44. Tip of radicle showing origin of root-cap. *p*, plerome, *d*, dermatogen, and *c*, periblem. × 200.
45. Cotyledonary lobes at an advanced state of development. The rolling of the cotyledons in conformity with the campylotropy is initiated by the outer cotyledon becoming bigger and commencing to roll up. The plerome of the root and that of the cotyledons are indicated by dotted lines. × 100.
46. A fully mature embryo from a ripe seed. Root-cap is shown in black and plerome in dotted lines, *p* is the plumule. × 50.
47. A few endosperm cells with prominent nuclei and starch-grains in the cytoplasm. × 600.

TEXT-FIGURE E (p. 63).

48. Ovule before fertilization. The dotted area in figs. 48, 49, 50, 51, 52, and 53 represents the nucellar tissue surrounding the embryo-sac. × 100.
49. Ovule immediately after fertilization showing the beginning of the campylotropous curvature. The embryo-sac has enlarged and the origin of the aqueous tissue as a micropylar cap is also represented. × 100.
50. Ovule having attained the campylotropous form. The funicle is fused with the micropylar end. The oospore has divided once, and a number of free endosperm nuclei are distributed in the embryo-sac. × 100.
51. Embryo at octant stage showing the further enlargement of the sac and the persistence of the nucellar tissue. × 30.
52. The stage of cellular endosperm when the sac has reached its maximum size. The nucellus is still persistent. The embryo has now reached the lobing-of-the-cotyledons-stage. × 30.
53. The mature seed with the perisperm (dotted) surrounding the embryo. × 50.
54. Micropylar portion of the ovule showing funicular strands fused with the outer integument. *s*, sclerotic cells, *a*, aqueous tissue cells (both being specialized structures of the inner integument) merging into one another; *t*, tracheal tissue. The endosperm nuclei are in a state of simultaneous division. × 120.

S.108 Blattgrösse
S.110 Verpflanzungsexperimente
S.120 Homozygie
S.123 Root growth
S.134 veg. Verhalten
S.144 Entwicklung
S.146 Anthese
S.148 Pollen ∅

98

S.134 veg. Verhalten / S.107 Formen Variabilität
S.146 Anthese

A revision of the British species of the genus *Agrostis* Linn.

By W. R. PHILIPSON, B.A. (Communicated by Sir ARTHUR W. HILL, K.C.M.G., F.R.S., F.L.S.)

(With Plates 4–21, and with 40 figures and 9 graphs in the text)

[Read 28 October 1937]

INTRODUCTION.

In an old-established genus with such a wealth of forms as *Agrostis* it is difficult to reconcile modern taxonomy with old nomenclature. This difficulty is at once encountered when the definition and limitation of the genus are attempted. The concept of the genus has changed since the time of Linnaeus, but it is desirable that the standard species should be as representative of Linnaeus's concept as is compatible with the modern limitations of the genus. With the increased knowledge of the floras of the world many new species have been included in *Agrostis*, and in many cases the conception of the genus has had to be broadened to include them. The result is that while there is a large nucleus of closely allied species, there are also numerous species which can be included only doubtfully in the genus, and this in turn results in the limitations of the genus being very vague and often a matter of convenience. The generic description given below (p. 76), while based on that of Stapf in Dyer, 'Flora Capensis', VII, p. 545, was drawn up after an examination of the species represented in the Kew Herbarium. It is not intended to include all the doubtful species, whose retention in, or exclusion from, the genus must be the subject of further research; it is intended to include only those species which undoubtedly belong to the genus.

The closely allied genera, *Calamagrostis* (with *Deyeuxia*), *Polypogon*, and *Apera*, were also examined ; and it soon became evident that no satisfactory distinction between these and *Agrostis* exists, so that their separation will have to be by arbitrarily chosen characters. Moreover, the tribe Agrostidae, as it is now understood, is by no means a natural group of genera, and it is to be hoped that in the future some character other than the single floret in the spikelet will be employed to define it.

The British species of *Agrostis* fall into two sections, *Trichodium* and *Vilfa*. This division of the genus is retained because of the very great number of species throughout the world in which the palea is minute. These species seem to form an alliance in contradistinction to those species with a longer palea.

In the construction of the Key, characters have been chosen which are truly diagnostic of the groups they are used to separate, and which, while readily observable, are free from differences of interpretation. For example, the length of the anthers is used to separate *A. stolonifera* and *A. semiverticillata*, because the roughness of the glumes and the density of the panicle cannot be precisely defined, and because the difference in size of the anthers can be detected without even the aid of a hand lens.

The treatment of each species follows a uniform plan. A description is given which is intended to include all the variations which are found within the limits of the species. When the species includes varieties, the group which is considered typical of the species is also treated as a variety, so that the species is subdivided into two or more groups of equal rank. Under the heading of minor variations are recorded such of the numerous variations and fluctuations as have received names in the past. In this way it is hoped that all the names which have been applied to British phenotypes of *Agrostis* and those based on exotic types which are applicable to British plants have been collected together, even though names are not applied to the variations in the present revision. An explanation of the status of the various categories into which the species have been divided is given in the section on ' Variation, fluctuation, and fixity of characters ' (p. 105 forward).

The notes on the general distribution of the species throughout the world have been compiled from floras, and their records have not, for the most part, been checked by specimens ; but the distribution in the British Isles has been most rigorously checked. The figures chosen for citation are (i) those which best represent the plants, (ii) those of historic importance, and (iii) those in readily accessible works. Representative specimens of all the species and varieties, and of many of the smaller variations, are cited and are arranged according to the herbaria in which they occur, so that students may readily discover where they may most conveniently find specimens of each group. The herbaria are indicated by letters in Clarendon type as follows :—**K**. The Royal Botanic Gardens, Kew ; **B**. The British Museum Herbarium ; **W**. The National Museum of Wales, Cardiff ; **E**. The Royal Botanic Garden, Edinburgh ; **D**. The Druce Herbarium, Yardley Lodge, Oxford ; **C**. The Botany School, Cambridge.

