostorum

3. Glumes acute; lowest lemma acute to shortly bifid; upper lemmas and rachilla segments glabrous ....... 1. macra

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 4.3 cm ........................................... subsp. *maora*

1. Spikelets 6-8 mm, always dark purple; glumes 3-4 mm;
   - stem up to 13 cm ........................................... subsp. *antalyensis*

subsp. *maora*

Syn: *Avena maora* M. Bieb., Fl. Taur.-Cauc. 1: 77 (1808);

*Ventenata maora* (M. Bieb.) Boiss., Fl. Or. 5: 540 (1884).

**Loc:** Bor, Fl. Iraq 9: 345, t. 130 (1968);

Bor, Fl. Iranoica (Gramineae) 70, t. 50 (1970).

**Fl.** 4-6. Open dry places, fallow fields, under Pinus and Tamarix scrub, 0-1750 m.

**Typus:** /Caucasia/ "Hab. in Iberia", Steven /Folo LEI/7

Widespread in Anatolia, but rare in N.

**A5** Sinop: Kargi, Köş 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 Kiseg, 1400 m, D.19258!
B8 Siirt: 28 km from Siirt to Baykan, 800 m, D.43191!
B9 Van: Timar to Bendimahi, 50 km from Erciğ, 1750 m, D.44200!
C2 Antalya: 31 km S.W. of Elmali, 1200 m, F. Sorger 67-23-5!
C6 Hatay: Rabat nr. Dörtyol, Coode & Jones 476!
C7 Urfa: Birecik, Kefre, Siirt. 543!
C8 Mardin: Savur, 900 m, D.28563!


subsp. antalyensis M. Dogan (ind.)
Fl. 6-7. Rocky slopes, 300-1350 m.

Typus: [Turkey C3 Antalya] "15 km südlich Korkuteli in Richtung Elmali, stark von Ziegen beweidetes Odland, 1350 m",

\[\text{\textcopyright} \text{vii 1973, F. Holts (494), P. Hanel \& T. Kesercioglu}\]

\[\text{S.W. Anatolia.}\]

B2 Burdur: 51 km N. of Fethiye, Altinyayla, 1000 m, Hub.\-Mor. 5546!
C3 Antalya: 6 km from Elmali to Korkuteli, R. Alava \& G. Bouquet 5256!
C3 Antalya: 3 km S. of Hafispaşa, 800 m, Hub.\-Mor. 5547!

Local endemic. E. Mediterranean element.

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<tr>
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<th>subsp. mara</th>
<th>subsp. antalyensis</th>
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<tr>
<td>Stem</td>
<td>up to 43 cm</td>
<td>7-13 cm</td>
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<tr>
<td>Spikelet</td>
<td>8-17 mm</td>
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<td>L. Glume</td>
<td>4-6.5 mm</td>
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<tr>
<td>Awn</td>
<td>7-10 mm</td>
<td>3.5-7 mm</td>
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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. Spikeslets 8.5-10 mm, with 5 florets. Lower glume 4.5 mm; upper glume 6 mm. Lemma 0.7 mm, glabrous, upper ones covered by pubescence especially in lower part and margins; awn 0.8 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 Bulgar Keui [Bolak Koy] Phrygiae, 950 m", 14 vii 1857, Balansa [Folo Gi, Iso K]

Endemic. E. Mediterranean element.


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 2-3.5 mm, puberulent. Spikeslets 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; rachilla 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: Romeo prope oppidum Messina, in litore arenoso maris.  
Morocco: Tangier, in arenosis maritimis.

Turkey-in-Europe, W. Anatolia, Islands.

A1(E) Çanakkale: Arıburmu, A. Baytop (ISTE 14770)!  
A1(E) Edirne: Enes, A. Baytop (ISTE 15733)!  
A1(E) Kirklareli: İgneada, A. Baytop (ISTE 13980)!  
A2(E) Istanbul: Florya, 20 vii 1890, A. 2382!  
B1 Izmir: Çeşme, C. Regol 18929!  
C1 Aydın: Kusadasi, Gâselcamli dunes, T. Uslu 3926  
Ia. 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.

Stem 0.5. 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**


Loc: Kulczynski, Atlas Fl. Polski, 4 (2): 403 (1932);
Hubbard, Grasses 290 (1968).

Annual. Stem 20-70 (-100) cm, tufted or solitary, erect to geniculate at nodes, slender 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, 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 5.5-8.4 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 Linn. 6/117

Turkey-in-Europe, W. Anatolia.

A1(E) Edirne: Enes, A. Baytop (ISTE 15793a)!
A1(E) Kırklareli: Demirköy, A. Baytop (ISTE 5465)!
A1(E) Tekirdağ: Gölüğü Köyü, A. Baytop (ISTE 13501)!
A2(E) İstanbul: Yağılıköy, 12 VI 1946, Asm.!
A3 Ankara: d. Beypaşar, Deliyer, Cuma deresi, 1400 m, Y. Akmam 15!
B3 Eskişehir: 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.


**Loc:** Reichb., *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, rather slender, 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.


**Loc:** 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, secaloid towards apex, glabrous at base; callus glabrous at base; callus glabrous; awn 9-9.5 mm. Anthers 1.2-1.5 mm. Fls. 5-7. Dry slopes, sandy river banks, open places, woodlands, 1000-1860 m.

Typus: Turkey B5 Kayseri, Erzincan Da., zwischen Sosisaluyd Evrek o., 1100 m, (10 vi 1902), Panther & Zederbauer [WU].

Widespread except in S. Anatolia.

A2(E) Istanbul: Yagilkoy, 12 vi 1861, Asm.!

A9 Kars: Kagusman, Grosheim I: Map 179

B2 Kutahya: 15 km from Cadi to Ugaz, 1140 m, Hub.-Mor. 12595!

B3 Afyon: 18 km from Cay to Afyon, 1000 m, Coode & Jones 2377!

B4 Konya: Yavuz Nemlehan Nr. Tus Göl, D. 18690A!

B5 Nevşehir: Acıkasaray Nr. Gülşehir, 1150 m, J. Roger 133!

B6 Maraş: Gıksun to Elbistan, 1400 m, Ste. & Hend. 5582!

B7 Erzincan: Egin (Kemaliya), 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 Diyarbakır, 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/Yıkzakova road junction, 1550 m, D. 44662!

External distribution: Caucasus, N. Iraq, N. Iran.


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 0.3-1.6 mm, slightly scarbid. 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 3.3-5.5 mm, lanceolate; aristate point 0.4-0.7 mm. Lemma 1.5-2.1 mm, rather firm, scarbid especially in upper half, almost terminally awned; awn 1-2.3 mm, straight, slightly scarbid. 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, Karabürtten", 30 vi 1972, E. Sebőbiczi, 8. Segmen & L. Bekat 2857!


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, scarbid. 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 6.5-7.5 mm, straight or slightly bent, scarbid. 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! Flb. 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. Rachilla disarticulating above glumes. Lodicules 2. Stamens 3.
Caryopsis elliptic to ovoid.

Type: A. alba L. = A. stolonifera L.

Literature:


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 exerted 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 1/3 as long
   as lemma .................................................. 8. *balansae*

8. Spikelets 1.5-2.5 mm; palea 1/2-2/3 as long
   as lemma .................................................. 6. *ospillaris*

6. Lemma without awn, or awn not exerted

9. Ligules of non-flowering shoots longer than wide;
   panicle branches aculeolate .............................. 5. *gigantes*

9. Ligules of non-flowering shoots usually broader than long; panicle branches smooth .......... 6. *ospillaris*


Io: 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 "Fab. in rupestribus regionis alpini Olympi Bithyni sat rara, legi floriferam" July 1842, Boissier

N., C., and E. Anatolia.

A2(A) Bursa: above Kilimli Göl, A. Baytop (ISTE 20936)?

A6 Gümüşhane: 23 km N. of Aşkale on road to Trabzon, 2390 m.

P. Uotila 1964?

Rize: Cimil, c. 2500 m, viii 1866, Bal. 1543?

B5 Kayseri: Erciyes Da., c. 2150 m, F. Sorger 77-75-15!

C5 Nigde: Bulgar Maden, 22 vii 1855, Bal.

C10 Pankari: Sat Da. (above Yükselova), 2800 m, Duncan & Tait 57!

External distribution: Lebanon, Caucasus, Transcaucasia, Iran, Afghanistan, W. Pakistan. Euro-Sib. (mt.) element.


Ic: Reichb., Ic. Pl. 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.
Spikelets 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 pasquis humidiusculis", L. Linn. 24/12

N.W., C. and E. Anatolia.

A2(a) Bursa: Uludag, 1800 m, A. Baytop (ISTE 33691)

A4 Bolu: Çamkolu, 81 km from Bolu to Ankara, M. Tanker (ISTE 6534)

Ankara: Kızılıkahan, Ali Da., 1250 m, Khan et al. 572

B9 Bitlis: Nemrud Da., 10 viii 1906, Ass. 708


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. rupestris Boiss., Fl. Or. 5: 517 (1884);


Laxly cespitose 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 0.9-1.8 cm,
lanceolate, rather dense, dark purplish; branches 1.5-4.5 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 ⅓ of its length. Palea absent. Anthers 1.5-1.7 mm. Fl. 8.

Wet alpine meadows, 2100 m.

Typus: "Auf den Südabhänge des unteren Kaukasus, auf Trachyt, 1524 m", C. Koch

N.E. and E. Anatolia.

A8 Rize: Cimil, 2100 m, vii 1866, Bal. 621!

A9 Kars: Sarikamis, Grossheim I: Map 167

B8 Mus: Kupak, 20 vii 1916, C. Koch


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 ⅓ 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*

**Loc:** Rep. Missouri Bot. Gard. 8, t. 51-56 (1897);

**Rusnot,** Gras. t. 33 (1899).

**Fl. 7. Mountain pastures, 1900 m.**

**Typus:** *Spain* "Hab. in collibus et arenosis et dumosis planitieis regionis montanae *Hispania* vulgarissima*, Reuter (*C*)

**E. Anatolia.**

**B8 Mus:** S.W. foot of Bingöl Da., 1900 m, D. 46203!

**External distribution:** Mainly S. Europe.


**Zeitschr.,** 10 (1901).

**Syn:** *A. byzantina* Boiss., Diagn. ser. 1 (13): 46 (1853);

*A. castellana* var. *byzantina* (Boiss.) Heckel in Allg. Bot.

**Zeitschr.,** 10 (1901).

**Fl. 6-7. Dry hillsides, sea level-600 m.**

**Typus:** *Hab. prope Byzantium, * (1844), No. 225 (Fol. C)

W. and N.W. Anatolia, Turkey-in-Europe.

**A2(E) Istanbul:** *Sigili* to Kagithane, **Asn. 2374.**

**B1 Balikesir:** Kaz Da., (near Edremit), 600 m, A. Baytop (ISTE 6051).

**B2 Bursa/Kütahya:** Kocayayla, between Inegöl and Tavşanlı,

**T. Baytop** (ISTE 5688).!

**External distribution:** Balkan peninsula, Euro-Sib. element.

3. *Agrostis gigantea* Roth, **Fl. Germ.** 1: 31 (1788).

**Loc:** 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 1.5-5 (-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 2-5.5 mm, lanceolate, dark purple to brownish. Glumes subequal, lancolate, 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 1-2/3 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., 1526 m, P. Furse 4471!
A6 Ordu: Çambaşı, 2200 m, Tobey 1425!
A8 Rize d. Iğdır: Yetimhoca (Cimil), 2100 m, D. 21007!
B6 Sivas d. Gürün: Gök Pınar, 1600 m, F. Sorger 77-101-14!
B8 Erzurum: Palandöken D. 25 km from Çat to Erzurum, 2350 m, D. 47378!
C9 Van: Bağkale to Gülşehir, 50 km from Bağkale, 1800 m, McNeill 697!


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 1/2 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. ternus Sibth., Fl. Oxon. 36 (1794);
Is: Hubbard, Grasses 300 (1968);
Described from: In Europae pratis, Sm. Linna. 84/15/17
N. and Inner Anatolia.
A4 Kastamonu: N. side of Ilgas Da., 1950 m, D.38332!
A5 Amasya: Ak Da., Kasteps area, 1650 m, K. Alpinar (ISTE 152)!
A7 Giresun: Balaban Da., above Tamders, 1800 m, D.20501!
A8 Rise: Kaokar Da., N. side of range, 2591 m, A.J. Riddell et al. 42!
B5 Kayseri: Eniyas Da., 2150 m, F. Sorger 77-75-14!
B6 Sivas: Yildizeli, 1600-1800 m, T. Ekim & A. Duzenli 3760!
B8 Erzurum: Palanııbleki Da., 2350-2560 m, K.P. Buttler 16120!
var. aristata (Boiss.) M. Dogan

Syn: A. vulgaria var. aristata Boiss., Fl. Or. 5: 515 (1884).

Typus: "Hab. in alpinis Graeciae, Olympus Thessalos", Ancker 3052
W. Anatolia.


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: Dizdere (M. Dogan 378). These plants come closest to var. capillaris, but further study is needed to settle their status.


Cespitose 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; pedicels 0.5-1.5 mm, glabrous; Spikelets 2-2.5 mm, elliptic to lanceolate, acute, scabrid on keel. Lemma 1.5-2 mm, awned in lower ½; awn 2-2.5 mm, usually straight, exerted; callus hairs 0.1-0.2 mm. Palea 0.6-1 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!

\[
\text{N.E., C. and E. Anatolia.}
\]

B5 Kayseri: Erciyas Da., 2870 m, K.P. & E. Buttler 2020.
B9 Bitlis: Süphan Da., 3300 m, D.24762a!

External distribution: Caucasus, 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).


Syn: Calamagrostis balansae Boiss., Fl. Or. 5: 522 (1844);


Cespitose perennial with short rhizomes. Stem 28-75 cm, erect to geniculately ascending from base, glabrous and smooth. Leaf blades (4-5) 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 3-4 mm, geniculate and twisted below, attached to lemma in lower 1/3; callus hairs 0.7-1 mm. Palea 1/2 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 Khabagkar, 2500 m", /Sept. 1866/ Balansae /Syntype C17/ N.E. and E. Anatolia.

A9 Kars: Sarikamis, 2100 m, D.30784!

9. *A. stolonifera* L., Sp. Pl. 62 (1753);

Syn: *A. alba* non L., Sp. Pl. 62 (1753);

*A. seahrigulmis* Boiss. & Reuter, Pugillus 125 (1852); 
*A. karsenst Litw., in Schoed. ad Herb. Pl. Ross. 8, fasc. 54: 147 (1921); 
*A. alba* var. armena Schischk., in Ber. Tomsk. Staat. Univ. 81: 447 (1929);

*A. alba* var. karsenst (Litw.) Schischk., in Ber. Tomsk. Staat. Univ. 81: 447 (1929);

Loc: Kulczynski, Atlas Fl. Polsk. 4 (2): 404 (1932);

Hubbard, Grasses 304 (1968).

Caespitose perennial with numerous long stolons. Stem 30-70 (-120) cm, erect or 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, 1.5-3 mm, greenish to purplish. Glumes aculeolate on keel, lanceolate, acute, equal to subequal. Lemma 2/3-3/2 as long as glumes, ovate-oblong, truncate, usually awnless, rarely with a short subterminal awn. Palea 1/3-2/3 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", L. Linn. 84/1447

Widespread.

A1(E) Kirklareli: between Demirköy and Iğneada, A. Bayton (ISTE 5493); 
A2(E) Istanbul: between Bakirköy and Yedikule, 11 vii 1893, Anu.

A3 Adapazari: Arifiye, 30 m, D. 36255.
A4 Ankara: 2 km S. of Kızılcabamam, 950 m, F. Serger 77-59-13!
A7 Trabzon d. Mağka: Bekçüler Yayla near Hamsiköy, 1600 m, R. Angin (ISTE 31281)!
A8 Gümüşhane: 23 km from Aşkale to Trabzon, 2390 m, P. Uotila 14700!
B2 Kutahya: between Inegöl and Tavşanlı, T. Baytop (ISTE 5688a)!
B3 Afyon: Bayat, Kurtlaralanitepe, 1480 m, M. Vural 78!
B6 Marag s. Elbistan: Kapidere, D.204,03!
B7 Tunceli: Goveçik, 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, 790-800 m, D.19830!

External distribution: Europe and Mediterranean area, S.W. Asia to Siberia. Introduced in Japan and N. America.

A. kurosensis, 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. & Rensl. 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.

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: Reichh., 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. Buttlcr 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 membraneous. 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. Rachilla 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


Syn: Agrostis viridis Gouan, Hort. Monsp. 546 (1762);
Phalaris semiverticillata Forskal, Fl. Aeg.-Arab.: 17 (1775);
Agrostis verticillata Vill., Prosp. Fl. Dauph.: 16 (1779);
Polypogon semiverticillatus (Forsk.) Hyl., Nomenkl. fil. Syst. Nord.
Gefäßbl. in Uppsala Univ. Araskr. n. 7: 74 (1945).


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, ovoid-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.


Widespread.

A1(E) Tekirdag: 25 km from Tekirdag to Marmaraareglisi, D.39260!
A2(E) Istanbul: Şişli to Kagithane, Asm.!
A4 Cankiri: Şabanözü, 1190 m, K.P. Buttler 15543!
A5 Amasya: Kirazlidere, H. Tanker (ISTE 4575)!
A8 Erzurum: 5 km N. of Tortum Göl, 1000 m, D.47635!
B1 Balikesir: Kas Da., A. Baytop (ISTE 6055)!
B2 Manisa: 13.5 km from Salihli to Üdemiş, 440 m, K.P. Buttler 17286!
B5 Nevşehir: nr. Nevşehir, K. Karamanoglu 5139!
B6 Sivas: 2 km S. of Sinoan (Divriği), 1400 m, E. Sorger 70-27-8!
C2 Denizli: Pamukkale, R. Alava 5298!
C3 Antalya: Alanya, fidanlık 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 Beşme, A. Baytop (ISTE 40112)!
C8 Mardin: 23 km S. of Savur, 1000 m, D. Spencer 601!
I: Gokceada, Todori fountain, 200 m, 17 vi 1976 E. Leblebici & Ü. Segmen (EGS)!

External distribution: Mediterranean, C. Europe, Crimea, C. Russia, N.W. & C. Iran, Afghanistan, W. Pakistan. Introduced into N. America.

Annual. Stem 2-4.2 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*

- subsp. *maritimus*


Io: 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 [Bl?]

W. Turkey, S. Anatolia.

A1(E) Edirne: Enesz, sea level, Coode & Jones 2904!

B1 Izmir: Foça, 10 m, K.P. Buttler 17201!

B1 Manisa: Marmara Göl, Akhisar, H. Pegman 706!
Bi Izmir d. Menemen: Çamalti, M. 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, Rees (ECE 16367)!

External distribution: W. Europe, Mediterranean, Caucasus, N. Iraq,
W. Iran, Afghanistan, Turkistan, 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. Gr. 5: 520 (1884).
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, Asn. 2379B!
B1 Izmir: Izmir, Bal. 143!
C3 Antalya: Dedenbass, 9 km N. of Antalya, 40 m, E. Hennipman et al. 337!
C4 Antalya: Antalya to Gazipaşa, Hub. -Hor. 14095!

External distribution: Mainly on the Aegean Islands.

Ic: Sibth. & Sm., Fl. Graecia 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] "Nablat Monspeli" [Tub. Linn. 82/71]

Widespread.

A1(E) Edirne: Enes, B. & V. Burbidge 1501

A2(E) Istanbul: Araplıdere, near Degirmen Köy, A. Baytop (ISTE 14446)!

A3 Erzurum: 34 km S. of Tortum Göl, 1150 m, D.47540!

B1 Izmir: Inciralti, A. Baytop (ISTE 10014)!

B2 Manisa: between Salihli and Üdemiş, 13.5 km from Salihli, 440 m, K.P. Buttler 17285!

B3 Eskişehir: Türkmen Da., Kızılınler, 800 m, T. Ekim 2205!

B4 Ankara: Serefliçhisar, nr. Tuz Gölü, 900 m, S. Erek & A. Güner (HUB)!

B5 Nevşehir: Ağıksaray nr. Gülşehir, 1150 m, J. Roper 1341

B6 Malatya: Gürün to Malatya, 40 km S. of Derende, 1000 m, McNeill 436!

B7 Tunuseli: nr. Fırat river, M. Tanker (ISTE 5575)!

C2 Muğla: Fethiye, E. Leblebiçi (ISTE 14846)!

C3 Konya: Beşiktepe, Kurupınar nr. Beşiktepe Göl, 1200 m, E. Feşmen & A. Güner 2301!
C4: Icel: Silifke, Aliaga Göl, T. Uslu 1445!

C5: Adana: Adana–Karatay road, 14 km from Adana, A. Baytop (ISTE 15034)!

C6: Hatay: 2-3.5 km N. of Iskenderun, D.26954!

External distribution: Europe, Mediterranean, Caucasus, Asia.

Introduced into N. America.
25. *LAGURUS* L., Sp. Pl. 81 (1753)


Type: *L. ovatus* L.

*L. ovatus* L., Sp. Pl. 81 (1753).

In: 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" (1753). Hort.

Cliff. 17

N. Anatolia, Turkey-in-Europe, W. Anatolia, S. Anatolia, Islands.

A1(E) Tekirdag: between Tekirdag and Malkara, 3-50 m, D.34572.
A2(E) Istanbul: Kilyos, Simen deresi, A. Bayton (ISTE 17721)
A6 Samsun: near Kizilay camp site, 5 m, Tobey 255!
B1 Izmir: Urla, 23 iv 1962, E. Reel (ISTE 12394)
G4 Mugla d. Marmaris: E. of Datça, sea level, D.41343
C3 Antalya: Alanya-Manavgat road, Çavuşköy road junction, A. Bayton (ISTE 9781)
C5 İçel: 27 km from Silifke to İçel, 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 occurring in Crimea and Transcaucasia.
26. GASTRIDIUM P. Beauv., Ess. Agrost. 21 (1812)


Type: G. australo Beauv. = G. ventricosum (Gouan) Schinz et Thellung

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


Annual. Stem 3.5-5.0 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 "Nab. in arvis inscultis Panormi", Presl.

N.W. Anatolia.

A2(E) Istanbul: Malkali to Safraköy, 19 vi 1898, Asn!: Yeniköy, 23 vi 1895, Asn!.


Syn: Lechnagrostis phleoides Nees & C.A. Meyer in Nova Acta Acad. Leop.-Carol. 19, Suppl. 1: 146 (1843);


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., Papasli, Sint. 964!
C1 Aydın: Dilek peninsula, Ilyas Da., 65 m, T. Uulu 3611!
C2 Muğla: Marmaris, Kran et al. 15!
C3 Antalya: Aytop between Demirciğ and Gazipaşa, A. Baytop (ISTE 9705)!
C4 Iğal: Kaledran (Anamur), A. Baytop (ISTE 9727)!
C5 Iğal: Baluklu, 8 vi 1855, Bel.!

External distribution: Cyprus, Palestine, N. Iraq, N. & W. Iran.

Introduced into N. America.


Syn: Agrostis ventricosa Gouan, Fort. Monsp. 39 (1762);
Milium lendigerum L., Sp. Pl. ed. 2, 91 (1762);
Gastridium australis Beauv., Ess. Agrost. 164 (1812);
Gastridium lendigerum (L.) Desv., Obs. Pl. Angers: 48 (1818);

Lo: Reichb., Io. 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.


Turkey-in-Europe, W. & S. Anatolia, Islands.

A1(A) Balikesir: Avsa Adasi, A. Cubukcu et al. (ISTE 10501)

A2(E) Istanbul: Balta liman, 10 vi 1892, Asn.

A2(A) Istanbul: Burgaz Adasi, A. Baytop (ISTE 6724)

C1 Aydin: Erbeyli, Cariklar, 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

27. **TRIPLACHIUM** Link, Enum. Hort. Berol. Alt. 2: 244 (1833)


**Type:** *T. nitens* (Gussone) Link


**Syn:** *Agrostis nitens* Guss., Fl. Sic. Prod. 1: 60 (1827);


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 3.7-4.4 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:** *T. nitens* (Guss.) Link, Enum. Hort. Berol. Alt. 2: 244 (1833).

**Syn:** *Agrostis nitens* Guss., Fl. Sic. Prod. 1: 60 (1827);


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 3.7-4.4 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:** *T. nitens* (Guss.) Link, Enum. Hort. Berol. Alt. 2: 244 (1833).

**Syn:** *Agrostis nitens* Guss., Fl. Sic. Prod. 1: 60 (1827);


S. Anatolia.

C5 Iğel: Viranşehir, A. Baytop (ISTE 15113).

C5 Iğel: Anamur, v 1872, Peronin 124.

28. MILLIUM L., Sp. Pl. 61 (1753)

Annual or perennial. Leaf blades flat. Ligule hyaline.
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

   Io: Hubbard, Grasses 276 (1968); Reichb., Io. Pl. 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. Anthems 2-3 mm. F1. 6-7. Moist
soil inside forest.

Typus: "Hab. in Europae nemoribus umbrosis" Linn. 83/34

Turkey-in-Europe and N.W. Anatolia.

A1(B) Kircilarle: near Demirkoby, A. Baytop (ISTE 54:16)!

A2(A) Bursa: above Bursa, vii 1874, Fichler 252!

External distribution: Europe, Cyprus, Caucasus, C. Russia,
Siberia, Afghanistan, W. Pakistan, E. Asia. Introduced into N. America.


(1897).

M. effusum subsp. schmidtianum (C. Koch) Tzvelev, Poaceae 294
(1976).

Perennial, with thick creeping rhizomes. Stem 60-120 (-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,
acuminated, 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. Anthems 2.2-2.8 mm. F1. 8.

Subalpine meadows, 2000 m.

Typus: "Crimis & Caucasus" "Hab. in Tauria et provinciis caucasiciis"
M. bieberstein (L.).

N.E. Anatolia.


Annual. Stem 30-50 cm, erect, solitary, smooth and glabrous, 3-noded. Leaf blades 3-5 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 ca. 1.5 mm. Fl. 5. Mountain slopes, with Quercus & Juniperus, on limestone, 1000-1400 m.

Typus: [Lebanon] "Antilibanon, westl. Abhänge bei Baalbek, 12-1300 m, Bormüller 12925".

S. & S.E. Anatolia.

G4 Izel: Mut, Adras Da., between Mut and Ermenek, 1300 m, Coode & Jones 9691

G8 Mardin: 19 km from Mardin, 930 m, H. Birand 861

G9 Mardin: Cudi Da., above Hessana (d. Silopi), 1200-1400 m, D. 42857A


Annual, with fibrous 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. *vernalis*

1. Panicle branches 3-7 cm; spikelets 3-3.3 mm

................................................................. subsp. *montisum*

**subsp. *vernalis***


Fl. 4-5. Calcareous steppes, inside Quercus woodland, 200-1100 m.

Typus: Described from Caucasus [\(F_{so K1}\)]

Turkey-in-Europe, W. and S. Anatolia, Islands.

A1(B) Kirkkareli: Kirkkareli to Pinarhisar, 200 m, P. 41931!

B1 Çanakkale: Kaz Da., Sint. 1835: 269!

C2 Antalya: Elmali, 18 v 1860, H. Bourgeau!

C6 Gaziantep: Dülük Baba, 7 km N. of Gaziantep, 1100 m, P. 28058!

Is. Leasos: Mt. Ordímos, at Ipsilon monastery, 500 m;

J.R. Edmondson 2637!

External distribution: W. and C. Europe, Mediterranean, Críses, Caucasus, N. Iraq, N. and W. Iran, S. Russia, Turkestan.

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2. subsp. montianum (Parl.) Jahandiz & Maire, Cat. Pl. Maroc. 1: 36 (1934).


Fl. 5-6. Rocky mountain slopes, inside Pinus nigra forest, wet places, 620-1750 m.

Typus: [Sicily] "Picuzza al bosco del Cappidderi e al bosco di Pizzo nero e nelle Madonie".

W., C. and S. Anatolia.

A3 Ankara: Beypazarı, Cuma Da. near Seytan bridge, Y. Akman 101
A4 Ankara: Kızıloğlanam, Çankorun, K. Karamanoglu 5228!
B1 İzmir: Kemalpaşa to Ovacık, 620 m, F. Holts (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. Pekmen & A. Gürer (HUB 1261)
C4 Iğdır: Mut, Sertavur pass, 1600 m, M. Doğan 179!
C6 Hatay: Dörtyüll, Karagöz Y., 1750 m, Y. Akman 68!

External distribution: Aegean, Cyprus, W. Syria, N. Iraq, N. Iran.
An 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 nub. 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: 2. bisbersteiniana (Claus) P. Smirnov

Key to Species

1. At least 10-20 branches arising from each node; upper
   glumes with a nub ........................................ 3. varticillata

1. Only a few branches arising from each node; upper
   glumes usually acute

2. Panicle branches erecto-patent; pedicel 0.7-4 (-8) mm;
   glumes with large hyaline margins ...................... 1. pisidica

2. Panicle branches effusa; pedicel 5-13 mm; glumes
   without hyaline margins .................................. 2. trichopoda

1. 2. pisidica (Boiss.) Tutin in Bot. J. Linn. Soc. 76: 365 (1978). Annual. Stem 4-44 cm, erect, glabrous, smooth and slender, usually tufted, 2-5-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 1.5-2.5 mm. Glumes ovate, acute, largely hyaline on margins. Lemmas as long as glumes.
Key to subspecies

1. Spikelets 1.7-2.3 mm; branches relatively long, patent; pedicels 1.5-4 mm .............................................. subsp. pisidica
2. Spikelets 1.5-1.6 mm; branches short, making 90° angle with main axis; pedicels 0.7-2 (-2.5) mm ........ subsp. paeforme

subsp. pisidica

Syn: Agrostis pisidica Boiss. in Tohbat., Asie Min., Bot. 2: 625 (1860); Agrostis trichocladua var. pisidica Boiss., Fl. or. 5: 516 (1884).


Fl. 5-8. Wet grassy meadows, rocky open slopes with scattered E. nigra, marshes, inside ditch, 1350-2400 m.

Typus: [Turkey C3 Isparta] "Hab. in Pisidia inter Tohukur et Abyrkevi ad extrematatem meridionalem lacas Egridir" [1854], Tohikatchoff /Holotype C3/

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

A3 Ankara: Beykazari, 1600 m, Y. Akman 15!
A4 Ankara: Karagöl, 72 km N. of Ankara, 1600 m, Coode & Jones 2197!
A7 Giresun: Balaban Da., above Tarabire, Avşar Y., 2400 m, D. 20660!
A9 Kars: Yalnizçam, 1900 m, D. 30293!
B3 Elâisheh: Türkmen Da., Hasan Da., 1300 m, T. Ekim 2231!
B6 Sivas: Yildizeli, 1350 m, A. Beytop (ISTE 29653)!
B9 Bitlis: Tatvan, 1829-2134 m, Tong 105!
C5 Niğde: Pertek, 2000 m, W. Siehe 594!

External distribution: Romania, Caucasus.

Syn: Milium trichopodum var. poaeformae Boiss., Fl. Gr. 5: 511 (1884).

Fl. 6. Open places in Pinea sylvestris forest, slopes, 1200-1350 m.

Typus: [Turkey B2 Uzeg7] "Natu. in campis humidis ad Yashamichlar keui prope Cushak Phrygiae, 1200 m", 5 vi 1857 Balanae 1331

/iso. BU7/

C. Anatolia.

A. Ankara: Kiziloahaman, A. Bayton (TTE 15492);

B3 Balikesir: Sindiiken Da., Gatasik, 1350 m, T. Eskin 934.

Endemic.


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. Caryopses ovoid, with pitted surface.

Key to subspecies

1. Spikelets 1.6-2 mm; leaf blades flat; glumes ovate-elliptic, acute .................................. subsp. trichopoda

1. Spikelets 1.3-1.5 (-1.6) mm; leaf blades convolute;

    glumes ovate, obtuse ............................ subsp. biebersteiniana
subsp. trichopoda
In: Bot., Fl. Iraq 9: 281, t. 99 (1968);

* Bot., Fl. Iranica (Gramineae) 70 t. 40 (1970).

Fl. 6-7. Edge of marshy fields and damp places, 1300-2300 m.
Typus: *Turkey C7 Urfq* "Siverek, 1844", Kotschy: 41 //so. KA

Inner, E. and E. Anatolia.

B6 SiVAS: Pinirhisar to Gürün, 30 km from Gürün, 1600 m, A. Beyton

(ISBN 37725)

B6 Malatya: Kangal to Nekışhan, 1300 m, Str. & End. 5384.

B6 Kayseri: Birboga Da., S.W. of Saris, 2300 m, E. H. Rex 664.

B9 Bitlis: Pelli, 2200 m, D 223991.

C6 Adana: 56 km N. of Salimayli, 1520 m, Hub. Nov. 116321.

C10 Hakkari: 30 km from Sedilili to Yürekova, 1950 m, D 450591.

External distribution: Syrian Desert, N. Iraq, Caucasus, N. and W. Iran, Transcaucasia, Siberia.


Syn: *Agrostis biebersteiniana* Clus in Beltr. Pfl. Russ. Reich. 8:

254 (1851);

*Agrostis trichopoda* Griseb. in Ledeb., Fl. Ross. 4: 439 (1852).

Fl. 7. Open places in Quercus infectoria wood, volcanic rocky places,

1650-1750 m.


E. Anatolia.

A8/B8 Erzurum: Taşlıgökdik, 24 VII 1916, Saposhnikov

A9 Kara: Sarikamis, 7 VII 1916, Saposhnikov

B9 Bitlis: Tatvan, Sorgun above Lake Van, 1650-1750 m, H. Pogran 29901.
B9 Mus: Malazgirt, 10 vi 1916, Saposchnikov

External distribution: Crimea, Caucasus, S.E. Russia.


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 G4/ Anatolia.

B3 Afyon: Bayat, S. slope of Otlugedik, 1550 m, H. Vural 82.

B3 Ankara: Aydos Y., H. Bagla (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. Rachilla disarticulating above glumes. Lodicules absent. Stamens 2. Caryopsis elliptic in side view. Embryo 1/2 as long as caryopsis.

Type: *A. odoratum* L.

Literature:


**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*

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**

Io: Trin. Sp. Gram. 1 (2): 14 (1828);

Hubbard, Grasses 270 (1968).

Pl. 4-5. Dry dune slacks, grassy banks, in shade of *P. nigra*.

10-1500 m.

Described from *in Europae pratis*, [Br. Linn. 46/1/17]

Turkey-in-Europe, W. and S.W. Anatolia.

A1(E) Edirne: 3 km from Siloglu to Kavankaya, *A. Baytop* (ISTE 31802)!

A2(E) Istanbul: Belgrad forest, Kayacik 40!

B1 Izmir: Yamanlar Da., 1000 m, Dudley 34897!

C1 Aydin: d. Salçuk: Çamlık to Yeniköy, 250 m, T. Uslu 4450!
Antalya: nr. Akseki, A. Pamukcuoglu & Quezal (HUB);

Isparta: Egri-Dir, 2 km S. of Yaka köy, 1400-1500 m, H. Pasm花生
& A. Güner 1312;

Psara: 10-20 m, W. Creutzer 10939;

Lesvos: 1 km W. of Ayiaessa, S. of Kasteli, 550 m, J.R. Edmondson 2251;

External distribution: N.W. Africa, N.S. and C. Europe, Crimea,
S. and C. Russia.


Brit. Is. 5, 4: 376 (1964),

Syn: A. odoratus var. alpinum Max. et Uschtr. in Flora 5, 2: 426 (1866);

Fl. 6-8. On peaty grassy banks, granite slopes, marshy area in

clearing of Fagus woods, 1000-3000 m.

Typus: "Reg. alp. montis Njullae Laplandiae" Löve et Löve 347.

Mainly N. Anatolia, rarely W. and C. Anatolia.

A3 Bolu d. Ala Da.: Kartal Kaya, 2000 m, Khan et al. 495;

A7 Trabzon: Zigana Pass, 1920 m, E.K. Balls 392;

A8 Rize: between Rize and Ispir, 3000 m, Stn. & Hand. 6270;

Artvin: dist. Murgul, Magara Y., Savval Tepe, 3000 m, Stn. & Hand.
6052;

B2 Kütahya: Simav, Kicir to Akdag, 1900 m, Coode & Jones 2742;

B3 Eskisehir: Sündiken Da. Atalan tekke, 1000 m, T. Ekim 918;

External distribution: N. and C. Europe, Caucasus, Iran,
Transcaucasia, Siberia.


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 5.5-9 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"

Is.: Rablos: N. Profeta, 500-600 m, Fiori 351


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).


Loc.: Huinot, Gram. t. 1 (1899).

Annual. Stem 4-53 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 lemma 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, Carrano Islands.

Gökeada: around Kuzu Limani, E. Leblebici & O. Segmen 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.
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. Rhusilla 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. Milum linear.

**Type:** *H. odorata* (L.) Beauv.

**Literature:**


Syn: Zanfheri, 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. Grass.

Mountain steppes. 2160 m.

Described from: In Europae pratis [Hb. Linn. 1212/1417]

E. Anatolia.

A8/B8 Erzurum: Karaca düz, 2160 m, 24 vii 1916, Saposchikov et

Soldiehin.

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. Rachilla 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.


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

5. Awns of lemmas exserted by 2-5 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 2-3.5 mm 6. vaginatus

1. Glumes acute to obtuse at apex, equaling lemma

9. Glumes connate for ½ 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 rhizomatus 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 1 mm; 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 1/2 to 1/5, 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. setarioidea

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).
Ic: Hubbard, Grasses 328 (1968);

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: 

Scattered.

A1(3) Kirklareli: 6 km from Kirklareli to Kofqay, A. Baytop (ISTE 3246!)

A3 Ankara d. Beypasari: Egriova, 1600 m, Y. Akman 5!

A4 Ankara d. Kizilcahamam: Igik D., Khan et al. 734!

A5 Samsun: Ladik (large lake near Ladik), 800 m, Tobey 774!

A9 Kars: Yalnizcam, 1900 m, D.29673!

B2 Uşak: Murat D., 1700 m, 1 vi 1964, Regel!

B8 Bitlis: 36 Km E. of Nus, D.24768!

C4 Konya: Konya-Adana road, 1000 m, T. Keserioğlu 15498!


Introduced into E. Asia and N. America. Euro-Siberian element.

This species resembles \( A. \) geniculata, 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 recognize further taxonomic divisions in this species.

In: 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, bulbosae 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. Panicle 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: Frang. "Habitat Monspelli: 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.!


In: Trin., Sp. Gram. 1 (4): 44 (1828);


Caespitose perennial. Stem 40-62 cm, erect to geniculately ascending from base, glabrous and smooth, 2-noded. Leaf blades 1.5-3 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 3.5-5.7 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 $\frac{1}{4}$ 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 $\frac{1}{4}$ 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", Linn. 82/1

Turkey-in-Europe.

A1(E) Edirne: Sarayği, A. Baytop (ISTE 18343)


Syn: *A. ventricosus* Pers., Syr. Pl. 1: 80 (1805), non Hudson (1778);

* A. nigricans* Hornem., Hort. Hoft. Hoft. 1: 68 (1813);

* A. pratensis* var. armenus* C. Koch in Linnaea 21: 381 (1846);

* A. armenus* (C. Koch) Grossh., Fl. Cauc. ed. 2, 1: 173 (1939);


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 $\frac{1}{4}$ 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: "Cultivae au Jardin des Plantes de Paris", Poiret

Widspread, rare in S. Anatolia.

A2(E) Istanbul: Topkapı to Maltepe, 28 v 1913, Amn.
A3 Bolu: Köroğlu Da., 1800 m, Y. Akman 6381!
A4 Canikiri: Ehlivan Da., 1200 m, A. Baytop (ISTE 35225)
A5 Amasya: between Mersifon and Çorum, 10 km from Mersifon, A. Baytop (ISTE 9121)
A7 Gümişbana: Aktaş, Sint. 1894: 6161!
A9 Kars: Kagışman, N. side of pass between Akçay and Cumacıy, 2350 m, D.46773!
B1 Manisa: Manisa Da., A. Baytop (ISTE 9923)
B3 Eskilşehir: Sundiken Da., Kuzulu 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.46447!
B9 Ağrı: 2 km S.W. of Hamur (Murat valley), 1680 m, D.44087!
C2 Denizli: Honas Da., Atalan Y., 1550 m, E. Tuzlaci (ISTE 26605)
C3 Konya: Konya Kara Gayiri, H. Birand 133!
C6 Marag d. Söksun: Hobak Da., 1700 m, D.20198!
C10 Hakkari: Yüksakova, 1950 m, D.45554!

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.


Inv. Trin. Sp. Gram. 1 (h): 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) 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", Fl. Linn. 82/317

Turkey-in-Europe.

A1(E) Çanakkale: Gelibolu, Sirkeci 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. asqualia* 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. COLOSTYCHIS (Beauv.) Trin

Syn: *Polygona vacinatus* Willd. in *Neue Schrift.* Ges. Berlin 3: 44 (1801);
*A. angustifolius* Sm. in Sibth. & Sm., Fl. Graeca 1: 64 (1808);
*Coloboschma vacinata* (Willd.) Beauv., Ess Agrost. 22 (1812);
*A. davatenthus* Trautv., Acta Horti Petrop. 5: 486 (1878);
*A. vacinatus* var. *unipalaceus* Boiss., Fl. Or. 5: 489 (1884).

In: Fl. Crusii 1: t. 10 (1941);

Cespitose perennial, rhizomatous. 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) 1-2 mm, linear, 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), ovoculate. 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; mm 5-10.5 mm, attached to lower 1/3 of lemma, geniculate and twisted below. Palea present. Anthers 2.3-3.3 mm.

_Fl. J.-6._ Rocky alpine mountain alone, 700-3100 m.


Mainly N. Anatolia
A2(A) Bursa: Ulu Da., A. Bayton (ISTE 2556);
A5 Amasya: Amasya, 700 m, 10.iv.1889, Barma!
A7 Gümüşhane: Karagöl Da., Sirt, 1895: 73875;
A8 Rize: d. Dicindere, Germanin Tepes above Cimil, 3100 m, D. 21091;
A9 Kars: Arpazay, Grosheim I: Map 157
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. laguroidea*, *A. cassius*, etc., under *A. vaginatus*. In fact the two former species are quite distinct species from *A. vaginatus*.