The synonymy has been made as complete as possible. When a name has been wrongly applied, the name and original author are cited in inverted commas followed by the later author's name, e.g. when Withering applied *Agrostis alpina* Scop. to *A. setacea* Curt. the citation is given as ' *A. alpina* Scop.' With. By this means incorrect identifications are distinguished from later homonyms.

In the second section variations and fluctuations are examined critically as they occur in the species and in populations. By such studies the true significance of the subdivisions of the species may be arrived at. The importance of recognizing the very great number of variations that can be found in an apparently uniform population cannot be too greatly stressed. These variations may be selected by the environment and, when the resultant ecological groups are sufficiently distinct, as they are in *A. stolonifera* var. *stolonifera*, they may be described as ecads—groups brought about and preserved by the environment.

The anatomy of the vegetative parts of the different species and varieties was investigated to determine their value as aids to identification. The anatomy is described in the third section, and the conclusion is reached that it is of very little use in the diagnosis of the species. Even the anatomy of the leaf-blade, which was very fully investigated, is essentially the same in all the species.

Complete life-histories are described (p. 134 forward), so that the characters, from germination to maturity, may become familiar, and none of consequence escape notice.

Taxonomy.

The standard species.

The original description of the genus *Agrostis* appeared in Linnaeus's *Genera Plantarum*, ed. i, p. 19 (1737), and though he widened the scope of the genus when he published the first edition of his *Species Plantarum* (1753) by including unawned forms, he retained the original description in the 5th edition of the *Genera Plantarum*, which was published in the following year. It ran : ' Cal. *Gluma*, uniflora, bivalvis, acuminata. Cor. bivalvis, acuminata, vix longitudine calycis ; altera majore aristata.'

The twelve species published in the *Species Plantarum* are divided into the sections *Aristatae* and *Muticae* ; and the standard species of the genus should be among the former, since the description of the genus includes reference to an awn. It cannot be among the several Linnaean species removed to other genera by later authors, e.g. the first three and the last of the *Aristatae*, and the last three of the *Muticae*. Two aristate species are left, viz. *A. rubra* and *A. canina* ; and since the identity of the former is uncertain (Hitchcock, Bot. Gaz. xxxviii, p. 141, 1904), it seems best to select *A. canina* as the standard species of the genus *Agrostis*.

There are species, now generally considered to belong to the genus *Agrostis*, which have been removed by various authors and placed in new genera. Thus Adanson (1763) based a new genus—*Vilfa*—on Bauhin's *Gramen caninum*

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supinum, which is quoted in synonymy under *A. stolonifera* by Linnaeus, while he retained the name *Agrostis* in the section *Avenae*, a group of genera which he describes as having a dorsal awn. At the same time in his index (p. 514) he quoted 'Scheuchzer 57' as a species of *Agrostis*; but this grass, which Scheuchzer figures (Tab. II, 4 A), probably belongs to the modern genus *Imperata*; and as it is unawned it must be considered to have been wrongly included by Adanson in his genus *Agrostis*. Michaux (1803) founded the genus *Trichodium* to include certain North American species in which the palea is minute and the lemma usually awnless. Schrader (1806) rightly included in Michaux's genus European species with a minute palea, whether unawned or awned; but Beauvois (1812) founded the genus *Agraulus* to include the awned species, retaining *Trichodium* only for those species with a minute palea and no awn. The size of the palea does seem to be of sectional importance in the genus; but the presence or absence of the awn should not be used as a generic or even a sectional character, as it is rarely either constantly present or constantly absent in any one species.

If these smaller genera should be revived, their correct nomenclature would depend on our conception of the typical *Agrostis*. If, for instance, we follow Hitchcock ('Genera of Grasses of the United States', U.S. Dep. Agric. Bull. 772, p. 125; 1920) and select *A. stolonifera* as the standard species of the genus as now understood, the name *Vilfa* Adans. becomes a synonym of *Agrostis*, and the name *Trichodium* Michx. can be used for the species with minute paleae. On the other hand, if, as suggested above, *A. canina* be selected as the standard species, the name *Agrostis* is retained for the genus including *A. canina*; and *Vilfa* Adans. may be used as the correct name of a genus including *A. stolonifera*.

Maintaining that Adanson was correct in retaining the name *Agrostis* for the awned species, and in coining a new generic name for the unawned species when he decided to remove these to another genus, the standard species of *Agrostis* should not be selected from among the species included in Adanson's new genus; but from among the *Aristatae* of Linnaeus, and for reasons given above *A. canina* is the most suitable species.

Generic description.—*Spikelets* small, 1-flowered, hermaphrodite, in diffuse or dense panicles; rhachilla usually not continued beyond the floret, rarely produced as a point or bristle. *Glumes* equal or subequal, usually lanceolate and acute, rarely obtuse, and very rarely acuminate or awned, usually 1-nerved, keeled, scabrous on the keel and sometimes over the whole surface. *Lemma* shorter than or rarely equal to the glumes, broadly ovate, usually truncate, membranaceous, sometimes scabrid or tomentose, 5- or, less frequently, 3-nerved, the lateral nerves sometimes excurrent, awned from the back or awnless; callus glabrous or with minute tufts of hairs. *Palea* usually shorter than the lemma, sometimes very short or obsolete, hyaline, 2-nerved or nerveless. *Lodicules* 2, lanceolate, hyaline. *Stamens* 3. *Ovary* glabrous; styles distinct, short; stigmas plumose, laterally exserted. *Caryopsis* free, enclosed in the scarcely altered floret, oblong, more or less dorsally compressed, grooved in front, rarely subterete; embryo small; hilum punctiform or elongate, usually basal.