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 0.5-1.5 cm, elliptic in outline. Spikelets 4.5-8 mm, elliptic. Glumes lanceolate, terminating in an aristate point (c. 1-2 mm) or acute, hirsute on keels.
connate to lower $\frac{1}{4}$ of their length. Lemma 4-5.5 mm, truncate-subtri-
dentate, ciliate at top, margins connate at base; awn 8-14 (-17) mm, attached to lower $\frac{1}{3}$ 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

2. Spikelets 7-8 mm (incl. aristate point), basal leaves flat ....................................................... subsp. tiflisensis

subsp. textilis

Syn: *A. textilis* Boiss., Diagn. Ser. I (13): 40 (1853);

*A. vaginatus* subsp. pubescent var. textilis (Boiss.) Westb. in

Trudy Bot. Sada Jur’ev. 5: 25 (1905).

Fl. 5-8. Stony mountain slopes, 1676-3353 m.

Typus: [N. Iran] "In glareosis vulcanicis jugi Beamtschal in m.


Widespread but mainly Inner Anatolia.

A7 Giresun: Balaban Da, (Kilic Tapa) above Tamerre, 2900 m, D.20619!

B5 Nigde: Hasan Da., above Tepinar Y., 2800 m, D.18968!

B7 Erzincan: Kasig Da., above Gümüş, 2800-2900 m, D.31795!

B8 Bingöl: Bingöl Da., 2438 m, Kotschy 540!

B9 Van d. Gevaç: Artos Da., 3353 m, D.22892!

C5 Nigde: Aladag, on Demir kasik, Findlay 175!

C6 Maraş d. Gardak: Berit Da., above Arpa Gukuru Y., 2700 m, D.20289!

C9 Hakkari: Kara Da., 3353 m, D.24446 p.p!

C10 Hakkari: Sat Da. between Veregoz and Sat G., 2900-3000 m, D.45588!

External distribution: Lebanon, N. Iraq, Iran.

Syn: *A. vaginatus* subsp. *pubescens* var. *tifliensiæ* Westb. in Trudy Bot. Sada Jur'ev. 5: 23 (1905);


Ic: Fl. Grusii 1: t. 12 (1941).

Fl. 5, Mountain slopes, 2300-2500 m.

Typus: "Tiflis", Westberg (Inv. LE!)

E. Anatolia.

B8 Erzurum: Palandöken Da., 2300 m, T. Baytop (ISTE 34885);

B9 Bitlis: Nemrut Da., S. of Bidyik şel, 2500 m, A. Tatlì (ISTE 27156);

External distribution: N. Iraq, Caucasus, Transcaucasia.


Syn: *A. ponticus* C. Koch in Linnaea 21: 382 (1848);


Ic: Fl. Grusii 1: t. 9 (1941);


Casapitose 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-ureeolate. Glumes lanceolate, slightly connate at base, terminating in a divergent aristate point, dorsally
densely oiliate. Lemma 3-4 mm, glabrous, denticulate at apex and with a muco, dorsally awned, margins connate at base; awn 3-4.4 mm, slightly exerted or not, sometimes geniculate, attached in lower 2/3 of lemma.

Pala 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 Gauze Nemschin, auf Granitboden, 2652 m, [viii 1866], C. Koch [G2].

N.E. Anatolia (Colchis).

A8 Rize: d. Ikizdere, Carmenin Tape above Cimil, 3100-3200 m, D.21094; Ikizdere, Baltaq Tape, 3200 m, D.21106; Cimil, 2600 m, [viii 1866], Bal.!

Camlihemsin, Amlahit Y., 2200-2720 m, A. Guner (ISTE 34111)

A9 Kars: Ardahan, Grosheim 1: Map 161

External distribution: Caucasus, 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.


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. Paniola 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

var. gerardii


Io: Trin., Sp. Gram. 1 (1): 1 (1928);

Typus: [France] Je l'ai cueilli au fond du Valgaudemar, a Crocières, 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: Kicir to Akdag, 1900-2100 m, Coode & Jones 2714!
B5 Kayseri: Bakir Da., nr. Akoluk Y. above Kisge, 2000 m, D.19520!

Erciyes Da., 2100 m, 9 vii 1856, Bal. 850!

C4 Konya: Boakir, Öğpinar-Öğyazi, 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, Hassakns.

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. unialeetus* 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.

1. var. *cassius* (Boiss.) M. Dogan, comb. et stat. nov.


Typus: "Turkey, C6 Natay, "Hab. in regione alpina montis Cassii", Junio 1846", Boissier [Plate C1]

*Amamus.*

C6 Natay: *Amanos Mt.*, v-vii 1845, Boissier!


*Gasaipitose 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), uroelate, 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 ⅓ 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, Auchoer 5457, ad nives deliquescentes ejusdem jugi supra pagum asadbar, Kotschy, loc. cit. No: 464 c 9 vii 1843 c 617

E, Anatolia.

B6 Sivas: Bay Da., S. of Zara, 2000 m, Stn. & Hnd. 5285!
B8 Erzurum: Palandöken Da., Dadaa, 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 Malatya: Sat Da. (above Yükselova), 2900 m, Duncan & Tait 81!

External distribution: Caucasus, Transcaucasia, Iran, Iran-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.


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 \( \frac{1}{2} \) 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. Pagman & C. Sezmen (EGE 16357).

Endemic. E. Mediterranean (Mt.) element. Related to A. lanatus.


Syn: A. phalaroides C. Koch in Linnaea 19: 5 (1858);


Casepitose 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. Soree and rock crevices on high mountain slopes, 2000-3450 m.

Typus: Turkey "In summite montis Olympi Bithyni nive peracta",

Sibthorp f. Hol. 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 Iğit Da. above Karli Y.,

2600 m, D. 19995!

C3 Antalya: Perge, 10 vii 1970, A. Pamukquoglu (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 & Pamukquoglu, 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 very dense tomentose indumentum.


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, scarios, 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-)1.1-1.4 (1.7) mm, yellow to purplish. Fl. 8.

Rocky mountain slopes near snow bed, 3000-4267 m.

Typus: [Turkey A3 Rise] "Region alpine superieure du Lasistan, vers 3000 metres d' altitude", [15 viii 1866], Balansa: 1552 [Iso E1]

N.E. and E. Anatolia.

A3 Rise: d. Ikisdere: Vercinin Tepe, 3400 m, D. 21137!
B9 Bitlis: Sûphan 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 Caucasus. 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 Tsvelev

Loc: Trin., Sp, Gram. 1 (4): 41 (1828);
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 usually 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 monorinate, connate for 1/2 to 3/5 of their length in lower part, ciliate in the upper half, especially on wing. Lemma slightly shorter than glumes, truncate at apex, connate for 1/2 to 3/5 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, Mr. sea level.

Typus: "Hab. in Creta", Sieber /iso Le/.

N.W. Turkey.

A2(E) Istanbul: Soguksu, Kılıçkçekece G., H. Demiriz (ISTE 7185)
A2(E) Istanbul: Bebek, 18 iv 1909, Asn.!
A2(A) Istanbul: Kadıköy, 1 v 1918, Asn.!
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 1/2 to 3/5 of their length in lower part, and with a winged keel. A. thracicus Penev & Kozhanov has been described from Bulgaria and an isotype at Edinburgh Herbarium has also been studied: no major difference was found to justify separation from A. creticus.

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 ½ to ¾ of their length, shortly hairy at base. Lemma equaling glumes or somewhat slightly longer, elliptical, ovate, obtuse, margins connate for ½ to ¾ 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. *latislatus*

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*


Ic: Hubbard, Grasses 326 (1968);

Typus: "Hab. in arvia, et ad vias, Anglia", Hudson.

Widespread.

A1(B) Kirklareli: 5 km S. of Kirklareli, 100 m, D.41977!
A2(B) Istanbul: Büyükdere, 6 v 1900, Anm.!
A3 Bolu: Büyük Melen, A. Baytop (ISTE 15500)!
A4 Ankara: Mithat Plain on road to Istanbul, A. Baytop (ISTE 9183)!
A5 Yozgat: 25 km from Çekerek to Alaca, 900 m, Coode & Jones 1637!
A6 Tokat: Yeşilirmak valley, R. Çetik 46!
A7 Gümüşhane: Görüh valley, N. of Bayburt, 1500 m, D.31994!
A8 Balıkesir: 10 km from Balıkesir to Bigadiç, nr. Mecidiyeköy, A. Baytop (ISTE 9868)!
A9 Beykoz: Inönü, A. Baytop (ISTE 9237)!
B4 Ankara: Polatlı, nr. Tomelli Köy, B. Kasaplıgil (ANK. 478)!
B5 Kayseri: betw. Soysalli and Inesu, 26 km to Inesu, A. Baytop (ISTE 20321a)!
B6 Sivas: Yıldızlı, 1370 m, A. Baytop (ISTE 40904)!
B7 Malatya: Hekimhan, 1300 m, Stn. & Fnd. 5445!
B8 Erzurum: betw. İlica and Terevan nr. the turning to Aşkale, 1850 m, D.30865!
B9 Van: Erviş, 1700 m, D.44432!
C3 Burdur: Göllhisar, W. of Göllhisar Lake, 1000 m, G. Segmen & E. Leblebiçioğlu (BDE 16362)!
C5 Adana: 9 km S. of Adana, betw. Adana and Karataş, Coode & Jones 236!
C6 Maraş d. Gökşun: Hobek Da., 1700 m, D. 20499!
C7 Urfa: 8 km from Diyarbakır to Şinar, 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 Karatas, 5 km S. of Adana, 1 v 1965, Coode & Jones 2581 [Holol E]

Only known from the type locality. A robust gathering with exceptionally broad-winged glumes.

3. var. breviaristatus Marchesetti ox Ascherson & Graebner, Syn: Mittaleur. Fl. 2: 130 (1899).

Typus: "Adriakiste von Istrien", Marchesetti

Outer Anatolia, Islands.

A2(A) Bursa: betw. Gemlik and Armutlu, nr. Gemlik, A. Baytop (ISTE 24217)!
A6 Ordu: betw. Teme and Ünye, 8 km from Ünye, A. Baytop (ISTE 15253)!
B1 Izmir: Germensik, 50 m, D. 25226!
C3 Antalya: Alanya, 2 m, D. 25912!
C5 Mersin: Kuyuluk, 10 km W. of Mersin, 2 m, D. 25523!
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.


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 \( \frac{1}{3} \) to \( \frac{1}{2} \) 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 wingless 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

\[ \text{subsp. utriculatus} \]

Io: Dor, Fl. Iraq 9: 293, t. 104 (1968).

Pl: 3-4. Waste places, grassy banks, on limestone rock, 30-1400 m.

Typus: \[ \sqrt{\text{Syria}} \] "Prope Aleppo", Russell \[ \sqrt{\text{Polo}} \] BB, S.

Mainly S.W. and S. Anatolia.

B6 Malatya: 40 km from Malatya to Maras, 1400 m, Stm. & Han. 5462!

C2 Mugla: d. Fethiye, Xanthus valley, nr. Kalkan, 10 m, D.25452!

C5 Mersin: 10 km S. of Mersin (Virangehir), 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. Dogansehir 30 km S. of Dogansehir on Malatya-Gaziantep road, 1380 m, H. Birand (ANK. 448)!

External distribution: Cyprus, Syria, Palestine, Iran.

Observation: \( \text{A. utriculatus} \) has been much confused with \( \text{A. rendlei} \) because of its rather complicated literature which is fully explained by Eig (1937).


Fl. 4. Terra rossa hills, oak scrub and grazed rocky limestone slopes, 550 m.

Typus: Turkey/Syria "Hab. in monte Cassio Syriac borealis".

S. Anatolia (Anti-Taurus).


Sect. **TOZZETTIA** (Savi) Endl.


Syn: *Phalaris utriculatus* L., Syst. ed. 10, 2: 869 (1767); non *A. utriculatus* Banks & Sol. (1794).


Zangheri, Fl. Ital. 2: 183, f. 6673 (1976) (as *A. utriculatus* Sol.).

Annual. Rhizomes fibrous. Stem 8-40 cm, erect or slightly ascending from base, loosely tufted, 3-4-noded. Leaf blades 0.7-16 cm x 1-5 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 $\frac{3}{4}$ to $\frac{1}{2}$ of their length, gibbous at sides, abruptly triangular-sapidate above middle, acute, slightly divergent at apex, ciliate on keel. Lemma as long as glumes or slightly longer, lanceolate, subobtuse to acute, awned above base, margins connate for $\frac{1}{4}$ of their length; awn 7-18 mm. Palea absent. Anthers 3.6-4.9 mm. Fl. 3-5. Moist water meadows nr. sea, 0-100 m.
Typus: [C. France] loc. of 'Gramen pratense' in Dalechamps, Historia Generalis Plantarum 1: 425 (1587).

N.W. Turkey.

A1(E) Tekirdag: Tekirdag-Neyranbolu road, 10 km from Tekirdag,

A. Baytop (ISTE 19794)! 

A1(E) Çanakkale, v. 1864, Schmidt 2568
A2(E) Istanbul: Florya, 1 iv 1894, Asn.!
A2(A) Istanbul: Maltepe, 2 v 1894, Asn.!
A2(A) Izmit: Ismit, 1 m., D.26250!
A6 Samsun: Samsun, 1858, Tolhabatof!
A3 Bolu: Düzce, Kühne 2508 p.p.!

External distribution: W. & S. Europe. In Turkey it has its eastern limit. Mediterranean element.


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, acuminated, slightly scabrid on upper surface, glabrous beneath; sheaths glabrous, uppermost one strongly inflated; ligule 1-2.5 mm, broadly acute to obtuse, denticulate. Panicle 0.8-5.2 cm x 6-11 mm, ovate to broadly cylindrical. Spikelets 3.2-4.5 mm, elliptic-uroeolate, solitary on branches. Glumes with long-glumel keel, acute at apex, connate for ½ of their length. Lemma 3-3.6 mm, acute at apex, slightly shorter than glumes, margins connate for ½ of their length; awn 6.5-10.5 mm, geniculate and twisted in lower half. Falea absent. Anthers 1.5-2 mm. Fl. 4-6. Seaside, dried up ditches, wet places, N.r. sea level.
Described from Marseille (France).

N.W. Turkey, W. Anatolia.


A2(E) Istanbul: Arnavutköy, 8 vi 1913, Agn.

A2(A) Istanbul: Haydarpaşa, 11 vi 1911, Agn.

A2(A) Bursa: Karacahay stud farm, 11 vi 1938, Krause (ANK 480).

B1 Izmir: Bornova, H. Paguen (BGZ 5044).


External native distribution: Jugoslavia, Greece. E. Mediterranean element.
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, 5-veined. Lemma equaling glumes, connate in lower $\frac{1}{3}$, 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. cusullatum* L.

*C. cusullatum* L., Sp. Pl. 54 (1753).

Ic: Sibth. & Sm., Fl. Graeca 1: t. 51 (1808);

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 Fl., Linn. 76/117
S. Anatolia, Islands.

B1 Izmir: iv 1827, Fleischer!
B7 Diyarbakir: Ergani, T. Ekim 1081!
C2 Mugla: Marmaris to Emercik, 10 m, P. 25357!

C4 Antalya: Alanya iv 1845, Heldrich.

C6 Gaziantep: Gaziantep to Narag, 1219 m, E.K. Balls 883!

C7 Urfa: Siverek, Karaca Da., Sint. 1888: 697!

Ia, Kos: Kos to Ascolpision, 50 m, P. 40430!

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. Lodicles 2, acuminate. Stamens 3. Caryopsis glabrous,
elliptic-oblong.

Type: B. ereucoiformis (L.) Host.

B. ereucoiformis (L.) Host, Gram. Austr. 3: 5 (1805).


Loc: Reichb., loc. Fl. Germ. 1: t. 171 f. 452 (1850);

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

Widespread, but rare in Inner Anatolia and Mediterranean area.

A1(E) Edirne: between Edirne and Hayva, A. Baytop (ISTE 6550)!
A2(E) Istanbul: between Yedikule and Bakirköy, 21 vi 1894, Ann.!
A3 Bolu: Aladag, 1300 m, O. Alpay 182!
A4 Ankara: Kizilcahamam, Kurumou Köyü, 1500 m, Khan et al. 751!
A9 Kars: Gildir Göl, 29 vii 1970, T. Baytop!
B3 Eskişehir: Türkmen Da., Yörük birka caylı, 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. Gösler!

C3 Konya: d. Beyşehir, Kurucuova nr, Beyşehir lake, 1200 m,

H. Pegman & A. Güner 2310!

C7 Adıyaman: 3 km from Gölbaşı, on road to Malatya, R. Alava 7024!

C10 Hakkari: 19 km from Yüksekova to Semdinle, 1950 m, D.45127!

External distribution: Europe, Caucasus, Crimea, N.W. Iran,
Transcaucasia, S. Russia, E. Asia. Introduced in N. America.

In Flora Iranica Beokmannia 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 Resaiyah, south of Shahpur, 1350 m, J. Lamord 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 equaling lemma or slightly shorter, 2-veined. Rachilla disarticulating above the glumes. Lodicules 2. Stamens 3 (-2). Ovary glabrous. Caryopsis elliptic to oval.

Type: *P. pratense* L.


**Key to Species**

1. Perennial, with non-flowering shoots at anthesis

2. Panicle branches free from main axis

3. Spikelets 2-3 mm; glumes abruptly terminating in an aristate point (c. 0.3-0.5 mm), glabrous on keel .......... 9. *phleoides*

3. Spikelets 3-4.6 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. bertoloni

1. Annual, without non-flowering shoots at anthesis
6. Glumes with a narrow wing on keel; stamens 2
.............................................................. 5. arensoides
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. exoratum
Sect. *PHLEUM*


Syn: *P. commutatum* Gaud., Alpina 3: 4 (1808);

*P. alpinum* var. *commutatum* Boiss., Fl. Or. 5: 484 (1884).

Io: Bor, Fl. Iraq 9: 307, t. 111 (1968);

Hubbard, Grasses 324 (1968).

Leaky ceaspitose perennial, shortly rhizomatus. Stem 10-54 (-61) cm, erect to geniculately ascending, smooth and glabrous, 2-5-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. ⅔ 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. 81/41/7

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 Tandere, Avşar Y., 2400 m, D. 20566!

A8 Rize: Çamlıhemşin, Amlahit Y., 1900-2000 m, A. Gürer 1198!

A9 Coruh: Kordewan Da., near Kütlül Y., 2100 m, D. 30487!

B1 Balikesir: Kaz Da., Sint. 528!

B7 Tunceli: Munsur Da., above Ovacik, 2400 m, D. 31343!
B8 Mus: W. side of Bingöl Da., 2530 m, D.46167!

B10 Kars: Bûyûk Agri Da., 2438 m, B. V. Post 2162!

C5 Niğde: Bulgah Maden, viii 1855, Bal.

C10 Hakkari: Sat Sa. betw. Varegûz and Sat C., 2600 m, D.45673!


This species is often mixed with another high mountain species, P. pratense, but differs in a number of characters, viz. 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.


Loc: Trin., Sp. Gram. 1 (1): 7 (1828);

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. Calcareous, near sea level.

Typus: "In Dalmatia inter Breviaqua & Amone" I. Host.

Localised.

A2(E) Istanbul: Istanbul, 1845, No 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.


In: Lowe, Nat. Hist. Brit. Grasses t. 18 (1891);
Hubbard, Grasses 322 (1963).

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 equaling lemma.
Anthemis 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" (Fl. Linn. 81/1)

Widespread, but not present in S. Anatolia.

A2(A) Istanbul: Gökau, 22 vi 1894, Asn.!

A4 Bolu: Gerade to Aktaş Ormanı, 1500 m, O. Ketençoğlu 343!

A6 Sivas: Yıldız Da., Sariyer, 1700 m, Tekey 2549!

A8 Trabzon: N. slope of Soganlı Da., above Çaykara, 1300 m, D.32084!

A9 Kars: 5 km N. of Kars, 1810 m, D. Spencer 101!

B1 İzmir: Bornova to Manisa, 420 m, Hub.-Mor. 2437!

B3 Baskıcık: Çifteler hamasi, H. Birand & M. Zohary 3281!

B6 Yozgat d. Akdagmadeni: Malbant Da., 2000-2200 m, T. Ekim & A. Dusanlı 3756!

B8 Erzurum: 29 km from Hınıs to Pasinler, 1800 m, D.46375!

B9 Ağrı d. Sulucam (Musun): 5 km E. of Balık G., 2250 m, D.47079!

C10 Hakkarı: Gevar Ovası betw. Yüksekova and Sat Da., 1900 m, D.45795!

External distribution: W., N and C. Europe, Mediterranean east to Aegean, Caucasus, Siberia, Syrian Desert, Iran, E. Asia.

Introduced into N. America.


Syn: *A. nodosum* auct. non L., Syst. Nat., ed. 10: 871 (1759);

- *A. pratense* L. var. *nodosum* Boiss., Fl. Or. 5: 494 (1884);


Io: 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. Serger 77-1-19!
A2(E) İstanbul: Kemerburgaz, A. Baytop (ISTE 5986)!
A2(A) İstanbul: Gamlica, 28 vi 1891, Azn.!
A3 Ankara: Beypasari above Karagar, Narli Kağı, 1500 m, Y. Akman 17!
A4 Çankiri: 1 km S. of Dogu gendarme station, 1430 m,
K.P. Buttler 1559B!
B3 Sakışehir: Türkmên Dağı, 1000 m, T. Ekim 2223!
Is. Bozcaada: Göstepe to Merkez, 30 m, Ö. Seçmen & E. Leblebiçio 1640a
External distribution: W. and C. Europe, Mediterranean, S. Russia, Crimea, Caucasus, N. Iran.