Annual or perennial grasses, caespitose or widely creeping above or below the soil, the culms low or tall, erect or geniculate, the leaf-blades flat or involute, the ligule membranous. The panicles often delicately branched, open or contracted, sometimes spike-like; spikelets numerous; the glumes opening widely during flowering.

KEY TO THE BRITISH SPECIES AND VARIETIES OF AGROSTIS.

Palea less than ¼ the length of the lemma; ligules of culm-leaves acute (*Sect.* TRICHODIUM).	
Radical leaves with a single ventral groove; glumes rough	*A. setacea.*
Radical leaves with four or more ventral grooves; glumes smooth	*A. canina.*
Rhizomes absent; stolons present	*A. canina* var. *fascicularis.*
Rhizomes with scale-leaves present	*A. canina* var. *arida.*
Palea more than ¼ the length of the lemma; ligules of the culm-leaves obtuse (*Sect.* VILFA).	
Palea ¾ the length of the lemma or less; anthers over 1 mm. long; glumes persistent.	
Rhizomes with scale-leaves present; panicle open in fruit.	
Ligule of sterile shoots shorter than broad	*A. tenuis.*
Rhizomes short; plants tall or low	*A. tenuis* var. *hispida.*
Rhizomes long; plants low (1 dm.)	*A. tenuis* var. *humilis.*
Ligule of sterile shoots as long as broad	*A. gigantea.*
Culms prostrate below	*A. gigantea* var. *ramosa.*
Culms erect or geniculate	*A. gigantea* var. *dispar.*
Rhizomes absent; panicle closing in fruit	*A. stolonifera.*
Innovations numerous, plants tufted at the centre; blades about 5 cm. or less	*A. stolonifera* var. *stolonifera.*
Innovations few, plants not tufted; blades longer than 5 cm.	*A. stolonifera* var. *palustris*
Palea and lemma subequal; anthers less than 0·75 mm. long; spikelets falling as a whole	*A. semiverticillata.*

THE DESCRIPTIONS OF THE SPECIES AND VARIETIES.

SECTION I. TRICHODIUM (*Michx.*) *Trin.* Agrost. p. 112 (1820) *.

Species with the palea less than ¼ the length of the lemma.

Synonymy.—*Agrostis* Adans. Fam. des Plant. II, p. 32 (1763): Bast. Fl. Maine et Loire, p. 27 (1809): Beauv. Agrost. p. 21 (1812). *Trichodium* Michx. Fl. Bor.-Amer. I, p. 41 (1803): Schrad. Fl. Germ. I, p. 198 (1806): Beauv.

* The genera *Trichodium* Michx. (1803) and *Agraulus* Beauv. (1812) resemble each other in that both have a minute palea, but an awn is present in the latter and absent in the former. Trinius reduced them to sections of *Agrostis* without changing their sense in any way. The two sections are now united, and the epithet *Trichodium* is chosen in preference to *Agraulus* because it is based on the earlier generic name, and because it was the first to be used (as a generic name) in the present comprehensive sense by Schrader (1806).

op. cit. p. 5 (1812): Roem. & Schult. Syst. Veg. II, p. 276 (1817): Link, Enum. Hort. Berol. I, p. 69 (1821). *Agraulus* Beauv. op. cit. p. 5 (1812): S. F. Gray, Arr. Brit. Plant. II, p. 149 (1821). *Agrostis*, sect. *Agraulus* (Beauv.) Trin. Agrost. p. 112 (1820): Spreng. Syst. Veg. I, p. 178 (1825). *A.* sect. *Trichodium* (Michx.) Spreng. op. cit. p. 259 (1825): Gaudin, Fl. Helv. I, p. 178 (1828): Godr. in Gren. & Godr. Fl. Fr. III, p. 483 (1856): Griseb. in Ledeb. Fl. Ross. VI, p. 439 (1853): Schur in Oest. Bot. Zeit. IX, p. 50 (1859). *A.* sect. *Agrostiotypus* in part (spp. 5–9) Aschers. & Graebn. Syn. Mittel-europ. Fl. II, p. 171 (1899). *A.* sect. *Nardagrostis* Aschers. & Graebn. loc. cit. (1899). *A.* subgen. *Trichodium* sect. *Eutrichodium* Rouy, Fl. Fr. XIV, p. 65 (1913).

1. AGROSTIS SETACEA *Curtis*, General Obs. 4 (1787).

Diagnosis.—Palea *minute*; lemma *5-nerved, awned*; glumes *uniformly scabrid*; panicle *closed in fruit*; radical leaf *with its blade setaceous, and its ligule acute*; *caespitose*. Anthers 1·5–2 mm. long.

Description.—A densely caespitose perennial, growing in isolated tufts or forming a close turf. *Culms* 2–6 dm. high erect, sometimes slightly geniculate below, rough, especially above, pale greyish green, usually with three brown nodes. *Sterile shoots* numerous at the base, intravaginal, never elongating as stolons. *Leaf-sheath* open above, closed below, terete, striated, slightly rough, rather loose, tapering towards the ligule, those of the culm-leaves green, of the radical leaves straw-coloured, the sheath of the lowest node of the culm longer than the internode, of the uppermost considerably shorter. *Ligule* up to 4 mm. long, acute, membranaceous, often torn. *Blade* of the sterile shoots up to 20 cm., usually shorter, filiform, about 0·3 mm. broad, with a slightly wider insertion and tapering gradually to the apex, elliptical in section, with a groove on the upper side, rough, pale or dark greyish green, rather stiff and erect, the blades of the culm-leaves 5 cm. or less, as the radical leaves or with two or four ventral grooves. *Panicle* 3–10 cm. long, spike-like before and after flowering, open to a varying extent during flowering; rhachis straight, rough, green or purple, lowest internode longest, 0·8–1·5 cm.; branches semi-verticillate, the lower up to 4 cm. long, minutely rough, the longer branches naked for half their length, the shorter with spikelets to the base; branchlets in groups of two or three, minutely rough; pedicels variable in length, up to 4 mm. *Spikelets* lanceolate when closed. *Glumes* 3–4 mm. long, the lower slightly longer, lanceolate, with an acute apex, tinged with pale or deep purple, toothed on the upper $\frac{2}{3}$ or $\frac{1}{2}$ of the keel and slightly on the margin, and covered with a fine uniform asperulence; rhachilla short; callus with two tufts of hairs, 0·5 mm. long. *Lemma* $\frac{2}{3}$ the length of the glumes, broadly ovate when flattened, truncate, with a minute scaberulence except at the apex, 5-nerved, the two marginal nerves shortly excurrent, the median nerve entering an awn near the base of the lemma; the awn usually projecting considerably beyond the glumes, usually bent near the middle, twisted below. *Palea* very minute, shorter than the rhachilla hairs, bifid. *Lodicules* about 0·4 mm. long. *Anthers* 1·5–2·0 mm., sometimes tinged with purple. *Ovary* ovoid, less than 0·5 mm. long. *Caryopsis* about 1·5×0·4 mm.

Type.—No authentic specimens of Curtis have been preserved. There is a specimen in the British Museum Herbarium, originally from Curtis's garden, which may be taken as representative of the species.

Synonymy *.—*A. caninà* var. γ Huds. Fl. Angl. ed. 2, I, p. 31 (1778) †. '*A. alpina* Scop.' With. Bot. Arr. ed. 2, I, p. 71 (1787). '*A. filiformis* Vill.' Bast. Fl. Maine et Loire, p. 28 (1809). *Vilfa setacea* (Curtis) Beauv. Agrost. p. 182 (1812) ‡. *Trichodium setaceum* (Curtis) Roem. & Schult. Syst. Veg. II, p. 280 (1817). *Agraulus setaceus* (Curtis) S. F. Gray, Arr. Brit. Pl. II, p. 149 (1821).

With the spikelets not tinged with purple—*A. setacea* var. *flavida* Rouy, Fl. France, XIV, p. 70 (1913); deeply tinged with purple—*Agraulus setaceus* var. *purpureus* S. F. Gray, Brit. Pl. II, p. 150 (1821). A form with two flowers in the spikelets—*Agrostis setacea* var. *biflora* Lange in Willk. & Lange, Fl. Hisp. I, p. 54 (1861)—recorded from Spain.

Figures.—Curtis, Fl. Lond. VI (date ?), pl. 12: Sowerby & Smith, Eng. Bot. XVII (1803), pl. 1188: Parnell, Grass. Brit. II (1845), pl. 83.

Representative specimens.—**K.** S. DEVON: Haldon, *Borrer*. N. DEVON: Cawsand, *Sherrin*. E. SUSSEX: Heathfield, *Borrer* (in Borrer Herb.). SURREY: Lightwater, *Turrill*. **B.** N. DEVON: between Ashbury and Beaworthy, *Rogers*. SOMERSET: Cathelston, *Marshall*. SURREY: Camberley, *Beeby*. GLAMORGAN: St. Donats, *Riddelsdell*. **W.** GLAMORGAN: Mynydd-y-Glen, *Wade*; Pontyrhyl, *Webb*. W. SUSSEX: St. John's Common, *Bailey*. **E.** CORNWALL: Ponsanooth, *Hamilton Davey*. **D.** S. HANTS: Bournemouth, *Linton*. **C.** DORSET: Wareham, *White*. 167 sheets have been examined.

Distribution.—South-west Europe, in Spain, Portugal, W. France (not in Holland, see Prod. Fl. Bat. ed. 3, p. 2193; 1916). British Isles: dry sandy

* *A. setifolia* Brot. Fl. Lusit. I, p. 74 (1804) is a nomenclatural synonym for *A. alpina* Scop., Fl. Carniol. I, p. 60 (1772).

† The name *Agrostis setacea* was first published with a description by Curtis in the *Flora Londinensis* in 179– (the exact date is uncertain; see Clarke in Journ. Bot. XXXIII, p. 112, 1895), but in August 1787 it was included by Curtis in a list of British grasses with the citation 'H. [Hudson] var. *canina* γ'. The description in the *Flora Londinensis* is antedated by *A. setacea* Vill. (Hist. Dauph. II, p. 76; 1787), but this name was probably published later than August (since it is not mentioned in the *Göttingische Anzeiger* until 17 January 1788). The validity of the name *A. setacea* Curtis therefore rests on the identity of Hudson's variety. The identification of this variety with Curtis's plant is upheld by Hudson's slight description: 'foliis setaceis rigidis glaucis, culmo erecto', and by the locality given by Hudson: 'in ericetis montosis aridis, supra Hall Down prope Exeter et alibi in Devonia'. There is now no Hall Down near Exeter, but this locality is almost certainly the Haldon, where Borrer collected *A. setacea*. If Hudson's statement that his variety changes in moist soil into the typical *A. canina* is an error (as I think it may be, as he also states that the caespitose *A. canina* changes into the stoloniferous variety), then his var. γ is most likely to be *A. setacea* Curtis, which therefore can be retained as the correct name for this species.

‡ Beauvois cites Poiret, who makes *A. setacea* Curtis a doubtful variety of *A. rupestris* All.

and peaty heaths and chalk downs in the south and south-west. Ascending to 1,400 ft. (430 m.) in Somerset. Recorded from vice-counties 1–5, 8–14, 17, 22.

Flowering period.—From mid-June to July.

2. AGROSTIS CANINA *Linn.* Sp. Pl. ed. 1, 1, p. 62 (1753).

Diagnosis.—Palea *minute* ; lemma 5-*nerved, usually awned* ; glumes *smooth* ; panicle *closed in fruit* ; radical leaf *with its blade linear, and its ligule acute* ; *caespitose or with overground stolons.* Anthers 1–1·5 mm.