Sect. MAILLEA (Parl.) Horn af Rantzien.
Syn: Phalaris crypsoides d'Urv., Enum. Pl. Ins. Pont. Sux. 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), channelled 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 3-3.5 mm, ovate to broadly elliptical. Glumes hyaline on margins, slightly hairy, with a dorsal wing, pectinate; aristate point 0.2-0.3 mm. Lemma 0.8-1 mm, 1-veined, ovate, obtuse at apex, glabrous. Palea 3/3 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!


Sect. ACHNODON Griseb.


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 \(\frac{3}{4}\) as long as glumes, hyaline ovate, denticulate-truncate at apex, covered with clavate hairs. Palea nearly equaling 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 tenue Host, Gram. Austr. 2: 36 (1802);
Phleum tenue (Host) Schrad., Fl. Germ. 191 (1806).
Loc: Reichb., loc. Fl. Germ. I: t. 179, f. 480 (1850);
Fiori, loc. 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, G. Code & Jones 2836!

A2 (E) Istanbul: Kiyvos, 27 km N. of Istanbul, 20 m, J.R. Edmondson 403!

A3 Adapazari: Arifiye, 30 m, D-36258!

A4 Zonguldak: Zonguldak to Çayumä, 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. Sorgor 66-5-15!

B2 Manisa/Izmir: 13.5 km from Salihli to Olgemig, 440 m, K.P. Butttler 17266!
C2 Denizli: Pamukkale, 400 m, R. Bercy 66-6-71
C3 Antalya: Manavgat, N. Birani & K. Karanavatolu (ANK. 1060)
C4 Igeli: Mut, 9 km from Mut to Karasman, 300 m, Coode & Jones 926
C5 Adana: Sultanhisar, Toros Da., Kasargioolu (BGE 15508)
C8 Siirt, Botan Gey Gorge, 11 km from Siirt, 450 m, D=43261
Is. Gökçeada: near Todori Fountain, 200 m, Çegman & E. Leblebiçi 1962!


subsp. gilliatum (Boiss.) C.J. Humphries in Bot. J. Linn. Soc.

Syn: Phleum tenerum var. gilliatum Boiss., Fl. Or. 5: 430 (1884)
Fl. 5-7. Grassy slopes and lawns, stony ground near sea, on limestone.
20-700 m.

Typus: "Fab. Pelouses du Cimetière Ture pres Rhodes", 8 v 1870,

Bourreau 617

W. Anatolia and Islands.

B1 Ismir: Yamanlar Da., Karagöl, 700 m, Regal & Leblebiçi (BGE 16365)
C1 Muğla: Marmaris: Datça to Knidos, 150 m, Khan et al. 111
C2 Muğla: 13 km S. of Fethiye, 0. Polunin 13964
Is. Pára: Ablakholmos, 20 m, W. Greuter 10349

Rhodos: Rhodes, Bal. 24541

External distribution: Jugoslavia, Greece, Crete, Aegian.

Sect. CHILIOCHLOA (Beauv.) Griseb.

7 P. paniculatum Hudson, Fl. Angl. ed. 1: 23 (1762).

Syn: *P. annuum* M. Bieb., *Fl.* Taur.-Cauc. 1: 46 (1808)!

*P. asperum* Will. 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 (-114) 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 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 2363!

C9 Hakkari: Zap gorge near turning to Hakkari, 1220 m, J. Trelawny 1103!

C10 Hakkari: S. of Cilo Da., N.W. slope of Talana, 2340 m,

J. Trelawny 1604!

C10 Hakkari: 45 km S. of Yüksekova, Piskasir road to Öramar, 1830 m,

J. Trelawny 1407!

External distribution: Crimea, Caucasus, Iran, Afghanistan.


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, oestinate-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

subsp. montanum

Ic: Reichb., Ic. Fl. Germ. I: t. 130 f. 487 (1850);
Fl. 6-7. Grassly igneous slopes, edge of Betula forest, Oak scrub, on sand stones, banks, 255-2300 m.
Typus: "Turkey A8 Çoruh" "Auf alk im Gaue Artamodsch östlich von Artvin",
C. Koch
N., E. and Inner Anatolia.
A2(A) Bilecik: Bilecik to Pasaryari, 500 m, ө.364621
A4 Ankara: Cubuk, Karagöl, S. Erik 453
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 708!
A9 Kars: Susas, 8 km from Kara, 1800 m, ө.30540!
B5 Nigde: Hasan Da., N. slope, 1500 m, A. Düzeli 409!
B6 Sivas d. Sarlıkla: Galdede Da., 2000-2150 m, T. Ekim &
A. Düzeli 3755!
B7 Erzincan: 48 km from Erzincan to Sivas, M. Taşkın (ISTE 5617)

B10 Kara d. Aralik: Kudük Agri Da., near Serdar Bulak 2300 m, D.46891

C6 Konya: Ermenek to Karaman, 53 km from Ermenek, 1430-1560 m,

Hub.-Nov. 10339!

C6 Sivas: Anamur Mountains, 1500-2000 m, Samsulsson 3797!

External distribution: C. Europe, Bulgaria, Jugoslavia, Albania, Greece, Crimea, Egypt, Lebanon, Caucasus, W. Iran, Afghanistan.

C. subsp. serrulatum (Boise.) M. Dogan in Notes R. B. C. Edinb. 3(1): 86 (1982)

Syn: P. boehmeri var. ciliatum Griseb. in Ledebr. Fl. Ross. 4: 457 (1852);

P. serrulatum Boise., Diagn. Ser. 2 (4): 125 (1859)!

Pl. 5-7. Mountain slopes, tree plantation fields, 750-1450 m.

Typus: [Turkey C5 Adana] "Neb. in collibus insultis Cilicieae supra.

Gilek Boghaz", 7 vi 1855, Balansa 12:

Mainly S. Anatolia.

C2 Antalya d. Kemer: Teke Da. near Ovacik, 1100-1200 m, D.15203!

C2 Denizli: Nomas Da., 750 m, E. Tuzlaç (ISTE 4969)!

C3 Antalya: around Side, 5 vi 1970, A. Pamukcuoglu A. Quezel (WUB)!

C5 Adana: Karsali, 24 vi 1970, A. Pamukcuoglu (WUB)!

C5 Adana: Karsanti, 1150 m, E. Yurdakulu (ISTE 23862)!

External distribution: Lebanon, Latakia.

9 P. phleoides (L.) Karsten, Deutsche Pl. 374 (1881).

Syn: Phalaris phleoides L., Sp. Pl. 55 (1753)!

Pleum boehmeri Wibel, Prim. Pl. Waterh. 125 (1799).

In: Hubbard, Grasses 318 (1968).

Densely caespitose perennial. Stem 14-33 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 3/6-3/4 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 versura", Wb. Linn. 78/517

N., W. and Inner Anatolia.

A1(E) Kirklareli: 17 km N. of Kirklareli, Kadıköy, N. Uluocak (ISTE 23871)

A2(A) Istanbul: Kayiş Da., 7.5 km E. of Bramköy, 9 vi 1895, Anm.!

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 İzmir: Bozdağ, 1500 m, K.P. Buttler 17427!

B3 Eskişehir: Türkmen Da., Kuyuouk alani, 1400 m, T. Ekim 2227!

External distribution: W., N. and C. Europe, Mediterranean area, Crimea, N. Iraq, Iran, C. and S. Russia, Siberia.


3: 345 (1933).

Kulozynski, 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 blades 0.5-4 cm x 2-4 mm, linear, acute, rough on margins; sheaths smooth, scarios, 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 1/2 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" (Fort. Cliffs, BM)

Islands.

Samos: Mittlere Region, Forsyth-Major: 396

Lesvos: Malea; Nerutsika, Candargy


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 Asnavour'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.


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. exaratum
1. Spikelets 2-2.5 (-3) mm; cilia less than \( \frac{1}{2} \) x as long as width of glumes and not dense ........... subsp. seagecum

subsp. exaratum

Syn: P. graecum Boiss., Heldr. ex Boiss., Diagn. Syst. 1 (13): 42 (1853);
P. cornutum Mes in Feddes Rep. 17: 293 (1921).

Io: Bor, Fl. Iraq 9: 309, t. 112 (1968);

Fl. 5-7. Open places, inside Pinus forest, on chalky soil, 600-2300 m.


Widespread.

A1(E) Edirne: 3 km from Siloglu to Kovankaya, A. Baytop (ISTE 3180h)!
A2(E) Istanbul: Belgrad forest near Topuslu Bent, 20 v 1959, Valt.!
A3 Ankara: Beypazarı, İhān, 1200 m, Y. Akman 1018!
A4 Ankara: 15 km N. of Ankara on Çankırı road, Coode & Jones 2133!
A5 Corum: Osmanlıık to Kargı, 600 m, Tobey 2671!
A6 Samsun: Gelemen, sea level, H. Birand (ANK 1061)!

A9 Kars: Sarikamis, 2300 m, G. Önuş & B. Yıldız (BGE 16358)!

B1 Manisa: Manisa Da., A. Bayto (ISTE 9921)!

B2 Kutahya: Gedis 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. Bayto (ISTE 7115)!

B5 Kayseri: 19 km from Kayseri to Sivas, 1020 m, H. Birand & M. Zohary 66!

C2 Denizli: Cakurtaran to Acipayam, 34 km from Denizli, 1250 m, A. Baytop & E. Tural (ISTE 2551.8)!

C3 Isparta: Egridir, Anamas, Yakaavşar köy, 1400 m, H. Pegden & A. Çınar 1426!

C4 Konya: Meram, Regal (BGE 4588)!

C7 Urfa: 32 km from Urfa to Halvan, 700 m, D.2825!

External distribution: Italy, Balkans, W. Syria, N. Iraq, Iran, Transcaspias.

subsp. aegaeum (Vierh.) M. Dogan in Notes R.B.C. Edinb.


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. 1096;


External distribution: Aegean.

Syn: *P. exeratum* Hochst. ex Boiss., Fl. Gr. 5: 460 (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 equaling 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 sitios Syriae borealis ad Aleppo" Kotschy: 197.

Inner and S. Anatolia.

B5 Nevşehir: 5 km from Gulşehir to Nevşehir, 450 m, McNeill 385!
B6 Malatya: Derende to Kavakaga, 14 VII 1906, G. & E. Post!
C5 Adana: near Tuzla, sea level, Goode & Jones 335!
C6 Maraq: 24 km from Maraq to Goksun, 1300 m, Str. & Hend. 5516!
C8 Mardin: 56 km N. of Mardin to Diyarbakir, 600 m, E. Birani!
C9 Hakkari: Çukurca, 1200 m, D.44763!


Type: *P. gibbum* (Boiss.) M. Dogan


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-ovate, 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: *A Turkey A2 Aydin* "Hab. in arenosis regionis superioris Mesogis supra Tralles in consortio Saponarias Mesogitanae etc."

*/vi 1842*, Boissier /Folo G17/

W. Anatolia.

B2 Manisa: Boz Da. Y., 22 vii 1854, Bal.!

B2 Uşak: Kaya Ağil Köy, S.W. of Uşak, 7 vii 1857, Bal.!
B2 Usak: Karagöl Köy, 7 vii 1857, Bal.

B2/C2 Burdur: Beyşehir to Sarkikaraağaç, 11 km E. of the latter, 1250 m, R. Çetik (ISTE 33840).


Endemic to Turkey. Mediterranean element.

Type: *R. orientalis* Boiss.


Syn: *Cyperus pycnantha* Jaub. et Spach, Ill. Fl. Orient. 4: 8, t. 307 (1850);


Annual. Stem 0.5-2 cm, tufted. Leaf blades 0.3-4 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" Ancher-Eloy: 3066 (Holotype) Inner Anatolia.

B4 Ankara: Tuz Gölü, 10 km S. of Sereflikochisar, 950 m, Coode & Jones 1361.
B5 Yosgat: 10 km N. of Bogazlayan, on road to Yosgat, 1200 m,

Coode & Jones 1497!

C5 Nigde: Aksaray to Ulukisla, S. of junction with Nigde road, 1200 m,

Coode & Jones 185!

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 Buxine province); Mediterranean (represented by the East Mediterranean provinces of West Anatolia, Taurus and Amanus \( \text{\footnotesize i.e.} \) West and South Anatolia respectively); and Irano-Turanian (represented by Inner Anatolia \( \text{\footnotesize i.e.} \) 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.
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, Perşembé (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 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 Turgül, 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 "Ataturk Baraji" (Gasiantep-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 relics 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, Meanderes), 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, Mertirmak, 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 Geyhan 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 (Dülşül Dag), most of the area consisting of igneous rocks.

In Central Anatolia 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 Ereiyas 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 Göli 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.
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, Nolineriella, Zingeria, Antinoria, Parvotrisetum, Gastridium, Triplachne, Avellinia, Cormoopia, 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. utriculatus: var. utriculatus
- A. Gerardii: var. Gerardii
- O. Rendlei

Map 17

- Anthoxanthum aristatum
- A. gracile
- A. odoratum: subsp. odoratum
- subsp. alpinum
Map 18

Δ Apera spica-venti ▼ A. intermedia
□ A. baytopiana ● A. triaristata

Map 19

□ Helictotrichon convolutum ▼ H. argaea
◆ H. planiculme ■ H. compressa
H. pubescens: ○ subsp. pubescens ○ subsp. longifolia
Map 20

\[\Delta \text{Holcus lanatus} \quad \Delta \text{H. annuus}\]

Map 21

\text{Phleum exeratum: } \blacksquare \text{subsp. exeratum} \quad \Box \text{subsp. aegaeum} \\
\text{OP. paniculatum subsp. ciliatum} \\
\text{●P. crypsoiides}
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 extensions 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, occurring 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. lasiaca*, *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 involuclar bristles (*Pennisetum*, etc.). One must not underestimate 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. parviflora*, 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 caryosoides*, 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 grain 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 Tragac, 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 rachilla, 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 it is very common among Bambusoid grasses.

8.6. 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, Caudinopsis sorgeri, C. quercetorum, C. huber-morathii.
Helictotrichon argaæum, Trisetum turcicum, Zingeria verticillata, and Ventenata eigii.

The following species are endemic to E. Anatolia and Caucasia: Agroœis lasica, A. balansaœ, 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), Haakel (1867), 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 rachilla, 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


   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
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|                  | Setaria              |                     |
|                  | Pennisetum           |                     |

|                  | Andropogoneae        |                     |
|                  | Imperata             | Sorghum             |
|                  | Saccharum            | Chrymopogon         |
|                  | Tobriochloa          | Dianthus            |
|                  | Andropogon           | Pyrrheia           |
|                  | Hyparrhena           | 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 festucoide 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) Tmesiphone
3. Tribe TRITICAE Dumort., Obs. Gram. Belg. 82 (1823)

Leaf blades linear, with festucaoid 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. Rachilla disarticulating above glumes. Glumes coriaceous, strongly nervet, 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 + 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) Crithopsia
11) Aegilops
12) Triticum
13) Dasypyrum
14) Secale
15) Leymus
16) Paathyrostachys
17) Hordeum
18) Hordelymus
19) Taeniotherum
20) Henrardia

4. Tribe BROMEAE Dumort., Obs. Gram. Belg. 82, 115 (1823)

Leaf blades linear, with festucaoid 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. Rachilla 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 AVENAEE Dumort., Obs. Gram. Belg. 82, 120 (1823)

Leaf blades linear, with festuroid 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 gniculate 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 31) Avellinia 40) Calamagrostis
23) Helictotrichon 32) Rostraria 41) Ammophila
24) Arrhenatherum 33) Koeleria 42) Apera
25) Gaudinia 34) Deschampsia 43) Agrostis
26) Ventenata 35) Molineriella 44) x Agropogon
27) Gaudinopsis 36) Antinoria 45) Polypogon
28) Trisetum 37) Aira 46) Lagurus
29) Trisetaria 38) Corynephorus 47) Gastridium
30) Parvotrisetum 39) Holcus 48) Triplachne
6. Tribe MILIEAE Endl., Fl. Poson. 109 (1830)


Genera
49) *Milium*
50) *Zingeria*


Leaf blades linear, with festuroid 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) Phalaria  
52) Anthoxanthum  
53) Hierochloe  
54) Alopecurus  
55) Cormusopia

8. Tribe PHLEBEEAE 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. Lodicles 2. Stamens 3(-2). Ovary glabrous. Styles 2. Starch grains compound. Chromosomes large; basic number 7.

Genera

56) Beakmannia  
57) Phleum  
58) Pseudophleum  
59) Rhicosphalbus


Genera

60) Scolochloe
10. Tribe POEAEE 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. Rachilla 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) × Festulolium
64) Lolium
65) Vulpia
66) Micropyrum
67) Nardusoides
68) Loliolum
69) Catapodium
70) Cutandia
71) Sphenopus
72) Psilurus
73) Poa
74) Erremoza
75) Nephrolechloa
76) Catabrosella
77) Hyalooza
78) Catabrosa
79) Paraolpodium
80) Colpodium
81) Puccinella
82) Sclerocchioa
83) Dactylis
84) Cynosurus
85) Lamarokia
86) Briza


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 rachis, sessile. Glumes 1-2; lower glume suppressed at

Genera
87) Pholiurus
88) Parapholis
89) Mainardi


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 MEERICRAE 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

Genera

35. Helica


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. Lodicles 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. Glycemia


Starch grains compound. Chromosomes small; basic number 9.

Genera
95) *Molinia*

16. Tribe **NARDEAE** Anderss., Gram. Scand.:112 (1852)


Genera
96) *Nardus*

17. Tribe **STIPSAE** Dumort., Obs. Gram. Belg. 83, 134 (1823)

Leaf blades setaceous to linear, usually convolute or folded, with bambusicoid 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. Rachilla 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*


Genera

99) *Amelodesmos*

19. Tribe ARUNDINAE 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. Rachilla 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*

Genera

102) Coptadorea


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, hermaphroditic, laterally compressed. Glumes about as long as lowest lemma. Rachilla 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) Dantbonia

104) Sobisma

Leaf blades setaceous to linear-convolute, with aristidoid anatomy; silica bodies dumb-bell shaped, or elliptic-oblance; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence a panicle. Spikelets with 1 hermaphrodite floret, laterally compressed or terete. Glumes shorter or longer than florets. Rachilla disarticulating above glumes. Lemma chartaceous, becoming coriaceous, with 3-fid terminal awn. Palea 2-leased. Lodicules 2-3. Stamen 3(-1). Ovary glabrous. Styles 2. Filum linear, as long as caryopsis. Starch grains compound.

Chromosomes small; basic number 11, 12.

Genera

105) Aristida
106) Stipagrostis


Leaf blades linear to convolute, with panicoid anatomy; (see Fig. 3, a) silica bodies dumb-bell or cross-shaped; 2-celled micro-hairs present; ligule a fringe of hairs. Inflorescence of racemously arranged, more or less sessile spikes. Spikelets with 2-many hermaphrodite florets, laterally compressed. Glumes shorter than spikelet. Rachilla disarticulating above glumes and between florets. Lemma coriaceous. Palea 2-leased. Lodicules 2, oblong-truncate. Stamen 3. Ovary glabrous. Styles 2. Filum punctiform. Starch grains compound.

Chromosomes small; basic number 10.

Genera

107) Aeluropus
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 suberect. 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. Lodicles 2, truncate. Stamens 2-3. Ovary glabrous. Styles 2. Filum punctiform. Starch grains compound. Chromosomes small; basic number 9, 10, 12.

**Genera**

108) *Eragrostis*  
110) *Decylaceps*

109) *Eleusine*  
111) *Gleistogonon*


**Genera**

112) *Cynosurus*


Genera

113) Sporobolus
114) Cryptus

in Dyer, Fl. Cap. 7: 315 (1896)

Leaf blades convolute, pilose or setose, with chloridooid anatomy; silica bodies saddle, bumbell 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. Rachilla 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 panicooid anatomy; silica bodies nodular, bumb-ball or cross-shaped; 2-celled micro-hairs present; ligules 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 equaling 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. Milum punctiform. Starch grains simple. Chromosomes small; basic number 7, 9, 10, 15, 17, 19.

Genera

116) Cenchrus 120) Paspalum
117) Pennisetum 121) Digitaria
118) Echinochloa 122) Setaria
119) Brachiaria 123) Pennisetum

29. Tribe ANDROPOGONEAE Dumort., Obs. Gram. Belg. 84, 141 (1823)

Leaf blades linear to lanceolate or ovate, with panicooid anatomy; silica bodies bumb-ball or cross-shaped; 2-celled micro-hairs present; ligules membranous or 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. Milum punctiform. Starch grains simple.
Chromosomes small; basic number 5, 9, 15, 17, 19.

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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.
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 species with a lax non-plumose peduncle, laterally compressed (at right angles to glumes) or not compressed with 2-many flowered spikelets, glumes shorter than floret (excluding awns), awn dorsal (including subbaseal) on the lemma, ligule membranous, auricle absent, leaf sheath glabrous and habit annual, will be found to have the formula CKMQTVXY. 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 HLMQTVXY, 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 armed *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. *HINXYV* or *HINXV*, 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(—)EFVXZ* represents *Leersia* which has no glumes.

**Inflorescence Type**

Nine character states are based on the inflorescence can be recognized 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, Henaridia, Parapholia*, etc.
B) Inflorescence an uninterrupted spike, with 1 or more sessile spikalets at each node (Fig. 25, B).

In certain genera the spikalets, as well as being sessile on the main axis, have at least two of them attached to the same node of the main axis. Spikalets are rather dense and almost hiding the internodes. The inflorescence is oblong in outline, as in Dactyglryrum, Secale, Eremopyrum, Triticum, Triticale, Agropyron, etc.

Hordeum and Hordeum present a slightly different variant of this character state, having two shortly pedicellate lateral spikalets; however, since each of the three spikalets 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 spikalets 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 Dianthus, Cynodon, Arthraxon, Hesperis, Dactylis, Deschampsia, 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 Dianthus, Androsace, Paspalum, Hyparrhenia, Arthraxon, etc.

E) Inflorescence a raceme (Fig. 26, E).

Each spikalet is directly connected to the main axis by a short or relatively long pedicel. In certain cases the pedicels are so short that the spikalets may be mistakenly thought to be sessile. In Turkey, there are certain examples for this character state,
such as Brochymedium, Caudinonisia, Welchia, Micronyrum, Dasthonia, Caterodium, 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 amn, rachilla, dorsal side of lemen, glumes, or below the spikelet. The typical examples for this character state are Sollemus, Arundo, Imperata, Stipa, and Phragmites. (It can also be seen in Salamagrostis epigeios (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, Caryea, 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, Rostania, Scalaria, 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 *Rhiscocephalus*, *Cormonina*, *Lagurus*, *Echinaria*, *Phleum crysoclados* (D'Urv.) Frankel, *Alopecurus textilis* Bois., 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*, *Corylus*, *Setaria*, *Echinochloa*, *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, Alonecurus,
Castridium, Tripleshus, Stipa and Lachurus.

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 scar (less than 0.5 mm) at the apex of the glumes is included within the length of the glumes, but scar length is always excluded.

M) Glumes shorter than lowest lemma (excluding awna), or rarely absent (-) (Fig. 29, M)

Glumes shorter than the lowest lemma, or very much reduced to scale-like organs, as in Caryza exata L. Rarely spikelets have no glumes at all, for example Levia crysoides (L.) Swarts. The latter state is scored as (-), instead of M. Examples of glumes shorter than lowest lemma are Cynodon, Trisetus, Nardus, Rhicoschelus, Gaudinopsis and Scirrochloa.

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, Alonecurus, Castridium, Holcus, Polygono, etc.
Awn Position on Lemma, or Awn Absent

In this group, the awn and its position of attachment to the lemma (not glume) is dealt with, but small biaristate points at apex of lemma are excluded (e.g. *Tripsaria*).

0) Awn(s) of lemma terminal (Fig. 30, 0)

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 exerted. Examples for this character state are *Aristida*, *Oryza*, *Festuca*, *Rhizoccephalus*, *Nardus* and *Loliolium*. Sometimes the lemma has more than one terminal awn (e.g. *Sealoria*, *Echinoaria*).

P) Awn(s) of lemma 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*, *Amelodesma* and *Spodiopogon*.

Q) Awn(s) of lemma 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. Cormscopia cuculatum L.), Examples of genera with awns absent include Poa, Aeluropus, Catabrosa, Briza, Paniceum and Eragrostis.

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, Pannum, Cynodon, Arundo, Dactytonia and Eragrostis.

T) Ligule membranous, of variable length, glabrous or hairy; rarely obsolete (−) (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 Booncholea. The latter state is scored as (−) instead of T.

Auricules

At the top of the leaf sheath, small usually falcate outgrowths are called auricules.
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, Aegilops, 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 Lagaricia, Pailurus, Heliocotrichon, Poa, Cornumonia and Brista.

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 in Holcus, Heliocotrichon, Secale, Alopecurus, Aegilops, Lagurus, Oplisnum, 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, Ansera, Agrostis, Catabrosella, Poa, Vulina, Echinoncha, etc.
The duration of grasses, either annual or perennial, is an important diagnostic feature.

1) 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, Vulna, Eleusine* and *Echinoaria*.

2) 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, Asturomus, 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 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 interrupted spike, with 1 (sessile) spikelet at each node
   a) Lolium   b) Rainardia   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. Dactylooctenium)

D) Inflorescence of paired spikes or false racemes
   (i.e. Paspalum)
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. 27. Character States used in the Formula Key

II) Inflorescence a spike-like panicle, more than twice as long as broad
   a) Inflorescence of Aloepecurus
   b) Spikelets of Aloepecurus

I) Inflorescence a dense head-like panicle, 1-2 x as long as broad (sometimes involucrate)
   a) Inflorescence of Cornucopiae
   b) Spikelets of Cornucopiae
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. Aloepecurus)
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
Fig. 30. Character States used in the Formula Key

0) 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. Trietum)
Fig. 31. Character States used in the Formula Key

R) Awn(s) absent on all lemmas
   a) Calpodium       b) Brisa

S) Ligule a fringe of hairs
   (i.e. Brachiaris)

T) Ligule membranous, of variable length, glabrous or hairy, rarely obsolete (-)
   (i.e. Eremopoa)
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. Heliotrichon)

X) Leaf sheaths glabrous (smooth or scabrid)
   (i.e. Cymnopus)
FORMULA KEY TO GENERA

AJNETUXY Lateral spikelets with 1 glume,
    not sunken ........................................ 64. Lolium

AJNETVXY Lateral spikelets sunken into axis,
    with 1 floret .................................... 89. Neanardia

AKNVTUWY Glumes with 1 or more teeth or awns ...... 11. Aegilops
AKNOTUXY Glumes with 1 or more teeth or awns ...... 11. Aegilops
AKNRTUXZ Glumes not keeled, 1-11-veined ............. 6. Elymus
AKNOTVXY Inflorescence curved; spikelets with
    1 floret .......................................... 72. Failurus
AKNPTUXY Glumes not keeled, 1-11-veined ............. 6. Elymus
AKNRTUWY Glumes ± truncato-uneate ................... 9. Amblyopyrum
AKNRTUXZ Glumes not keeled, 1-11-veined ............. 6. Elymus
AKNRTUXZ Glumes not keeled, 1-11-veined ............. 6. Elymus
AKNRTUXZ Glumes not keeled, 1-11-veined ............. 6. Elymus
AKNRTUXZ Glumes not keeled, 1-11-veined ............. 6. Elymus
AKNRTUXZ 1. Spikelets in pairs at each node .......... 6. Elymus
    2. Spikelets in groups of 2-6 at each node ...... 15. Leymus
AKNOTWY Glumes with 1 or more teeth or awns ...... 11. Aegilops
AKNOTVXY Lateral spikelets with 2 glumes .......... 68. Lolium
AKNPTUXY Lateral spikelets with 1 glume ............. 64. Lolium
AKNPTUXY Lateral spikelets with 1 glume ............. 64. Lolium
AKNQTWY Glumes 3(-5) to 5-7(-11)-veined ............ 25. Gandinia
AKNRTUZ 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. Fanaradia
AKNRTUXZ Lateral spikelets with 1 glume ............. 64. Lolium
AKNPTVXY Spikelets with 2 florets ..................... 87. Pholiurus
    Spikelets with 4-6 florets ..................... 67. Narduroides
<table>
<thead>
<tr>
<th>ALMOTVXY</th>
<th>Inflorescence curved; spikelets with 1 fertile floret</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>72. Psilurus</td>
</tr>
<tr>
<td>ALMOTVXZ</td>
<td>Spikelets second, triangular</td>
</tr>
<tr>
<td></td>
<td>96. Nardus</td>
</tr>
<tr>
<td>ALMOTUXY</td>
<td>Lateral spikelets with 2 glumes, sunken</td>
</tr>
<tr>
<td></td>
<td>20. Panardia</td>
</tr>
<tr>
<td>ALMOTVXY</td>
<td>Inflorescence curved; lateral spikelets with 2 glumes</td>
</tr>
<tr>
<td></td>
<td>88. Parapholis</td>
</tr>
</tbody>
</table>

| ALOMTUWY | 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. Bremopyrum                                        |
|          | 4. Spikelets dimorphic, the fertile                  |
|          | one or warty                                         |
|          | 8. Noteranthelium                                    |
|          | 5. Spikelets with 2(-3) florets; glumes subulate     |
|          | 14. Secale                                           |

| ALMOTUXZ | Glumes boat-shaped, keeled                           |
|          | 5. Agropyron                                         |

| ALOMTUXY | 1. Glumes truncate, with 1 or more teeth or awns    |
|          | 11. Aegilops                                         |
|          | 2. Spikelets with 3-6 florets                       |
|          | 7. Bremopyrum                                        |
|          | 3. Lemma with a long awn                             |
|          | 14. Secale                                           |

| ALMOTUXZ | 1. Glumes not keeled                                 |
|          | 6. Elymus                                            |
|          | 2. Spikelets with 2 florets; glumes                  |
|          | 0-1-veined                                           |
|          | 14. Secale                                           |
|          | 5. Agropyron                                         |
|          | 3. Glumes boat-shaped, with 1-2 lateral veins        |
|          | 5. Agropyron                                         |

<p>| ALMOTVXY | Spikelets with 3-6 florets; glumes                  |
|          | 7. Bremopyrum                                        |
| ALMOTVXZ | Glumes boat-shaped, with 1-2 lateral veins           |
|          | 5. Agropyron                                         |</p>
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BKOPTUY</td>
<td>Glumes truncate, keeled</td>
<td>12.</td>
<td>Triticum</td>
</tr>
<tr>
<td>BKOPTUXY</td>
<td>Glumes truncate, keeled</td>
<td>12.</td>
<td>Triticum</td>
</tr>
<tr>
<td>BKOPTVXY</td>
<td>Glumes truncate, keeled</td>
<td>12.</td>
<td>Triticum</td>
</tr>
<tr>
<td>BKNOVXXZ</td>
<td>Leaves patent; ligule a fringe of hairs</td>
<td>107.</td>
<td>Aeluropus</td>
</tr>
<tr>
<td>BKNOTUY</td>
<td>Glumes truncate, rounded dorsally</td>
<td>11.</td>
<td>Aegilops</td>
</tr>
<tr>
<td>BKNOTUXZ</td>
<td>Lateral spikelets hermaphrodite</td>
<td>18.</td>
<td>Hordeum</td>
</tr>
<tr>
<td>BKNOTUXY</td>
<td>1. Awn of lemma 6-12 cm, recurved</td>
<td>19.</td>
<td>Teanatheterum</td>
</tr>
<tr>
<td></td>
<td>2. Spikelets solitary at each node</td>
<td>14.</td>
<td>Secale</td>
</tr>
<tr>
<td></td>
<td>3. Lemma (incl. awn) equaling glumes (incl. aristate points), axis pilose</td>
<td>10.</td>
<td>Cryptopsis</td>
</tr>
<tr>
<td>BKNOTUXZ</td>
<td>Glumes covering sides of lower floret</td>
<td>15.</td>
<td>Leymus</td>
</tr>
<tr>
<td>BKNOTVXY</td>
<td>Spikelets with 3-6 florets</td>
<td>7.</td>
<td>Eremopyrum</td>
</tr>
<tr>
<td>BKNOTVXZ</td>
<td>1. Rachiis fragile; spikelets with 1-2</td>
<td>16.</td>
<td>Paathyrrostachya</td>
</tr>
<tr>
<td></td>
<td>2. Rachiis tough; spikelets with 3-5</td>
<td>15.</td>
<td>Leymus</td>
</tr>
<tr>
<td>BKOPTUXY</td>
<td>Glumes truncate, keeled</td>
<td>12.</td>
<td>Triticum</td>
</tr>
<tr>
<td>BKOPTVXZ</td>
<td>Glumes covering sides of lower floret</td>
<td>15.</td>
<td>Leymus</td>
</tr>
<tr>
<td>BLNOTUXY</td>
<td>Central spikelets sessile, hermaphrodite</td>
<td>17.</td>
<td>Hordeum</td>
</tr>
<tr>
<td>BLNOTVXY</td>
<td>Central spikelets sessile, hermaphrodite</td>
<td>17.</td>
<td>Hordeum</td>
</tr>
<tr>
<td>BLNOTVXZ</td>
<td>1. Lateral spikelets sessile</td>
<td>16.</td>
<td>Paathyrrostachya</td>
</tr>
<tr>
<td></td>
<td>2. Lateral spikelets pedicellate, sterile</td>
<td>17.</td>
<td>Hordeum</td>
</tr>
<tr>
<td>BLNOTVXZ</td>
<td>Only central spikelets sessile</td>
<td>17.</td>
<td>Hordeum</td>
</tr>
<tr>
<td>CJMOFTWHY</td>
<td>Spikelets second, 2-3, 5 mm, pedicellate</td>
<td>121.</td>
<td>Digitaria</td>
</tr>
<tr>
<td>CJMOFZWZ</td>
<td>Spikelets second, 2-3, 5 mm, pedicellate</td>
<td>121.</td>
<td>Digitaria</td>
</tr>
<tr>
<td>CJMOSVXZ</td>
<td>Sessile spikelets with 2 florets</td>
<td>130.</td>
<td>Dicranonthium</td>
</tr>
<tr>
<td>CJMOFTVZ</td>
<td>Stem nodes long hairy</td>
<td>130.</td>
<td>Dicranonthium</td>
</tr>
<tr>
<td>CJMOSVZZ</td>
<td>Spikelets 10-18 mm, paired</td>
<td>135.</td>
<td>Phaseurus</td>
</tr>
<tr>
<td>CJMOFTVXY</td>
<td>Spikelets second, 1.8-2.2 mm</td>
<td>121.</td>
<td>Digitaria</td>
</tr>
</tbody>
</table>

335
CJNRTVXZ Spikelots 4-6 mm, sunk into rachis .... 136. Hemarthria
CKNIVXZ Axis extending; upper glume terminally
awned ........................................ 110. Peaagoecenium
CKNRSVXY Spikelots second, 5-8 mm ............... 109. Eleusine
CKKRSVWW Leaf blades lanceolate .................. 133. Arturaxos
CKKRSVWZ Leaf blades lanceolate .................. 133. Arturaxos
CLMRSVXZ Spikelots second, with 1 floret, 2 mm .... 112. Cynodon
DJNQTVXZ Stem nodes covered by long hairs ...... 130. Dichanthium
DJNFIVXZ Sessile spikelots 8-16 mm, with
2 florets ...................................... 131. Andropogon
DJNQSVWZ Leaf blades lanceolate; ligule hairy .... 133. Arturaxos
DJNIVTVXZ Sessile spikelots 8-16 mm, with
2 florets ...................................... 131. Andropogon
DJNQTVXZ Spikelots second, 3 mm ................... 120. Paspalum
DKNRSVXZ Spikelots second; ligule a fringe of
hairs ........................................... 109. Eleusine
DKNIVTVXZ Sessile spikelots 4-6, 5 mm, with
2 florets ...................................... 132. Hyparrhenia
DKNIVTVXZ Sessile spikelots 4-6, 5 mm, with
2 florets ...................................... 132. Hyparrhenia
EJRNSWZ Spikelots 10-18 mm, paired ................. 135. Phacelurus
EKNRTVWZ Spikelots 1-3 cm; lemma with
apical awn .................................... 3. Breckypodium
EKNRTVXY 1. Glumae very unequal; lower glume
1-veined ...................................... 65. Vulva
2. Spikelots 1-3 cm; palea with pectinate
ciliate ........................................ 4. Trechynia
3. Awn of lemma 1-4 mm ......................... 66. Hieroppyrum
EKNIVTVXZ Spikelots 1-3 cm, only a few ............ 3. Breckypodium
Lowest lemma without an awn .................. 27. Saudinopsis

1. Glumes unequal, obtuse, margins
   hyaline ........................................ 82. Solerocloa

2. Glumes subequal, acute, membranous ..... 69. Catapodium

1. Glumes very unequal; lemma keeled .......... 65. Vulpia

2. Glumes subequal; lemma rounded
   on back ........................................ 4. Trachynia

Ligule a fringe of hairs ........................ 103. Danthonia

Spikelets 10-30 mm, with 5-15 florets ....... 63. Festulolium

1. Spikelets with 5-9 florets; glumes
   acute ......................................... 69. Catapodium

2. Spikelets with 3(-5) florets; glumes
   obtuse ........................................ 67. Nardusoides

Spikelets surrounded by hairs; lemmas
   terminally awned .............................. 125. Saccharum

Spikelets surrounded by hairs; lemmas
   terminally awned .............................. 125. Saccharum

Spikelets surrounded by hairs; upper
   awned from sinus .............................. 124. Spodiopogon

Spikelets surrounded by bristles ............. 122. Setaria

1. Spikelets surrounded by bristles ........... 123. Pennisetum

2. Rhachilla with long hairs ................... 101. Phragmites

1. Hairs from involucral bristles ............. 123. Pennisetum

2. Hairs from rhachilla ........................ 101. Phragmites

Dioecious; leaf blades sharply
   serrulate ...................................... 102. Cortaderia

Spikelets with 5-10 florets; lemma
   9-veined ...................................... 104. Solidago

Ligule a fringe of hairs; panicle 30-60 cm ... 100. Arundo
Spicalets surrounded by hairs ................................ 124. Spodiopogon

Lemma dorsally armed; spicalets 8-11 mm .......................... 26. Trisetum

Spicalets with 5-10 florets; lemma

9-veined ........................................................................ 104. Schismus

Spicalets terete, with 2 florets;
.. branches though .......................................................... 126. Imperata

Hairs from dorsal side of lemma ......................................... 93. Helica

1. Spicalets surrounded by hairs .................................. 124. Spodiopogon

2. Hairs from dorsal side of lemma ................................. 93. Helica

Awns 3-fid, at least middle awn long

hairy ............................................................................. 106. Stipagrostis

Awns 3-fid, at least middle awn long

hairy ............................................................................. 106. Stipagrostis

Awns hairy; callus acuminate ............................................ 97. Stipa

Awns coming from sinus of glumes .................................... 45. Polypogon

Hairs from callus; glumes acuminate to

aristate ........................................................................ 40. Calamagrostis

1. Spicalets 1.5-3.5 mm; glumes acute ..................... 43. Agrostis

2. Glumes acuminate or shortly

aristate ........................................................................ 40. Calamagrostis

Spicalets 2.3-3.5 mm; glumes unequal .......................... 121. Digitaria

Branches verticillate; lemma clavate

hairy ............................................................................. 50. Zingiberia

Spicalets 3-5 mm; ligule absent .................................. 118. Echinochloa

1. Spicalets 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 golden hairs on their callus .................. 128. Chrysopogon

GJNPSVXY Sessile spikelets 4.5-5.5 mm; lemma thick ........................................ 127. Sorghum

GJNRTVXY Sessile spikelets 4.5-5.5 mm; lemma thick ........................................ 127. Sorghum

GJNRSVXY 1. Panicle branches very long ............... 417. Panicum

2. Glumes hairy; pedicels shorter than 1 mm ........................................ 119. Brachiaria

GJNRSVWZ Spikelets 10-16 mm; branches 14-30 cm .... 135. Phacelurus

GJNRSVXX Lower glume minute; lemma cordate........ 417. Panicum

GJNRTVWZ Spikelets second, 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. Zingiber

4. Spikelets with 1 floret; lemma shiny ...... 49. Milium

GJN-RVXY Ligule absent; glumes unequal ........ 118. Echinochloa


2. Spikelets surrounded by spathe, armed .... 134. Themeda

3. Spikelets with 1 floret; lemma shiny ...... 49. Milium

GKOMOTUXY Glumes scale like; 2 lower florets sterile .... 1. Ozysa

GK-OTUXY Glumes scale like; cultivated ...................... 1. Ozysa

GKOMOTUXZ Lemma lanceolate, dorsally rounded .......... 61. Festuca

GKOMOTWZ Lemma lanceolate, dorsally rounded .......... 61. Festuca

GKOMOTVXY Branches divaricate; spikelets 9-17 mm .... 70. Cutandia
1. Glumes navicular; rachilla disarticulating below glumes .................................. 56. Beckmannia
2. Callus with a fringe of hairs .......... 62. Bellardiclocha
3. Awn of lemma 1–1.5 mm ..................... 85. Dactylis
4. Lemma gradually terminating into awn, lanceolate; awn at least 2 mm ........... 61. Festuca

GKOMPVZK

Spikes 6–10 mm; glumes 1-veined ........ 111. Cleistogaeas

GKOMTWY

Leaf sheaths with connate margins ......... 21. Bromus

GKOMTWZ

Caryopsis with a terminal appendage ....... 21. Bromus

GKOMTVY

1. Lowest lemma without a dorsal awn ... 27. Gaudinopsis
2. Branches verticillate; spikes 6–10 mm up to 5.2 mm ...................... 75. Nephaloclocha
3. Branches divaricate at maturity ......... 70. Curandia
4. Leaf sheaths with connate margins ...... 21. Bromus

GKOMTVZ

1. Stem up to 250 cm, solid; lemma coriaceous ........................................... 99. Anemodactys
2. Leaf sheaths with connate margins ....... 21. Bromus

GKOMTWY

Leaf sheaths with connate margins .......... 21. Bromus

GKOMTWZ

Spikelets 4–11 mm, shiny ........................ 28. Tritacum

GKOMTVY

Glumes 3–7 mm; glumes 5–9-veined; lemmas awned .......... 26. Ventanata

GKOMTVZ

Spikelets 7–16 mm; glumes 5–9-veined .... 24. Arrhenatherum

GKORSVZ

Spikelet with 2-many florets; glumes 1-veined .................................................. 108. Fragrosta