Description.—A perennial of diverse habit. Caespitose or forming a turf with usually short rhizomes, or with often very long trailing sterile stolons. *Culms* from 1–6 or rarely 8 dm., usually about 4 dm. long, erect or geniculate, sometimes decumbent and rooting at the lower nodes, green or tinged with purple, sometimes rough above, with 4–6 brown or purple nodes. *Sterile intravaginal shoots* numerous, either all short and tufted, with the blades close together and hardly spreading, or some elongating as stolons, also extravaginal shoots with scale-leaves may be present. *Leaf-sheaths* split almost to the base, terete, striate, smooth, close-fitting, green or tinged with purple, especially near the ligule and the node, the sheaths of the lower nodes of the culm longer than the internodes, of the upper much shorter. *Ligule* up to 3 mm. long, usually much shorter in the leaves of the sterile shoots, acute, membranaceous, often torn. *Blade* up to 2 dm. long, the upper blades of the culm often very short, 1–3 mm. broad, folded or rolled in the bud, tapering gradually from the base to a filiform apex, pale to dark green or often greyish green, frequently rough, the upper surface strongly furrowed, flat or involute. *Panicle* 4–15 cm. long, in flowering ovoid or pyramidal, diffuse, in fruiting the branchlets are contracted against the branches, and these are raised more or less, especially the upper, producing a spike-like appearance ; rhachis straight or angled only at the uppermost nodes, quite smooth below, rarely throughout, green or purple, first or second internode the longest, 1–1·8 cm. long ; branches triangular with minute scabridity on the angles, especially above, rarely entirely smooth, dividing at about half their length ; branchlets usually in unequal pairs, rarely quite smooth ; pedicels very rarely smooth. *Spikelets* lanceolate. *Glumes* 1·5–4 mm. long, the lower slightly the longer, broadly to narrowly lanceolate with acute apices, pale green, very rarely yellowish when in flower, more usually tinged, sometimes very deeply, with purple, the margins colourless and shining, sometimes denticulate near the apex, the keel of the lower glume toothed on the upper $\frac{2}{3}$ or $\frac{1}{2}$, the upper glume with fewer teeth or none ; the hairs of the callus very short. *Lemma* $\frac{2}{3}$ the length of the glumes, ovate when flattened, truncate, with a close asperulence except towards the apex, 5-nerved, the lateral nerves usually slightly excurrent, the median nerve usually entering an awn below the middle of the lemma, or ending blindly between the middle and the apex, the awn frequently twice the length of the lemma and bent, or shorter and straight, or entirely absent. *Palea* very minute, usually much shorter than the ovary, bifid. *Lodicules* about 0·4 mm. long. Anthers 1–1·5 mm.

long, frequently tinged with purple. *Ovary* ovoid, about 0·5 mm. long. *Caryopsis* about 1·1×0·3 mm.

Type.—*Agrostis* sheet No. 12 in the Linnaean Herbarium *.

Distribution.—Throughout Europe, and Asia from the Caucasus and Himalayas northwards. Introduced into N. America (? native in Newfoundland) ; closely related forms in New Zealand, Patagonia, and the Falklands. Throughout the British Isles ; Channel Isles.

Flowering period.—From mid-June to July.

Var. FASCICULARIS (*Curtis*) *Sinclair*, Hort. Gram. Wob. p. 278 (1824).

The *culms* frequently decumbent, rooting and branching freely at the lower nodes. The intravaginal *branches* frequently elongated as stolons, which are often long and rooted at most of the nodes, where clusters of short extravaginal branches arise. When growing in very wet situations the habit is very lax, with long trailing stolons and large panicles. The *leaves* are usually narrow, pale green, and soft. The branches of the *panicle* frequently become only slightly raised against the rhachis after flowering. *Spikelets* 2–4 mm. long. *Lemma* with or without an awn of variable length. Growing usually in damp situations, sometimes floating in ditches.

Type.—The specimen in Sinclair's own copy of the folio edition of *Hortus Gramineus Woburnensis*, which is preserved at Woburn Abbey, may be taken as the type of this variety.

Synonymy.—*A. canina* Linn. Sp. Pl. ed. 1, 1, p. 62 (1753) ; With. Bot. Arr. ed. 1, p. 30 (1762) ; Roth, Tent. Fl. Germ. 1, p. 31 (1788) ; Sibth. Fl. Oxon. p. 36 (1794) ; Smith, Fl. Brit. ed. 1, 1, p. 78 (1800) ; Host, Fl. Austr. 1, p. 99 (1827) ; Bab. Man. Brit. Bot. ed. 1, p. 360 (1843). *A. canina* var. α Huds. Fl. Angl. ed. 2, 1, p. 30 (1778). *A. tenuifolia* Curtis, General Obs. p. 4 (1787). *A. mutabilis* Sibth. op. cit. p. 36 (1794) †. '*A. vinealis* Schreb.' With. op. cit. ed. 3, II, p. 127 (1796) ‡. *A. fascicularis* Curtis, Practical Obs. ed. 3, p. 46 (1800), nomen ; Sinclair, Hort. Gram. Wob. ed. 1, p. 154 (1816). *Trichodium caninum* (Linn.) Schrad. Fl. Germ. 1, p. 198 (1806). *Agrostis hybrida* Gaudin, Agrost. Helv. p. 66 (1811) §. *Agraulus caninus* (Linn.) S. F. Gray, Brit. Plant. II, p. 148

* The specimens consist of panicles and part of the culms only, so that it is impossible to determine to which variety they belong. There are three other specimens pinned to this sheet (which implies that Linnaeus considered them probably the same species), and as the first of these is *A. canina* var. *fascicularis*, and as the other two specimens belong to *A. stolonifera* Linn., it is clear that Linnaeus had a stoloniferous plant in mind. The diagnosis in the *Species Plantarum* is insufficient, but the citations of Bauhin and Scheuchzer, and the habitat, all support the view that Linnaeus had the stoloniferous variety in mind.