GKORSVZ

2. Stem 1-noded; lowest lemma 3–3.5 mm .... 95. Kolinia
3. Spikelets with many florets; glumes 1.5–2 mm ...................... 108. Fragrosta

GKRMUXY

Glumes scale-like; cultivated .................. 1. Oryza

GK-REUXY

Glumes scale-like; spikelet with 3 florets .... 1. Oryza
1. Glumes 3-9-veined; spikelets broadly ovate .......... 86. Brama
1. 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. Holineriella
5. Lemmas keeled; spikelet ovate .................. 73. Poa
6. Glumes 1/2 as long as spikelet .................. 69. Catanopodium
7. Lower branches vericillate; lemma acute ................. 74. Eremopoa

1. Spikelets 3-4-tetrate; glumes 1-veined .......... 94. Glyceria
2. Leaf sheaths with connate margins ............. 21. Bromus
3. Spikelets broadly ovate; glumes 3-9-veined ......................... 86. Brama
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

Ivaline ............................................ 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

GKROTVXZ Glumes 5-7 to 7-9-veined; upper lemmas
dorsally appressed .............................. 26. Ventenata

GKROTVXZ 1. Spikelets 3-6 mm; smelling coumarin .... 53. Hierochloe
2. Spikelets in threes; sessile spikelets

with long golden hairs .................... 123. Chrysopogon

GKROTVXZ Lemma lanceolate, dorsally rounded ........... 61. Festuca
Leaf sheath margins connate; caryopsis with a hairy terminal appendage ................. 21. Bromus

Spikelets with 2 florets, 3-4 mm .............. 39. Povoa

1. Spikelets dimorphic; glumes subequal .... 85. Lepidium
2. Spikelets with 2-4 florets; glumes unequal __________________________________________ 31. Avellinia

1. Lowest floret with geniculate awn ... 24. Arvheatherum
2. Stem up to 200 cm; pales equaling lemma __________________________________________ 60. Scalochea

1. Spikelets 2.6-6 mm; lemmas with
   2 setsa ........................................ 29. Triactaria
2. Spikelets 15-40 mm; lemma 7-veined .......... 22. Avana

Spikelets 11-25 mm, with 3-6 florets .......... 23. Heliototrichon

1. Glumes 5-7 to 7-9-veined; lowest lemma
   terminally awned _________________________ 26. Ventanata
2. Spikelets 15-40 mm; lemma 7-veined .......... 22. Avana
3. Awn clavate shaped in upper half ....... 38. Corynocephalus
4. Rachilla not prolonged above second floret _____________________________ 37. Atra
5. Lemma bifid at apex; teeth aristate ___________________________ 30. Pervotriestum

1. Lower floret male, upper
   hermaphrodite __________________________ 24. Arvheatherum
2. Spikelets 3.5-6 mm ......................... 34. Desschampsia
3. Spikelets 4-11 mm, shiny .................... 28. Trisetum
4. Spikelets 11-25 mm, with 3-6 florets

.................................................. 23. Heliototrichon

Glumes 1-veined; lemmas 1.4-2 mm ........... 108. Eragrostis
Ligule a fringe of hairs; upper glume and lemma 1-vained ........................ 113. Sporobolus

Spikelets 10-30 mm, with 5-15 florets .. 63. x Festulolium

1. Glumes shorter than spikelet; lemma acute ...... 73. Poa
2. Glumes equaling spikelets; lemma truncate ............ 36. Antinoria

1. Upper 2-3 sterile lemmas clavate like ...... 93. Melica
2. Glumes equaling spikelet; smell of coumarin .................... 53. Hierochloë

3. Stem up to 200 cm; glumes 5-9-veined ... 60. Scolochloë
4. Lemma + truncate, margins hyaline ........ 77. Hylodium

Lemma with 3-fid terminal awn ..................... 105. Aristida

Glumae equaling spikelet; cultivated .......... 1. Oryza

Glumes small, scale like; cultivated ............. 1. Oryza

Lower 2 lemmas empty, glume like; cultivated .... 1. Oryza

Glumes small scale like; cultivated ............. 1. Oryza

Glumes largely hyaline; lemmas truncate; hairy below .............................. 79. Paracolpodium

Spikelets 5-6 mm; glumes absent ............... 2. Leersia

Awns 6-7 cm; glumes equaling spikelet ........ 97. Stipa

Spikelets 2.4-3.7 mm; terminal awn 1-2.3 mm .... 42. Apera

Awn caducous; lemma shiny; glumes

5 to 3(-5)-veined ....................... 96. Piptatherum

2. Lemma shorter than glumes; awn 0.6-40 cm .... 97. Stipa

1. Glumes swollen, shiny, coriaceous

below ........................................ 47. Gastridium
2. Glumes as long as lemma ........................ 42. Apera
1. Glumes acuminate to aristate  ......  40. Calamagrostis
2. Spikelets 1.5-3.8 mm; glumes acute  ......  43. Agrostis

1. Glumes acuminate to aristate  ......  40. Calamagrostis
2. Glumes acute; spikelets 1.5-3.8 mm  ......  43. Agrostis

1. Spikelets falling entire  .................  45. Polygono
2. Lemma puberulent in lower half;
   pedicels glabrous  .......................  80. Colpodium
3. Rachilla disarticulating above glumes  ..  43. Agrostis

HJNRSVXY Spikelets subtended by bristles  ........  122. Setaria

HJNRSWZX Leaf blades lanceolate; glumes with
   an awn  ................................  116. Opismenus

HJNRTVXZ Leaf blades lanceolate; glumes with
   an awn  ................................  116. Opismenus

HJNQ-VXY Spikelets with 2 florets, upper one
   hermaphrodite  ..........................  118. Echinochloa

HJNRSWY 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

HJNQ-VXY Glumes unequal; upper lemma shiny; ligule
   absent  ..................................  118. Echinochloa

HJKOTVXY Lemma rounded dorsally, terminally awned  ......  65. Vulpia

HJKOTVXZ
1. Spikelets dimorphic  ......................  84. Cynocorus
2. Glumes aristate; lemma teeth aristate  ....  90. Eulalia
3. Spikelets navicular, arranged in 2 rows
   along one side of branches  .............  96. Beckmannia
4. Lemmas terminating into awn  ............  61. Festuca
5. Pedicels puberulent  ......................  33. Koehleria
6. Spikelets densely clustered in lobed panicles

........................................  83. Dactylis
Lemma keeled, 5-veined, bifid at apex ........ 32. Rostraria

Lowest lemma awl-shaped; glumes 3 to

3(-5)-veined .................................. 27. Gaedinopsis

Ligule a fringe of hairs ...................... 107. Aeluropus

Pedicels puberulent; spikelets with

2-5 florets ................................... 33. Koeleria

1. Glumes unequal, margins hyaline ..... 82. Solerocelos
2. Glumes subequal; lowest lemma 2-2.5 mm

.................................................. 69. Catapodium

1. Lemma truncate, margins hyaline .... 76. Catapeceella
2. Pedicels puberulent; lemma 4-6 mm ...... 33. Koeleria
3. Pedicels glabrous or not; spikelets

with 2-10 florets ................................ 73. Poa

Pedicels puberulent; lemma 4-6 mm .......... 33. Koeleria

Lemma dorsally rounded, terminally awned .... 65. Vulpia

1. Lemmas with aristate teeth at apex ..... 90. Salaria
2. Spikelets dimorphic; lemma (fertile)

with 1 terminal arm .......................... 64. Cynocurva

Ligule a fringe of hairs; lemma 9-veined ... 104. Schizachyrium

Spikelets with 2-5(-10) florets .............. 32. Rostraria

Lower 2 lemmas with obtuse lobes

at apex ........................................ 52. Anthosxanthon

1. Spikelets strongly dimorphic .............. 85. Lommerelia
2. Lower floret male, without an arm .......... 39. Nolcus
3. Lemma dorsally rounded; glumes unequal ... 31. Avellinia
4. Lemma keeled; glumes subequal ............ 32. Rostraria

Lower 2 lemmas with obtuse lobes

at apex ........................................ 52. Anthosxanthon

Lower 2 lemmas with obtuse lobes

at apex ........................................ 52. Anthosxanthon
1. Spikelets 1.5-3.5 mm; glumes equal ........ 37. Aina
2. Lower 2 florets male, upper floret
   hermaphrodite .................................. 52. Anthoxanthum
3. Lemmas with 2 fine arista point
   at apex ........................................ 29. Triasteria
4. Lower 2 lemmas with obtuse lobes
   at apex ........................................ 52. Anthoxanthum
5. Leaf blades lanceolate; ligule hairy .... 116. Oplismenus
6. Ligule fringe hairy; lemma 9-veined ..... 104. Solanum
7. Spikelets only a few, 3-6.5 mm .......... 103. Dantonia
8. Glumes winged on keel, equaling
   spikelet ....................................... 51. Phalaris
9. Spikelets dimorphic; fertile spikelets
   armed .......................................... 85. Lamarckia
10. Uppermost 2-3 sterile lemmas clavate like .. 93. Helica
11. Lower 2 florets sterile; glumes winged ... 51. Phalaris
12. Lemmas 2-3 mm; spikelet with 2-10 florets .... 73. Poa
13. Pedicels puberulent; lemma 3-veined ...... 33. Eosaria
14. Glumes unequal; lemma terminally armed .. 58. Pseudophleum
15. Terminal 3-branchled .......................... 105. Aristida
16. Glumes 3-veined; lemma 3-veined .......... 54. Aloeocurus
17. Glumes 3-veined; lemma 3-veined .......... 54. Aloeocurus
18. Ligule hairy; lemma and glumes 1-veined ...... 114. Cypria
19. Glumes 3-veined; lemma 3-veined .......... 54. Aloeocurus
20. Glumes largely hyaline; lemma
   truncate ...................................... 79. Paracolpodium
21. Ligule fringe hairy; lemma 1-veined ...... 114. Cypria
22. Spikelets 2.4-3.7 mm; am 1-2.3 mm .......... 42. Apera
1. Spikelets dimorphic; sterile ones
   awnless .................................. 85. Lepanthes

2. Glumes swollen and coriaceous at base .................................. 47. Geastridium

3. Glumes awned from sinus; spikelets falling entire ...................... 45. Polypogon

4. Glumes persistent; spikelet with 1 floret .......................... 42. Aprea

1. Spikelets 2-3 mm; glumes awned from sinus .......................... 44. x Agropyron

2. Spikelets 10-14 mm; callus hairy .......................... 41. Ammophila

1. Lemma with 2 long apical setae .................................. 48. Triplachmus

2. Glumes 3-veined; rachilla disarticulating below glumes .......................... 54. Alopecurus

Glumes 3-veined, connate below .................................. 54. Alopecurus

Ligule a fringe of hairs .................................. 114. Crypsis

Spikelets 1.5-2.5 mm; glumes and lemma 1-veined .......................... 113. Sporobolus

1. Glumes swollen, coriaceous at base .................................. 47. Geastridium

2. Lemma 3-veined, awned .................................. 54. Alopecurus

3. Lemma 5-7-veined, awnless, rounded
dorsally .................................. 57. Phleum

Lemma 5-7-veined, awnless, rounded
dorsally .................................. 57. Phleum

Spikelets surrounded by spaths .................................. 134. Thamnella

1. Lemma with 5 aristate points at apex .......................... 91. Echinaria

2. Glumes 1-veined; lemma mucronate .................................. 92. Ammophila

3. Spikelets dimorphic; lemma with 1 awn .................................. 94. Gymnopus

1. Non-flowering shoots strongly compressed .......................... 83. Dectylis

2. Non-flowering shoots + terete .................................. 33. Koeleria
Glumes as long as spikelet; annual ........ 32. Rostraria
Ligule hairy; lemma 9-11-veined ............ 107. Aeluropus
Stem up to 5 cm; glumes 1-veined ........... 92. Ammochloa
Spikelets dimorphic, with long awn .......... 84. Cynocurus
Lemma with 2-5 aristulate teeth at apex ....... 90. Sealaria
Glumes winged; spikelets with 3 florets ....... 51. Phalaris
Stem about 1 cm; lemma with an apical
ligule .............................. 59. Rhizocephalus
Ligule a fringe of hairs; glume 1-veined .... 114. Crypsis
Ligule a fringe of hairs; glumes 1-veined ... 114. Crypsis
Spikelets villous hairy; lemma with
2 setae .................................. 46. Lagurus
Spikelets hairy; lemma 3-veined, keeled ... 54. Alopecurus
1. Panicle surrounded by obconical
involucre .................................. 55. Cornucoopia
2. Spikelets + hairy; involucre absent ... 54. Alopecurus
Lemma 3-veined, anned, keeled ............... 54. Alopecurus
1. Lemmas shorter than glumes, not keeled .... 57. Phleum
2. Panicle surrounded by obconical
involucre .................................. 55. Cornucoopia
Lemmas shorter than glumes, rounded
dorsally .................................... 57. Phleum
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 Tutić et al. (1980) and *Posceae* by Tsvetev (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*, *Lemarckia*, *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 plumeose (long-haired) panicle ....................................... Group E

5. Inflorescence a dense or non-plumeose lax panicle

6. Inflorescence a lax non-plumeose 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 ........................................... 135. Zea

1. Male and female spikelets in the same inflorescence

2. Female spikelets seated in a bony involucre

   involucre .................................................................................................................. 137. Coix

2. None of the spikelets seated in a bony involucre

3. Inflorescence a spike; fertile spikelets

   warty ...................................................................................................................... 8. Wateranthelium

3. Inflorescence a rather dense panicle; fertile spikelets not warty

4. Lemmae of fertile spikelets obtuse to truncate at apex; fertile and sterile spikelets falling together in fruit ......................................................... 85. Lamarcia

4. Lemmae 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 ......................................................... 105. Danthonia

1. Ligule membranous; glumes shorter than spikelet

2. Lemmae 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

351
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 exerted 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. Nardusoides

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  .......... 32. Solarochloa

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. Aeolopus

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 $\frac{1}{2}$ as long as the lowest lemma of lateral spikelets
5. Perennial; spikelets with 1 floret .................. 96. Nardus
5. Annual; spikelets with 2 florets .................. 72. Passiflora
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 $\pm$ 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. Nardus

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. Lolium

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. Henradia

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. Elymus

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. Crithonsea

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. Paethlyrostachya
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

22. Glumae with 2 prominent keels, bearing tufts of hair only on dorsal side of middle vein

23. Glumae usually rounded dorsally, with 1 or more teeth or awns at apex; rachis fragile

24. Glumae covering sides of lower florets

25. Glumae dorsally rounded

26. Spikelets with 2(-3) florets; glumes subulate, with 0-1 veins

15. Spikelets solitary at each node of the main axis

21. Glumae truncate, with or without 1 or more teeth or awns at apex

22. Glumae with 1 keel or rounded dorsally, without tufts of hair on dorsal side of middle vein

23. Glumae keeled, usually with 1 or 2 teeth at apex; rachis tough

24. Glumae covering back of lower florets

25. Glumae dorsally keeled

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. Anthraxon
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. Botrychloa
4. Pedicels not grooved; lower glume of sessile
   spikelets broadly elliptic, or slightly broader
   above the middle, rounded at apex ........ 130. Diabanthium
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
   minute; stem nodes glabrous ...................... 132. Hyparrhenia
6. Sessile spikelets 3-4 mm; bases of awns
   glabrous; stem nodes covered by
   long hairs .............................................. 130. Diabanthium
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 exerted; upper glume obtuse and terminally armed .................. 110. Dactyloctenium

10. Axis of inflorescence branches not exerted; 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 plumeose 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. Stingrostia

3. Terminal awn of lemma not branches (simple), when hairs present attached awn; ligule membranous ...... 97. Stina
2. Plumose hairs coming out from callus of lemma

4. Spikelets 1.5-3.6 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. Fannietum

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 0.5-11 mm ........................................ 124. Spodiopogon

8. Spikelets 9-6.5 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 rachilla segments; all florets alike, with a dorsal awn, lemma 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; lemma acute to obtuse at apex ........................ 95. Melica

9. Ligule a fringe of hairs

11. Spikelets unisexual; glumes 1-veined .... 102. Cortaderia

11. Spikelets bisexual; glumes 3-veined
12. Rachilla with long hairs; lemma glabrous on dorsal surface .................................................. 101. P. nigra
12. Rachilla 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. P. nigra

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. M. glauca

3. Stem with several nodes; glumes unequal; lemma
   2 dentate at apex and with a short awn
   from sinus .......................................................... 111. C. sativa

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. A. ssp.

6. Spikelets longer than 1.6 mm; lemma 3.5 mm;
   perennial

7. Only uppermost floret hermaphrodite; lower 2 florets
   male; smelling of coumarin .................................. 53. E. caespitosa
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. Crype

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. Bixia

12. Spikelets ovate; glumes 3(-1) to 3-veined;

   lemma 5-veined, not cordate at base ........... 75. 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 ........ 95. Melica

14. Florets in each spikelet all alike; lemmas truncate-lacerate at apex ...................... 60. Scoochlea

13. Lower glume 1(0-3), upper glume 3(-4)-veined

15. Annuals

16. Lemmas obtuse to truncate at apex; glumes equal ........................................ 35. Molinierella
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 glumes as long as or longer than lowest lemma ........................................ 77. Elymopoa

18. Upper glumes 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. Glycemia

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. Cutanilla

24. Perennial; panicle branches not dichotomously arranged

25. Rhabdilla and basal part of lemma

  glabrous ............................................. 61. Festuca
25. Rhachilla and basal part of lemma covered by short stiff hairs .................................. 62. \textit{Ballardiochloa}

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. \textit{Holcus}

27. Spikelets 6-17 mm; glumes 5-7 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. \textit{Caudinopsis}

28. Glumes 5-7 to 7-9-veined; lowest lemma aristate at apex ........................................ 26. \textit{Veneta}

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. \textit{Amelodesmos}

30. Glumes not terminally awned; awn longer than 2 mm, from further below tip

31. Florets only 2, lower floret male, upper floret hermaphroditic or female ...... 24. \textit{Aegyptatherum}

31. Florets 2-8, at least lower 2 florets hermaphroditic

32. Spikelets 10-30 mm, with 3-8 florets; caryopsis hairy at apex ........ 23. \textit{Holotetrichon}

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. \textit{Deschampsia}
33. Spikelets with 2-4 florets; lemma 2-fid
   at apex .................................................. 26. Triasatum

29. Annual

34. Both glumes shorter than spikelet

35. Branches verticillately arranged; spikelets
   3.5-5 mm .................................................. 75. Nephelechochla

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. Araya

36. Spikelets 1.5-4.5 mm; glumes 1-3-veined

37. Spikelets 4.5-5 mm; upper half of am
   clavate .................................................. 38. Gonyeophorus

37. Spikelets 1.5-3.5 mm; upper half of am
   tapering to a point

38. Spikelets with 2 or more florets; rhachilla
   prolonged beyond upper floret

.................................................. 30. Parvosatetum

38. Spikelets with 2 florets; rhachilla
   not prolonged beyond upper floret ........ 37. Astra
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

4. Spikelets without an exserted awn

5. Glumes equal; spikelets with 1 floret

6. Lemma glabrous and shiny

7. Upper glume equaling spikelet; lower glume 0.7-3 mm, surrounding entire spikelet

8. Ultimate unit of panicle subtended by spathes

9. Spikelets with an exserted awn

10. Spikelets not sunk in concavities of branches

11. Spikelets not sunk in concavities of branches

12. Spikelets sunk in concavities of branches

13. Spikelets not sunk in concavities of branches

14. Spikelets with an exserted awn

15. Spikelets with 2 florets

16. Glumes unequal; spikelets with 2 florets

17. Upper glume shorter than spikelet; lower glume 0.2-0.3 mm, not surrounding spikelet

18. Ultimate units of panicle not supported by spathes

19. None of spikelets with a tuft of long reddish-brown hairs from callus

20. None of spikelets with a tuft of long reddish-brown hairs from callus
10. Glumes unequal; ligule absent 

11. Glumes equal or subequal; ligule present

11. All spikelets pedicellate and with

1 floret

12. Some of spikelets sessile on the branches; spikelets with 2 florets

Pedicels with a median groove; spikelets

3-4 mm

12. Pedicels terete; spikelets 4-7-7 mm

12. Spikelets laterally compressed always only with 1 floret

13. Ligule a fringe of hairs; at least middle branch of terminal awn plumose

13. Ligule membranous; when awn branched, branches glabrous

14. Lemma with a long terminal awn

15. Awn of lemma 3-branched

15. Awn of lemma simple

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

18. Spikelets usually longer than 10 mm; glumes 5-7 to 7-9-veined

17. Perennial

19. Spikelets 1.5-3.8 mm; glumes acute

19. Spikelets 4-6 mm; glumes acuminate

16. Lemma without an awn

118. Echinochloa

98. Piptatherum

129. Botriochloa

127. Sorghum

106. Stipagrostis

97. Stipa

42. Apera

22. Avena

43. Agrostis

40. Calamagrostis
20. Both glumes absent

20. Both glumes present

21. Glumes shorter than spikelets, largely hyaline, obtuse; lemma truncate

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

22. Lemma not puberulent in lower half; pedicels scabridulous

23. Rachilla disarticulating above glumes; lemma usually awned

23. Rachilla disarticulating below glumes; lemma awnless

Group II

Inflorescence a dense head-like panicle

1. Ligule a fringe of hairs

2. Spikelets with 1 floret; lemma keeled, 1-veined

2. Spikelets with 5-10 florets; lemmas rounded dorsally, 9-veined

1. Ligule membranous

3. Spikelets with 1 floret

4. Spikelets seated in a cup-shaped toothed involucre

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

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5. Glumes 3-veined, glabrous to shortly hairy; lemma without a setae at apex