† This species is included in his sect. *Muticae*, but he refers to Scheuchzer (Agrost. taf. 3, fig. 9 c), which is of an awned species.

‡ The palea is described as nearly equal to the lemma. This is probably an error, or Withering may have been describing an awned form of *A. stolonifera* Linn. Gaudin (Agrost. p. 87 ; 1811) suspects that *A. vinealis* Schreb. is an awned form of *A. decumbens*.

§ A specimen collected by Gay in the company of Gaudin 'au bord du Katzensee (lacus felinus)' in 1805 is in the Kew Herbarium.

(1821). *Agrostis canina* var. *hybrida* (Gaud.) Gaudin, Fl. Helv. I, p. 182 (1828). *A. canina* var. *genuina* Godr. in Gren. & Godr. Fl. Fr. III, p. 484 (1856). *A. canina* var. *stolonifera* Blytt, Norg. Fl. I, p. 81 (1861).

Figure.—Hoffmann, Deutschl. Fl. I, pl. 6 (1800).

Representative specimens.—**K.** SURREY : Wimbledon Common, *Turrill*; Richmond Park, *Philipson* 167 ; Black Pond, Oxshott, *Hubbard*. CARDIGAN : Borth Bog, *Philipson* 156. NORTHUMBERLAND : *Philipson* 202–4. **B.** E. CORNWALL : between Polscove and Polbathick, *Briggs*. SURREY : Esher, *Britton* 703. CARDIGAN : Pont-ar-fynach, *Augustine Ley*. CUMBERLAND : Cross Fell, *Baker*. **W.** No locality : *Conway* in 1834. **E.** DUMFRIES : Bruce's Castle, *Webb*. **D.** BERKSHIRE : Wellington College, *Druce*. CAMBRIDGESHIRE : Wimblington, *Fryer*. LINCOLNSHIRE : Bourne, *Webster*. **C.** CAMBRIDGESHIRE : March, *Fryer*. 125 sheets have been examined.

Distribution.—Probably throughout the British Isles in low-lying grassland, but imperfectly known.

Var. ARIDA *Schlechtendal*, Fl. Berol. I, p. 45 (1823).

Differing from the preceding mainly in habit. Caespitose or spreading underground to form a turf. *Culms* erect or geniculate, infrequently rooting at the lower nodes, and branching sparingly. The intravaginal *branches* not elongating as stolons ; extravaginal branches with scale-leaves are present, either at once ascending, or spreading, often widely, as rhizomes with narrow, straw-coloured scale-leaves, and occasionally with solitary branches at few of the nodes, and producing at the surface a tuft of intravaginal branches. The *panicle* usually becomes spike-like after flowering. *Spikelets* 2–4 mm. long. *Lemma* with or without an awn of variable length. Growing on heaths and acid grassland.

Type.—No specimen has been preserved.

Synonymy.—*A. canina* var. β Huds. Fl. Angl. ed. 2, I, p. 30 (1778). *A. stricta* Curtis, Obs. Brit. Grass. ed. 4, p. 35 (1804) : Sinclair, Hort. Gram. Wob. ed. 1, 150 (1816). *A. capillaris* Sinclair, op. cit. 182 (1816). '*A. canina* Linn.' Hook.* Fl. Scot. p. 24 (1821) : Blytt, Norg. Fl. I, p. 80 (1861) ; Rouy, Fl. Fr. XIV, p. 66 (1913). *A. canina* var. *sylvatica* † Schlechtend. Fl. Berol. I, p. 45 (1823). *A canina* var. *capillaris* Sinclair, op. cit. ed. 2, p. 300 (1824). *A. canina* var. *vulgata* Döll, Rhein. Fl. p. 108 (1843). '*A. canina* var. *genuina* Godr.' Aschers. & Graebn. Syn. Mittel-europ. Fl. II, p. 184 (1899).

Figures.—Host, Ic. Gram. Aust. IV (1809), pl. 53 : Reichenbach, Agrost. Germ. (1834), pl. 33, fig. 1424 : Parnell, Grass. Scotl. (1842), pl. 15.

* This variety of *A. canina* has latterly become to be regarded as the typical form of the species. In England this interpretation probably began with Hooker, who would find the caespitose variety much the more numerous in Scotland ; he includes stoloniferous plants in his description.

† The varietal epithet *arida* is selected in preference to *sylvatica* because of the inappropriateness of the latter.

Representative specimens.—**K.** SOMERSET : Porlock, *Maynard*. SURREY : Richmond Park, *Hubbard* in 1928. NORFOLK : Dersingham, *Hubbard* 9273. CARDIGAN : Pwell Peiran, *Philipson* 179. NORTHUMBERLAND : Sweethope, *Philipson* 194. **B.** SURREY : Wimbledon, *Moore*. KENT : Forest Hill, *Sowerby*. ESSEX : Walthamstow, *Forster*. ISLE OF MAN : Grundle, *Holt*. **W.** GLAMORGAN : Caerphilly Common, *Wade* and *Hyde* in 1931. **E.** ORKNEY : Kirbister, *Johnston* 837. **D.** LEICESTER : Peckleton Common, *Horwood*. **C.** CAMBRIDGESHIRE : Horse Moor, Wimblington, *Tutin* and *Gilmour*. 412 sheets have been examined.

Distribution.—Throughout the British Isles ; abundant on heaths and upland grass.

Minor variations.