6. Glumes shorter than lemma; lemma mucronate at apex

6. Glumes equaling lemma or longer; lemma obtuse, acute to truncate at apex

7. Lemma 3-veined, keeled dorsally, usually with an awn; rachilla disarticulating below glumes

............... 59. *Rhizosepalus*

7. Lemma 5-7-veined, rounded dorsally, awnless; rachilla 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. *Dehoilis*

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. *Scleria*

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. Salerschion
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
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 amless ....................... 52. Anthoxanthum
16. Spikelets all alike; lemmas glabrous and with
   2 apical setae ................................ 29. Trisetaria

Group I

Inflorescence a dense spike-like pincle
(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. Stipaagrostis
1. Terminal awn usually absent, when present always
   simple
3. Ligule a fringe of hairs
4. Leaf blades lanceolate ........................... 116. Callimemum
4. Leaf blades linear
5. Upper glumes covered by hooked spines ........ 115. Tragia
5. Upper glumes not covered by hooked spines
6. Spikelets with 1 floret

7. Perennial; rachilla disarticulating above

   glumes ........................................ 113. Scorobolus

7. Annual; rachilla disarticulating below

   glumes ........................................ 114. Cyparia

6. Spikelets with 2-18 florets

8. Both glumes shorter than spikelet ............... 107. Aelurosum

9. Glumes very unequal; spikelets 2-2.5 mm .... 119. Brachystachyis

9. Glumes subequal; spikelets 4.5-9 mm

10. Annual; lemmas plumose; glumes

   3-5-veined .................................... 108. Schizanthes

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 macro at apex

13. Perennial; awn 0.6-4.0 cm; spikelet longer

   than 3 mm ...................................... 97. Stipa

13. Annual; awn less than 3 mm; spikelets 2.5-3 cm

14. Glumes unequal, shorter than lemma, awnless;

   lemma micrornate at apex ................. 58. Pseudophleum

14. Glumes equal, equaling lemma, with a

   terminal seta; lemma with a terminal awn

   .................................................. 42. Apsina

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 Agropyropogon
16. Spikelets not persistent; sets of glumes 4-7 mm

.............................................. 45. Polynema

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. Aemophila

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. Gastrodictium

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. Tribolisema

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; rachillia disarticulating below

glumes ........................................ 54. Alopocorys

21. Lemma 3-7-veined, rounded dorsally,

awnless; rachillia 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;

awn 2-4 times as long as spikelet ...... 42. Apera

22. Perennial; lemmas more delicate than glumes;

awn 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. Helica
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. Salarochloa
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. Keolaria

25. Lemmas with an awn or mucro

35. Lemmas terminally awned

34. Both glumes terminating in an aristate point; lemmas with 2-5 aristate teeth at apex .......... 90. Selariae

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. Bealgaemia

36. Spikelets with 2-5 florets, irregularly arranged; glumes acuminate ............. 83. Daestylia

33. Lemma 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 awnedless .................. 52. Anthoxanthum

37. Spikelets with 2-11 florets; florets all alike, fertile and awned
30. Lemmas with 2 setae at apex

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

39. Lower glume \( \frac{1}{2} \) to \( \frac{3}{4} \) x as long as upper glume;
lemmas keeled; palea equaling lemma

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31. Avellinia

32. Rostraria
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  aurea (Ten.) Pignatti
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  phleoides (Vill.) Nevski

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*nisidica* (Boiss.) Tutin

subsp. *nisidica*

subsp. *pocaformae* (Boiss.) M. Dogan

*trichopoda* (Boiss.) P. Smirnov

subsp. *biebersteiniana* (Claus) M. Dogan

subsp. *trichopoda*

*verticillata* (Boiss. et Bal.) Chrtek
Fl. 7. In P. nigra subsp. pallasiana forest, 1250 m.

Typus: Turkey C3 Isparta "17 km E. of Egridir, 1250 m", 15 vii 1968, E. Sorger 68-36-12! Holotype Hb. Sorger.

Endemic. E. Mediterranean element.


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.


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. Rachilla disarticulating above glumes and between florets, hairy. Lodicules 2. Stamens 3. Caryopsis elliptic, laterally compressed.


**Literature:**


**Key to Species**

1. Rachilla hairs as long as lemma, protruding from open spikelet ........................................ 1. *rigidum*

   1. Rachilla 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 
aespitose; leaf blades pilose .................. 4. *thospiticum*

4. Spikelets with 3 florets; rhachilla almost glabrous;
  laxly aespitose; leaf blades not pilose ............ 5. *turciicum*

Syn: *Avena rigidia* M. Bieb., Fl. Taur.-Cauc. 1: 77 (1808);

  *Laxly asepitose perennial. Stem (16-) 30-45 cm, erect to genicu-
lately ascending from base, slender and glabrous but sometimes slightly
hairly 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: ²U.S.3.R.²² "Fab. in Caucasi orientalis glareosis",
  M. Bieberstein ²iso LE!²

  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 Bıdyk Ejder Da., 2300 m, F. Holz et al. 832!
C5 Nigde: Bulghar Meden, Bal. 29!

  External distribution: N. and C. Iran, Caucasus to Siberia.

Syn: *Avena flavescens* L., Sp. Pl. 80 (1753).

Loc: Hubbard, Grasses 246 (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, acuminated, 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 purplish; pedicels 1-7 mm, slightly scouleolate. Spikelets 4.7.5 mm, oblong or finally wedge-shaped. Glumes broadly hyaline; lower glume 2.2-4.4 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: "Fab. in Germania, Anglia, Gallia", P. Linn. 95/1517

N.W. Turkey, Inner & N.E. Anatolia.

A1(3)Kirkaloveli: Demirköy to Iğneada, A. Bayton (ISTE 5494)!

A2(A) Istanbul: Camlica, N. Tanker (ISTE 10583)!

A3 Ankara: Baypasari, Nahiye Tepe, 2000 m, Y. Akman (ISTE 21030)!

A6 Sivas: Yıldız Da., Sariyer, 1700 m, Topay 2356!

A7 Giresun: below Tandere, 1600 m, D.20638!

B8 Erzurum: 20 km from Erzurum to Pasinler, 1950 m, D.46264!

B9 Bitlis: Tatvan, 1750 m, D.22187!

C4 Konya: Ermensek, Peronin 214!

C9 Hakkari: Karadag, 2896 m, D.24393!


Laxly caespitose perennial. Stem up to 130 cm, erect, glabrous and smooth, 3-4-noded. Leaf blades 8-24 cm x 3-6 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. Rachilla 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.


E. Anatolia.

A9 Kars: 6 km from Sarikamis to Karakurt, 2150 m, D.46563!

External distribution: C. Europe, Caucasus, C., N. and W. Russia.


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. Rachilla 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 basalt and earthy slopes, 3200–3300 m.

Typus: Turkey B9 Bitlis "Suphan Da., 33300 m., 28 viii 1954", P.N. Davis 28763a "Holo E17"

Endemic.


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 8–8 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. Rachilla 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 E17"

External distribution: Caucasus (fide Tsvelev).
8. TRISETARIA Forsskal, Fl. Aeg.-Arab. 27 (1775)


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


Syn: Trisetum aureum Ten., Fl. Nap. 2: 378 (1820);


Loc: Io. Fl. Ital. 1: 28, f. 237 (1895); Zangheri, Fl. Ital. 2: 185,


Annual. Stam 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; lodicels 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. Rhaedillasegments 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, Tenare.

Rare, only recorded once from Istanbul.

A2 Istanbul: Istanbul, 1845, No 116!


The province of some of Noē's specimens is open to doubt.


Syn: Avena loeflingiana L., Sp. Pl. 79 (1753);
Trisetum loeflingianum (L.) C. Presl, Fl. Sic. 3 (1820);
Trisetum cavaniillesii Trin. in Mem. Acad. Sci. Petersb., Ser. 6, 1: 63 (1830);
Trisetum gaudinianum Boiss., Voy. Bot. Espagne 2: 653 (1841);

IO: Fiori, Io. Fl. Ital. 1: 28, f. 236 (1895) as Trisetum cavaniillesii;

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 rudiment of third floret. Glumes largely hyaline, smooth; lower glume 3-4 mm; upper glume 4-5 mm. Lemma 4 mm, smooth nearly; terminal setae
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" [Fb. Linn. 95/5]

E. Anatolia.

E10 Kars: 3-5 km E. of Aralik (Aras valley), 850 m, 9243672.

External distribution: C. Europe, Mediterranean, Caucasus, N. Iraq, W. Iran, Afghanistan, Turkestan, W. Pakistan, S. Russia.
9. **PARVOTRISTETUM** Chrtek in Preslia 37: 201 (1965)


Type: *P. myrianthum* (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).


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


External distribution: Italy, Jugoslavia, Albania, Greece.

Mediterranean element.
10. **Aveillinia** 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 1/2 as long as lemma, 2-veined, bifid at apex. Rachilla 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);


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. Rachilla 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) Istanbul: Heybeliada, 23 v 1897, Anm. Büyükkada, 9 v 1897, Anm.

B1 Izmir: Inseln im Golf von Izmir, Bal.

External distribution: N.W. Africa & S. Europe eastwards to Aegean.

Mediterranean element.

Syn: *Lophochloa* Reichh., Fl. Germ. Excurs. 42 (1830);  
*Tri-Setum* 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. Rachilla disarticulating above glumes and between florets. Lodicules 2. Stamens 3. Caryopsis narrowly oblong, laterally compressed.

Type: R. pubescens Trin. (= R. cristata (L.) Tzvel.)

**Literature:**  

**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; awns 3–5 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

**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, x 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 (1845);
*Koeleria phloeoides* var. *obtusiflora* Boiss., Fl. Or. 5: 573 (1884);
*Koeleria obtusiflora* var. *typica* Domin in Bibl. Bot. 65: 272 (1907);
*Lopchohloa 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 provinciae Schiras" [in vicinitate pag. Dalech iiii 1842] [in loco El]

S.E. Anatolia.

C9 Mardin: Cizre, 350 m, D.42516!

subsp. amblyantha (Boiss.) M. Dogan (ind.)

Syn: Koeleria amblyantha E. Desv. ex Boiss., Diagn. ser. 2 (4): 134 (1859);

Loc: Domin in Bibl. Bot. 65: t. 18 f. 9; t. 19 f. 4 (1907).

Fl.: 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 Datqa, 41359!
C3 Antalya: Kumköy, between Antalya and Serik, 20 m, 25735!


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).

Loc: Domin in Bibl. Bot. 65: t. 18 f. 6 (1907);

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 3.2-4.4 mm, lanceolate; upper glume 4.5-5 mm, elliptic, acuminate. Rhaedilla 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. Fls. 4-5. Damp places, on rocky limestone slopes, roadside ditch, 0-600 m.

Typus: Lebanon "Hab. in Syria littorali circa Berythum et Sidonem" iiii-6 iv 1853, Blanche [folio C], Iso K!

S. Anatolia.
C3 Antalya: Catallar, T. Baytop (ISTE 11175)
C5 Adana: Karatay, 9 km S. of Adana, Jones & Coode 239A
C7 Urfa: 15 km E. of Birecik, 600 m, F. Sorger 30-15-45

External distribution: Cyprus, W. Syria, N. Iraq, W. Iran.

3. R. hispida (Savi) W. Dogan

Syn: Festuca hispida Savi, Fl. PIs. 1: 117 (1798);

Koeleria hispida (Savi) DC., Hort. Monspel.: 119 (1813);


Io: 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 2.2-3.4 mm; upper glume 3.2-4.4 mm. Rhaedilla 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. Elytra 4-6. Dry places on the coast, muddy places, 0-30 m.

Tipo: Italy. "Il' no trovata fra i sassi nel Monte Pisano vicino a Calci" Savin.

N. W. Turkey and S. Anatolia.

A2(E) Istanbul: Yedikule, 7 vi 1898, Asn!
A2(A) Istanbul: Tuzla, 31 v 1896, Asn!
C3 Antalya: Serik to Manavgat, 30 m, E. Hendipsman et al. 839!
C5 Adana: Tarsus, Alifeki, 25 iv 1955, K. Karamanoglou (ANK. 957)!


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 sometimes 7-11 florets. Glumes unequal, acuminate, glabrous or with an irregular pubescent to hirsute; lower glume 1.4-2.8 mm; upper glume 2-4 mm. Rachilla 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. Elytra 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
2. 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);
        URSS, ser. 1, faso. 4, 339 (1937);

Typus: "Habitat in Lusitanæ collibus sterilbus" Hb. Linn. 92/24,

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 435B!
B1 Izmir: Izmir, vi 1877, J. Ball 2513!
C1 Mugla: Bodrum, 0-10 m, D.40875!
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. Degan (ind.)

Syn: Koeleria phleoides var. glabriflora Trautv. in Acta Horti Petrop. 7 (2): 526 (1881);

Typus: "Prope Lenkoran" Radde

Widespread.

A1 Edirne: Sarayici, A. Baytop (ISTE 6579)!
A2 Îstanbul: Yedikule, 7 vi 1898, Azn.!
A3 Bilecik: 50 km N. of Bilecik, A. Baytop (ISTE 8823)!
A5 Amasya: Havaa to Merzifon, T. Baytop (ISTE 15452)!
A6 Tokat: Erbaa, Kalaköy, 300 m, Tobe 691!
A7 Trabzon: 32 km from Trabzon to Mağra, N. Jardine 435B!

B1 İzmir: Geçme, 10-50 m, D.4391A1!
B2 Kütahya: 4 km N. of Abide to Simav, 700 m, Coode & Jones 2614!
B3 Eskişehir: Eskişehir to Mayislar, 300 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. & Ross!

C1 Muğla d. Milas: Becir Köy above Gökders, 150 m, E. Besik (ISTE 7727)!
C2 Muğla: Marmaris to Emecik, 200 m, D.25337!
C3 Antalya: Kumköy between Antalya and Serik, 20 m, D.25735!
C4 Antalya: Alanya, A. Baytop (ISTE 8344)!
C5 Mersin: Tarsus, 20 m, D.26506!
C6 Mersin d. Pazarlık: between Narli and Karabiyikli, 600-700 m, D.27835B!
C8 Mardin: 8 km from Mardin to Nusaybin, 850 m, D.28290!
C9 Mardin: Cizre, 350 m, D.42516!

İsl. Tokmakia (N.E. of Lesvos), Asprosos, 0-30 m, J.R. Edmondson 2500!
Rhodos: Rhodos, 4 v 1870, Bourgeau!
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 equaling lemma, 2-veined, keeled, bifid at apex. Rachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis oblong-trullate in side view, laterally compressed.

Type: K. oristata (L.) Pers.

Literature:


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 scabridulous

5. oristata

4. Glumes subequal, pilose; leaf blades pilose

4. eriostachya

Syn: K. lobata non (Bieb.) Roemer et Schultes, Syst. Veg. 2: 620 (1817);
Ex: Domin in Bibl. Bot. 65: t. 3 f. 5 (1907);

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 (0.1-1.5 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 0.1 mm). Pales as long as lemma.
Anthers 2-2.5 mm. Fl. 5-7. Dry calcareous places, 0-1000 m.

Typus: /Grzes/ "Tauria, Sudak, 1832" Steven.

Turkey-in-Europe, W. Anatolia.

A1(B) Kirklane d. Taştepe: 4 km N. of Kofçaz, N. Ulucak (ISTE 27160)!
A2(E) Istanbul: Halkali to Yarımurgas, 27 v 1834, Amm! 
B3 Kütahya: 50 km N.W. of Afyon, 1000 m, 1894, F. Sorger 63-46-44! 
B3 Eskişehir: İnegöl, tree plantation field, Kayacık 820!

External distributions: 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. dagei. Recently this species has been reassigned 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).
Synt: 12ytis lobata M. Bieb., Fl. Taur.-Cauc. 1: 67 (1808); 

To: Domin in Bibl. Bot. 65: t. 5 f. 1 (1907).

Densely cespitose 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) 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 LEB

Turkey-in-Europe, Islands.

A1(E) Tekirdag/Kirklareli: Saray to Vize, 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. desenii and K. brevia.

The type material of K. lobata has been borrowed from Leningrad (LS) 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.


K. nitidula var. obscura (Vel.) Domin in Bibl. Bot. 65: 167 (1907).

In: Domin in Bibl. Bot. 65: t. 11 f. 3 (1907).

Laxly cespitose 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 Beldedihan" Skorpi
[Holotypus]

Mainly N. and E. Anatolia, rare in C. Anatolia.

A1(K) Kirklareli: Hasköy to Kızılçambeşli, A. Beytou (ISTE 6619)!
A2(K) İstanbul: Halkalı to Safraköy, 27 v 1894, Azm.!
A2(A) İstanbul: Soganlık to Kartal, 8 vi 1905, Azm.!
A9 Kars: Gölbaret near Artahan, 1800 m, D.20439!
B6 Sivas: Gürün to Pinarbaşı, 35 km from Gürün, 1700 m, Stn. & Hand. 5705!
B10 Van: 3-4 km N.E. of Başkale, 2300 m, D.44520!
C6 Adana d. Saimbeyli: Doğanbeyli to Akcal, 1300 m, D.19900!

External distribution: C. Europe, Jugoslavia, Bulgaria, Greece, Aegean, N. and W. Iran, Afghanistan.

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);


Io: Domin in Bibl. Bot. 65: t. 15 f. 1 (1907);

Fl. Grusii 1: t. 20 (1944).

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: Jugoslavien, "An den Kämmen des M. Kapaonik bei Kruševac, Serbien" Panić

E. Anatolia.

A9 Kars: SW slope of Kisir Da., 2500 m, D. 30567!

A9 Kars: Digor, N. of Susus Köy, 2360 m, A. Yürlü (BGE 16354)!

External distribution: C. Europe, Italy, Bulgaria, Jugoslavie, Caucasus, W. Iran.

Syn: *Aira cristata* L., Sp. Pl. 63 (1753);

*Poa cristata* (L.) L., Syst. Nat., ed. 12, 2: 94 (1767);

*Koeleria gracilis* Pers., Syn. Fl. 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. *terefulosa* Boiss., Fl. Or. 5: 575 (1884);

*K. glaucovirens* Domin in Mag. Bot. Lap. 3: 273 (1904);


Io: Bor, Fl. Iraq 9: 347, t. 131 (1968);

Hubbard, Grasses 242 (1968).

Densely caespitose perennial. Stem 8-4.0 (-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 equaling 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 siocioribus"
Widespread.

A1(E) Kırklareli: Reşadı to Kızılçamayesilim, A. Baytop (ISTE 6619)!
A2(E) İstanbul: Halkali, 4 v 1939, Post!
A3 Bolu: Abant G., 17 vil 1940, Post!
A4 Ankara: Beynam Forest, 1430 m, Y. Akman 8275!
A5 Çorum: Osmancık to Kargı, 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 Dogubayazıt, 1650 m, D. Spencer 301!
B1 Balıkesir: Kaz Da., Sınıf. 64.2!
B2 İzmir: Boz Da., 1500 m, E. Erben & K. Buttler 17429!
B3 Eskişehir: Türkmen Da., 790 m, T. Ekim 2260!
B4 Ankara: nr. Tuz G. 25 km N. of Koçhisar, 925 m, MacNeill 338!
B5 Niğde: Nevesehir, 1200 m, D. 19089!
B6 Sivas: 10 km S. of Gürün, Gökpinar, 1800 m, E. Sorger 71-50-27!
B7 Tunceli: Monsur Da., above Ovacık, 2300 m, D. 31308!
B8 Erzurum: above the Atatürk 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: Egriöyr, Yaka Köy, 1600-1980 m, H. Pegasus & A. Göner 1617!
C4 Konya: Bezkır, Kızılkızı, 1800 m, E. Çetik et al. 269!
C5 Niğde: 22 km E. of Ulucilga, 1200 m, E. Sorger 62-66-7!
C6 Adana: Karsanti, Sogukoluk, 1420 m, E. Kuyukulolu 10239!
C8 Mardin: 2 km E. of Mardin, 1150 m, D. 28440!
C10 Hakkari: Zap river, 1.7 km from turning to Yüksakova, J. Trelawny 1306!

External distribution: N., W., and C. Europe, Mediterranean (except N. Africa), Crimea, Caucasus, Iran, Transcaucasia, Turkestan, S. Russia, Siberia, Afghanistan, W. Pakistan.
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. Rachilla 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 5.5-3 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

   Io: 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 aeculeolate. 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 ½ of upper
floret. Anthers 2.2-3.4 mm. Grains enclosed by the slightly hardened
lemma and palea. Fl. 6-8. Dry edge of Pinae sylvestris forest,
rocky igneous slopes, 1097-2150 m.

Typus: "Habitat in Europae petris, rupibus" HB. Linn. 85/11
W. & N. Anatolia.

A6 Ordu: Erbaq above Çamab, 2000 m, C. Tobe 1407!
A7 Giresun: Balaban Da. above Tambare, 1700-1800 m, D.20652!
Gümüşhane: Argyri Da. (12.5 km S.W. of Gümüşhane, Sint. 1894: 6259
A8 Trabzon: Soganli Pass, 2134 m, P. Furse 4037!
A9 Kars: 6 km from Sarikamis 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.