1. The awn absent, or short and straight, the median nerve ending about the middle of the lemma or rarely continued to the apex. Otherwise as in the awned form and with the same distribution.—*A. canina* var. *mutica* Gaud. Fl. Helv. I, p. 182 (1828). *A. canina* var. *pudica* Döll, Rhein. Fl. p. 108 (1843). *A. canina* var. *submutica* Čelak. Fl. Böhm. IV, p. 710 (1881).

Representative specimens.—**K.** WESTMORLAND : Patterdale, *Philipson* 197. **B.** WARWICKSHIRE : Balsall Common, *Bromwich* 1655. FIFE : Balmuto, *Syme*. **D.** CHESHIRE : Oakmere, *Holt*.

2. Spikelets large, with glumes 3–4 mm. long. Radical leaves often broad and flat. Moorland in the west and north, especially in the Highlands.—*A. vinealis* Schreb. Spicil. Fl. Lipsic. p. 47 (1771) : With. Bot. Arr. ed. 2, I, p. 72 (1787). *A. canina* var. *elatior* Hartm. Scand. Fl. ed. 2, p. 19 (1832). '*A. canina* var. *hybrida* Gaud.' Schur in Oestr. Bot. Zeitschr. IX, p. 52 (1859). *A. canina* var. *grandispiculata* Schur, loc. cit. (1859). *A. canina* var. *scotica* Hack. ex Druce in Bot. Exchange Club Rep. for 1889, p. 274 (1890) *. *A. canina* var. *grandiflora* Hack. ex Druce in Scot. Nat. X, p. 293 (1890). *A. canina* var. *laevis* Hack. ex Druce in Irish Nat. XVI, p. 152 (1907).

Representative specimens.—**K.** MIDLOTHIAN : Pentlands, *Balfour*. PERTH : Ben Lawers, *Don*. **B.** WESTMORLAND : Fairfield, *Ridley*. PERTH : Ben Lawers, *Robert Brown* in 1794 as ? *A. vinealis* Schreber '. ABERDEENSHIRE : between Clova and Invercauld, *Robert Brown* in 1794 named ' var. *montana* '. W. Ross : Ben Eay, *Druce* (var. *scotica* Hack.). KERRY : Brandon Mts., *Druce* (var. *laevis* Hack.). **D.** ABERDEENSHIRE : Glen Callater, *Druce*, with the name f. *coarctata*. W. Ross : Ben Eay, *Druce* (var. *scotica* Hack. and var. *grandiflora* Hack.). KERRY : Brandon Mts., *Druce* (var. *laevis* Hack.).

* This grass does not approach *A. rupestris* All. as suggested by Druce. *A. canina* and *A. rupestris* are distinct species, most readily and surely separated by the smaller anthers in the latter.

3. The glumes deeply tinged with purple.

Representative specimen.—**D.** Perth : Lochan Larig, *Druce*, with the subvarietal name *nigrescens*.

4. Plants low, culms rarely over 15 cm. The dwarf habit is retained on cultivation. Growing on high mountains.—? *A. pusilla* Dumort. Obs. Gram. Belg. p. 129 (1823). *A. canina* var. *alpina* Parnell, Grass. Scot. p. 37 (1842). ? *A. canina* var. *humilis* Willk. in Willk. & Lange, Fl. Hisp. I, p. 54 (1861). ? *A. canina* var. *pusilla* (Dumort.) Aschers. & Graebn. Syn. Mittel-eur. Fl. II, p. 185 (1899).

Representative specimens.—**K.** Cumberland : Dale Head, summit, *Philipson* 196. **D.** Inverness : Skye, *Druce* as f. *macra* Hack.

5. The glumes green, without any tinge of purple. A shade form which becomes darker when grown in open situations.—*A. pallida* * Hoffm. Deutsch. Fl. ed. 1, I, p. 34 (1800). *A. canina* var. γ Hook. Fl. Scot. p. 24 (1821). *A. canina* var. *pallida* (Hoffm.) Rouy, Fl. Fr. XIV, p. 67 (1913).

Representative specimens.—**K.** Cornwall : Perranzabuloe, *Rilstone*. **B.** Glamorgan : Pontneathvaughn, *Riddelsdell*. **D.** Berkshire : Fence Wood, *Druce*. E. Inverness : Philmorach Falls, Beauly, *Druce*.

6. The glumes at all times pale yellow or yellowish green.—*A. nivea* (vel *Trichodium niveum*) Sinclair, Hort. Gram. Wob. folio 152 (1816). *A. canina* var. β Hook. Fl. Scot. p. 24 (1821). *A. canina* var. *varians* Aschers. & Graebn. Syn. Mittel-europ. Fl. II, p. 185 (1899) †.

Representative specimens.—**K.** Scotland : without precise locality, *Don*. **D.** Cheshire : Fish Pool, *Holt*.

Diseased states.

1. Infection with *Anguillina agrostis* (Steinbuch) Goodey. Symptoms as in *A. tenuis* (see p. 89). Rare.

Representative specimen.—**B.** Middlesex : Hampstead, *Buddle* (in Buddle's Herb.).

2. Infection with *Tilletia decipiens* (Pers.) Körn. Symptoms as in *A. tenuis*. Infrequent.

Representative specimens.—**K.** Shetlands : Foula, *Gladstone*. **B.** Kent : Tunbridge Wells, *Forster* (2 sheets).

* Hoffmann cites (with a note of doubt) *A. pallida* With. Bot. Arr. ed. 3, II, p. 128 (1796). The description of this latter grass would conform to this variation of *A. canina* but for having the ' inner valve deciduous, more like a very short slender hair than a husk, and so minute that it is with difficulty found '.

† Based on *A. varians* Thuill. (Fl. Par. ed. 2, p. 35 ; 1799), but this description mentions a reddish panicle. Rouy doubtfully gives *A. varians* Thuill. as a synonym for *A. canina* var. *mutica* Gaud.