Syn: Aira caespitosa L., Sp. Pl. 64 (1753);
     D. caespitosa var. colorata Griseb., Spic. 2: 457 (1844).
Io: 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, sculeolate 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 sculeolate.
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 ½ of upper floret. Grain 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" [Hy. Linn. 85/8f]

Widespread in Anatolia.

A2(A) Istanbul: Beykoz, 4 VI 1900, Asn.!
A3 Bolu: Abant Göl, 1350 m, A. & T. Baytop (ISTE 1840!)
A4 Kastamonu: N. of Ilgaz Da., 2100 m, D.38361!
A7 Trabzon d. Mağka: Hamsiköy, Balakor Y., 1650 m, R. Angin 533!
A8 Rize: Çamlıhemşin, Amlakî Y., 2200-2720 m, A. Güner 1069!
A9 Kars: Yalnızçam, 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., 1600 m, D.20259!
B7 Erzincan: 48 km from Erzincan to Sivas, M. Teker (ISTE 5624!)
B8 Erzurum: Büyük Ejder Da nr. Sütlüce, 2300 m, E. Holts 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 Yüksekov), 2700 m, Duncan & Tait 1144!

External distribution: W., N. and C. Europe, Mediterranean (except E. Mediterranean), Caucasus, Turkistan, E. Asia, N. America.

Type: *M. minuta* (L.) Rouy

*M. minuta* (L.) Rouy, Fl. Fr. 14: 102 (1913).

Syn: *Aira minuta* L., Sp. Pl. 64 (1753);
     *Airoopsis minuta* (L.) Desv. in J. Bot. (Paris) 1: 201 (1808);
     *Molineria minuta* Parl., Fl. Ital. 1: 237 (1848);

Io: *Fiori*, It. Fl. Ital. 1: 26, f. 223 (1895);

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 Queroucocosisifera, up to 300 m.
Typus: [Spain] "Hab. in Hispania", Loebling, [Hb. Linn. 85/417

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: Sigli to Kagithane, 30 ill 1891, Ayn.

A2(A) Istanbul: Çamlıca, 26 iv 1919, Ayn.

B1 Çanakkale: Kas Da., Sint. 1883: 1231

G2 Aydin: Çine to Yatagan, 300 m, D. 25218

External distribution: S. Europe.
15. **ANTINORIA** Parl., Fl. Palerm. 1: 94 (1845)


Type: *A. agrostidea* (A.P. de Candolle) Parlatozé

*A. insularis* Parl., Fl. Palerm. 1: 94 (1845).

Syn: *Airopsia insularis* (Parl.) Nyman, Syll. Fl. Europaea 4: 1 (1854-1855);

*Aira insularis* (Parl.) Boiss., Fl. Or. 5: 528 (1884).

Loc: *Fiori*, *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. 4-5. Damp places on mountains.


W. Anatolia.

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. Rachilla not prolonged, disarticulating above glumes and between florets. Lodicules 2, lanceolate. Stamens 3. Caryopsis oblong-elliptic, longitudinally sulcate on adaxial face, glabrous.

Type: *A. caryophyllea* 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*


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 ⅔ of lemma. Anthers 0.2-0.3 mm. Fl. 5. Sea level.

Described from: "In Europae australioria campis arenosis inundatis"

L. Linn. 85/20

N.W. Anatolia.

A2(A) Istanbul: Çatal Da., v. 1865, Rene du Parquet (BM)


A new record for Turkey, and presumably adventive.


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 ⅔ 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
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).

Io: Reichb., Io. 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 Transylvania, Turkey-in-Europe, N. & S. Anatolia,

Islands.

A2(E) Istanbul: Sarıyer, Belgrad Forest, *V. Valtirik* 2433!

A3 Bolu: Düzce, Kühne 2523!

A5 Sinop: Inceburun, 30 m. Tobay 1627!

C3 Antalya: Manavgat, Kara point, 3 m. 2.25833!

Is: Psara: 'Ahladokambos', 20 m. W. Greuter 10 820!

External distribution: S. & C. Europe, N.W. Africa, Cyrenaica,

Crimea. Introduced into N. America.

subsp. *ambigua* (De Notarisi) M. Dogan (ned.)

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)!


Fl. 4-6. Along dry stream beds, dry slopes and grassland, open places

caused by fire, sandy soil, 0-1400 m.
Typos: [Italy] "Habui semina specimenaque in pascaus secus Ticinum lecta a ej. inventore".

N. & W. Anatolia, Islands.

A3 Rize: Rize, v 1866, Bal. 706!

B1 Balikesir: Kaz Da., Sint. 1883: 103!

B2 Izmir: Selçuk, Belevi, s. Oflas 29!

B2 Kütahya: Simav, Kiçir to Akdag, 1100 m, Coode & Jones 2682!

B3 Sakifahir: 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 254.8!

External distribution: Aegean, Caucasus, N. & N.W. Iran.


H. 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 3 x as long as glumes, narrowly ovate, scabridulous especially in upper half, with short hairs at base, brownish in colour; awn 3-3.5 mm, geniculate and twisted in lower half, arising lower 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. 35/2217)

Turkey—in—Europe, W. Anatolia, Islands.

A1(E) Edirne: Kegan, Griseb.

B1 Izmir: Izmir, sea shore, iv 1827, Fleischer!

Is. Rhodos: Santo Elia Montagne de Salakos, 4 vi 1870, Bourgeau!

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. Rachilla disarticulating above glumes. Lodicules 2.

Stamens 3. Caryopsis elliptic.

Type: C. canescens (L.) Beauv.


Syn: Aira divaricata Pourret in Mem. Acad. Sci. Toulouse 3: 307 (1788);
Coryneophorus articulatus (Desf.) Beauv., Ess. Agrost. 159 (1812);
Anachortus articulatus (Desf.) Jiras. et Chrlk in Preslia 34: 383 (1962).

Io: Fiori, Io. Fl. Ital. 1: 27, f. 225 (1695) as Aira articulatus

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 ⅓ 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, Ann.

A7 Trabzon: 20 km W. of Trabzon, 2 m, E. Hennipman et al. 1749!

B2 Izmir: Boz Da., 1100 m, E. Wall 156!

C1 Aydın: Dilek peninsula, Dipburun Kumulu, 2 m, T. Uulu 3542!

C3 Antalya: 6 km W. of Antalya, 10 m, T.A. Tengwall 445!

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, Caucasus, Transcaucasia.
18. POLCUS L., Sp. Pl. 1047 (1753)

Annual or perennial. Leaf blades flat. Ligule hyaline. Inflorescence a rather dense panicule. 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. Rachilla 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. annua


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 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: "Fab. in Europae pascius arenosis" Ric. Linn. 1212/1017

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

A1(E) Tekirdag: 7 km from Çarlu to Seymen, A. Baytop (ISTE 22381!)
A1(A) Balikesir: Avsa adaği, Araplar köyü, T. Avcioglu (ISTE 6810!)
A2(E) Istanbul: Alibey Köy, 17 vi 1894, Asn.
A3 Bolu: Koru Motel, 850 m, P. Uotila 20132!
A5 Amasya: Suluova, Karakilise köyü, 1500 m, K. Alpinar (ISTE 38 388!)
A6 Samsun: Kiraslık, 1 m, C. Tobey 605!
A6 Ordu: 8 km from Ünye to Fatsa, 160–180 m, Hub. & Mor. 16431!
A7 Trabzon: N. slope of Soganli Da., above Çaykara, 1500 m, D. 32073!
A8 Rize: 5 km from Ikisdere to Ispir, 2000 m, Stn. & Hand. 6229!
B1 Izmir: Bozdağ köyü towards Göldek, S. Regel (ISTE 12347!)
B2 Izmir: d. Ödemiş; between Alem gediği and Bey Da., T. Uulu 5743!

External distribution: Europe and most of Mediterranean, Georgie. Introduced into N. America.


Annual. Stem 13–86 cm, erect or slightly geniculate at base, tufted
or solitary, with 3-4 villous nodes. Leaf blades 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. Rhechillia 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, Aea.;

B4 Izmir: Karaburun, G. Bouquet 2063

G1 Aydin: Kocarli, between Mersinbelen and Yigintaş, 690 m, T. Ulu 5144!

G2 Aydin: Cine, 310 m, T. Ulu 5151!

C3 Antalya: Kumkøy, between Antalya and Serik, 5 m, D.25703!

C4 Icel: Anamur, v 1872, Feronin 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 1/2 as long as lemma. Palea hyaline, 2-veined, keeled. Rachilla disarticulating above glumes. Lodicules 2. Stamens 3. Caryopsis elliptic to oblong.

**Type:** *Arundo calamagrostis* L. = *C. lanceolata* Roth. = *C. canescens* (Web.) Roth.

**Literature:**


**Key to Species**

1. Lemma at least 3/4 as long as glumes; callus hairs shorter than lemma; rachilla prolonged into a hairy stipe

2. Glumes acute to acuminate; leaf blades with short shiny hairs at base, covered by fine hairs

3. Glumes shortly aristate; leaf blades without any hairs at base, glabrous

4. *arundinacea*

5. *parsana*

1. Lemma 1/2-3/4 as long as glumes; callus hairs longer than lemma; rachilla not prolonged beyond 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

Syn: Arundo canescens Weber in Wigg., Prim. Fl. Hols.: 10 (1780);
C. lanceolata Roth, Tent. Fl. Germ. 1: 34 (1788).
Io: Hubbard, Grasses 262 (1968);
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 3 x as long as lemma. Anthers about 1.5 mm, purple, with well developed pollen.
Typus: [Germany] "R. in tortolis prope Pagum Safal"
E. Anatolia.
B8/B9 Mus: Nur im Hochlande auf Trachyt, bei Ssurp Garabied im Paschalik Musch. .... 1372 m, C. Koch
External distribution: Europe, Crimea, Caucasus, C. and S. Russia.
The record needs confirmation.
2. C. epigejos (L.) Roth, Tent. Fl. Germ. 1: 34. (1788).
In: Lowe, Nat. Hist. Brit. Grasses t. 15 (1891);

Cespitose 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, scabrified on margins, closely veined; sheaths smooth; ligule 4-10 (-12) mm, membranous, becoming lacerate. Panicle 3-30 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 \(1/2\) 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 \(1/2\) 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", [Fl. Linn. 97/1177]

Turkey-in-Europe, N.W. Anatolia, W. & E. Anatolia.

A1(E) Tekirdag: between Saray and Midye, T. Baytop (ISTE 11830!)
A2(E) Istanbul: Pagebahce, 19 vii 1939, Asm.!
A3 Bolu: Abant Göl, 1350 m, A. Baytop (ISTE 33663!)
A9 Kars: Yagmurlu Da., above Sarikamış, 2300 m, D.32606!
B9 Bitlis: Nemrut Da., N.W. of Büyük Göl, 2500 m, A. Tatli 1592!
C1 Aydin: Saka, Kayas nr. TET antenna, 465 m, T. Uslu 3454!
C10 Hakkari: Yüksekova, 1950 m, Duncan & Tait 245!

External distribution: Europe, Crimea, Caucasus, Iran, Transcaucasia, Turkestan, Afghanistan, C. and S. Russia, E. Asia.

Introduced into N. America.

Syn: *Arundo pseudophragmites* Hall. fil. in Arch. Bot. (Roemer) 1 (2): 11 (1797);
*Arundo glauca* H. 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).

Loc: Reischl., loc. Fl. Germ. 1: t. 83, f. 152 (1850);

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, 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. Lemmas 2.1-3.2 mm, 3-veined, bifid, with a subterminal 1.3-2 mm awn. Anthers 1.3-2 mm.

Typus: Switzerland "Legi primum ad aggerem areas, inqua ligna Civitatis Bernensis congeruntur, in Marsihli dein Morellius a ripa fluminis Schwarzwasser", Haller f.

Widespread.

A1(E) Edirne: nr. Marig River, A. Baytop (ISTE 13996)!
A2(A) Kocaeli: Gölcük, C. Rege (ISTE 14852)!
A4 Bolu: Gerede, Aktas Ormanlı, 1150 m, O. Ketenoglu 346!
A5 Amasya: Kirazli dere, M. Tanker (ISTE 4562)!
A9 Artvin: Hoca, Grossheim I: Map 96
B2 Kütahya: Murat Da., 1400 m, D.36670!

**Syn.:** *Agrostis arundinacea* L., Sp. Pl. 61 (1753);

*C. silvatica* Schrd., Fl. Germ. 1: 218 (1806);

*Deyeuxia arundinacea* (L.) Beauv., Ess. Agrost. 160 (1812).


Casapitose 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 scouleolate. 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: "Lab. in Europae monticulis, silvatis glareosis juniperetis"

Mainly N. Anatolia.

A2(A) Buras: Uludag, Cennet Kaya, M. Beilbrum 129!

A4 Kastamonu: 69 km from Çankiri to Kastamonu, 1800 m, K.P. Buttler
15615!

A5 Kastamonu: Tosya, Sint. 1892: 4733!

A7 Trabzon: Meryeme, nr. Altindere Kaya, 1400 m, R. Angin 768!

A8 Trabzon: N. slope of Soganli Da., above Gaykara, 1700 m, R. 32192!

A9 Mars: Göle, 2000 m, A. Tatlı 1341!

B1 Canakkale: Kar Da., Sint. 1883: 537!

External distribution: Europe, Caucasus, C. and S. Russia.


Syn: *Devaudia paraena* Bor in Kew Bull. 3: 42 (1948);

*Asystis paraena* (Bor) Beetle in Bull. Torrey Club 76: 290 (1949).

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 3-4.5 mm, 5-veined,

denticulate at apex, with a sub-basal awn; awn up to 5.5-7.5 mm,

scabrid; callus haora 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 Guba, \[\text{Iran}\]

S. E. Anatolia.

G10 Makkar: Sat Da. (above Yiksekova), N. of lake, 2700 m,

\[\text{Duncan \& Tait 109}\]

External distribution: N. Iran.
20. **AMMOPHILA** Host, Gram. Austr. 4: 24, t. 41 (1809)


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).


Syn: *Psamma australis* Mabille in Rech., Pl. Corse 1: 33 (1867);


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, obovoid 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
Reprint from
NOTES FROM THE ROYAL BOTANIC GARDEN EDINBURGH
VOLUME 40 NO. 1
1982
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 triaristala* 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 davisi* Boiss., *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.


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FIG. 1. *Pseudopheum gibbum*: A, habit; B, spikelet; C, lower glume; D, upper glume; E, lemma from dorsal view; F, palea; G, flower; H, caryopsis. A $\times \frac{3}{2}$, B $\times$ 6, C–H $\times$ 13.
**Table 1**

<table>
<thead>
<tr>
<th>Life form</th>
<th>Phleum</th>
<th>Pseudophleum</th>
<th>Rhizocephalus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf blade</td>
<td>Flat</td>
<td>Convolute</td>
<td>Flat</td>
</tr>
<tr>
<td>Glumes</td>
<td>Equal</td>
<td>Shorter than spikelet</td>
<td>Shorter than spikelet</td>
</tr>
<tr>
<td></td>
<td>Shorter than spikelet</td>
<td>± Unequal</td>
<td>Equal</td>
</tr>
<tr>
<td></td>
<td>Venous free at apex</td>
<td>Acute</td>
<td>Acute</td>
</tr>
<tr>
<td>Lemma</td>
<td>Rounded dorsally</td>
<td>Venous free at apex</td>
<td>Venous united at apex</td>
</tr>
<tr>
<td></td>
<td>Hyaline</td>
<td>Keeled in upper half</td>
<td>Rounded dorsally</td>
</tr>
<tr>
<td></td>
<td>Apex obtuse to truncate</td>
<td>Coriaceous</td>
<td>Coriaceous</td>
</tr>
<tr>
<td></td>
<td>Clavate &amp; short</td>
<td>Terminally awned</td>
<td>Terminally mucronate</td>
</tr>
<tr>
<td></td>
<td>acuminate hairs on</td>
<td>Long acuminate hairs</td>
<td>Clavate hairs on dorsal</td>
</tr>
<tr>
<td></td>
<td>dorsal surface, or</td>
<td>(tapering to a point)</td>
<td>surface</td>
</tr>
<tr>
<td></td>
<td>glabrous</td>
<td>on dorsal surface</td>
<td></td>
</tr>
<tr>
<td>Lodicules</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Stamens</td>
<td>3 (rarely 2)</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Caryopsis</td>
<td>Subacute at apex</td>
<td>Subacute at apex</td>
<td>Long-acuminate at apex</td>
</tr>
</tbody>
</table>

Pseudophleum gibbum (Boiss.) M. Doğan, comb. nov. Fig. 1.


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).


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 × 3/4, B × 6, C–I × 13.
Apera baytopiana M. Doğan, sp. nov. Fig. 2.

Affinis *A. triaristata* 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, posterioris lacerata. Panicula anguste oblonga, 2.2–6.2 cm longa, 5–17 mm lata, aliquan tum 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 excusae), uniflorae, lateraliter compressae. Glumae marginibus albomembranaceis, terminaliter 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.


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>
<thead>
<tr>
<th>Species</th>
<th>Spikelet Length mm</th>
<th>Lower Glume</th>
<th>Upper Glume</th>
<th>Lemma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Length mm</td>
<td>Apex</td>
<td>Awn mm</td>
</tr>
<tr>
<td>A. spica-venti</td>
<td>2.5–3.6</td>
<td>2.2–2.8</td>
<td>Acute</td>
<td>Absent</td>
</tr>
<tr>
<td>A. interrupta</td>
<td>2–2.8</td>
<td>2–2.2</td>
<td>Acute</td>
<td>Absent</td>
</tr>
<tr>
<td>A. intermedia</td>
<td>2.5–3</td>
<td>2.5–2.7</td>
<td>Acuminate</td>
<td>Absent</td>
</tr>
<tr>
<td>A. baytopiana</td>
<td>2.4–2.8</td>
<td>1.9–2</td>
<td>Terminal awn</td>
<td>0.8–1.5</td>
</tr>
<tr>
<td>A. triaristata</td>
<td>2.6–2.9</td>
<td>1.9–2.1</td>
<td>Terminal awn</td>
<td>2.2–2.9</td>
</tr>
</tbody>
</table>
Apera triaristata M. Doğan, sp. nov. Fig. 3.

Affinis A. baytopianae M. Doğan sed panicula latiore magis ramosa, ariste glumarum minus inaequalibus, arista lemmatis longissima 6.5–10 mm longa differt.

Herba annua. Culmi 15–23 cm longi, erecti vel nodis plus minusve geniculati, 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 disarticulants et brevissime producta. Lodiculi 2. Stamina 3. Antherae 1.5–1.7 mm.

Typus. ITurkey 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 elliptico-lanceolatae, 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 $\times \frac{2}{3}$, B–G $\times$ 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 × ½, 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 × ¼, B × 3, C–J × 6.
CONTRIBUTIONS TO THE STUDY OF TURKISH GRASSES, I


This new species from SW Anatolia has a rather lax panicle and is closely related to Gaudinopsis quercetorum (Boiss.) M. Dogan (see p. 83). The lowest lemma is without an awn but bears a mucro (c. 1 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

<table>
<thead>
<tr>
<th>Spikelet (mm)</th>
<th>macra</th>
<th>quercetorum</th>
<th>huber-morathii</th>
<th>sorgerae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floret number</td>
<td>6–17</td>
<td>8.5–10</td>
<td>8–11</td>
<td>4.5–10</td>
</tr>
<tr>
<td>Lower glume (mm)</td>
<td>4–6.5</td>
<td>4.5</td>
<td>4.5–6</td>
<td>3–4</td>
</tr>
<tr>
<td>Upper glume (mm)</td>
<td>5–7</td>
<td>6</td>
<td>6–6.5</td>
<td>3.7–4.8</td>
</tr>
<tr>
<td>Lowest lemma (mm)</td>
<td>4.5–7.5</td>
<td>7</td>
<td>5.5–6.4</td>
<td>4.2–5.5</td>
</tr>
<tr>
<td>Apex of lowest lemma</td>
<td>Acute</td>
<td>Acuminate</td>
<td>Bifid, with a terminal mucro</td>
<td>Acute to minutely bifid</td>
</tr>
<tr>
<td>Awn of lemma (mm)</td>
<td>3.5–10</td>
<td>8</td>
<td>3–6</td>
<td>Absent</td>
</tr>
<tr>
<td>Palea (mm)</td>
<td>4.5–5</td>
<td>4.5–5</td>
<td>5.5–6</td>
<td>3.8–4.8</td>
</tr>
<tr>
<td>Anthers (mm)</td>
<td>1.5–2.5</td>
<td>2.4–3.1</td>
<td>3.5</td>
<td>2.1–3</td>
</tr>
</tbody>
</table>

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 paniculum 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.

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**


*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.: *Phileum asperum* Vill. var. *ciliatum* Boiss., *Fl. Or.* 5:482(1884).


*Zingeria trichopoda* (Boiss.) P. Smirn. subsp. *biebersteiniana* (Claus) M. Doğan, *comb. et stat. nov.*


**NEW RECORDS FOR TURKEY**


A2(A) İstanbul: Çatal Da., v 1865, *René du Parquet* (BM).

*Alopecurus davisii* Bor in *Notes RBG Edinb.* 25:63(1963).


Previously only known from the type collected on the island of Samos.

B7 Sivas: d. Divriği, Dumluca Da., 30 v 1968, T. Baytop (ISTE 12878).

A9 Kars: 6 km from Sarikamış to Karakurt, 2150 m, 15 vii 1966, P. H. Davis 46563 (E).

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