Section 2. VILFA (*Adans.*) *Roem. & Schult.*
Syst. Veg. II, p. 343 (1817).

Species with the palea more than ⅓ the length of the lemma.

Synonymy.—*Vilfa* Adans. Fam. des Plant. II, p. 495 (1763) : Beauv. Agrost. p. 16 (1812) : S. F. Gray, Brit. Plant. II, p. 144 (1821). *Agrostis* Schrad. Fl. Germ. I, p. 207 (1806) ; S. F. Gray, loc. cit. (1821). *Decandolia* Bast. Fl. Maine et Loire, p. 28 (1809). *Agrostis* sect. *Agrostis* (Linn.) Trin. Agrost. p. 111 (1820) ; Gaudin, Fl. Helv. I, p. 185 (1828). *A.* sect. *Vilfa* (Adans.) Link, Enum. Hort. Berol. I, p. 70 (1821) : Spreng. Syst. Veg. I, p. 257 (1825). *A.* sect. *Euagrostis* Godr. in Gren. & Godr. Fl. Fr. III, p. 481 (1850) : Griseb. in Ledeb. Fl. Ross. IX, p. 463 (1853) : Schur in Oestr. Bot. Zeitschr. IX, p. 44 (1859). *A.* sect. *Agrostiotypus* in part (spp. 1–4) Aschers. & Graebn. Syn. Mitteleurop. Fl. II, p. 171 (1899). *A.* subgen. *Vilfoideae* and *Vilfa* Rouy, Fl. Fr. XIV, pp. 59 & 60 (1913).

3. Agrostis tenuis *Sibthorp*, Fl. Oxon. p. 36 (1794).

Diagnosis.—Palea *half the length of the lemma or longer* ; lemma *usually 3-nerved, occasionally awned* ; glumes *smooth* ; panicle *remaining open in fruit* ; radical leaf *with its blade linear and its ligule shorter that broad, blunt* ; *caespitose or stoloniferous*. Anthers 1–1·5 mm.

Description.—A perennial which often forms a dense turf, caespitose, spreading by usually short rhizomes or, in addition, with short or occasionally long stolons. *Culms* usually from 2–5 dm., but varying from 2 cm.–10 dm. long, usually erect or geniculate, often procumbent and branching, finally becoming upright or inclined, sometimes remaining almost horizontal, green or tinged with purple, smooth or rarely rough below the panicle, with 3–5 yellow or brown nodes. *Sterile shoots* usually with blades distant and markedly distichous and spreading at an angle of 30–45°, the intravaginal shoots often becoming elongated as stolons, sometimes long and much branched, the extravaginal usually short with few brown scales, sometimes long with branches in the axils of the scale-leaves ; scale-leaves split at the apex. *Leaf-sheaths* open above, closed near the base, terete, striate, smooth, close fitting, green or occasionally tinged with purple, the sheaths of the lower nodes of the culm longer than the internodes, the upper usually shorter, occasionally longer. *Ligule* of the sterile shoots usually less than 0·75 mm., rarely up to 1 mm., of the upper culm-leaves often longer, truncate or very obtusely rounded, membranaceous. *Blade* up to 2·5 dm. long, the upper blades of the culm often very short, 1–5 mm. broad, parallel-sided or sometimes broadest above the base, rolled in the bud, pale to dark green, sometimes greyish or tinged with purple, slightly rough on both surfaces, furrowed above, flat or involute. *Panicle* 1–20 cm. long, erect or nodding above, in flowering ovoid, cylindrical or pyramidal, diffuse, rarely spike-like, the spikelets of adjacent verticils intermingling, in fruiting the branches and branchlets may remain spreading or the ultimate branchlets may become parallel,

forming bunches of spikelets, rhachis usually angled at the uppermost nodes, sometimes straight throughout, entirely smooth or slightly rough above, rarely throughout, green or tinged with purple, first or second internode longest, up to 3 cm. long, branches semi-verticillate, up to 10 cm. long, triangular, entirely smooth or with scabridity at the angles, especially above, rarely throughout, dividing at about half their length, usually angled at the nodes; branchlets usually in unequal pairs, smooth or minutely rough; pedicels smooth or rough. *Spikelets* lanceolate. *Glumes* 2–3·5 mm. long, the lower slightly the larger, broadly to narrowly lanceolate, with acute apices, pale green, at least on the midrib, or usually tinged with purple, especially between the keel and the margins which are usually colourless and shining, the keel of the lower glume usually slightly toothed in its upper half, of the upper glume usually smooth; the hairs of the callus short. *Lemma* $\frac{2}{3}$ the length of the glumes, broadly ovate when flattened, rounded at the apex, with a scattered asperulence towards the base, 3-nerved at least in the upper half, rarely 5-nerved, the two marginal nerves usually shortly excurrent, the median nerve usually ending just below the apex, sometimes excurrent between the apex and the middle of the back of the lemma as an awn which is usually short but may protrude considerably beyond the glumes. *Palea* $\frac{1}{2}$–$\frac{2}{3}$ the length of the lemma, bifid, faintly 2-nerved. *Lodicules* about 0·4 mm. long. *Anthers* 1–1·5 mm. long, sometimes tinged with purple. *Ovary* ovoid, about 0·4 mm. long. *Caryopsis* about 1·0×0·35 mm.

Type.—There is a sheet in the Fielding Herbarium, Oxford, written up by Sibthorp as the *A. tenuis* of the *Flora Oxoniensis*. There are two specimens on the sheet: the one to the right is awned, but is without doubt *A. tenuis*; the other specimen being unawned, and therefore agreeing better with this description may be taken as representative of *A. tenuis* Sibth.

Distribution.—Throughout Europe, Northern Asia and N. America. Introduced into New Zealand, Australia, and Tasmania. Throughout the British Isles; Channel Isles.

Flowering period.—From late June to August; maximum early in July.

Var. HISPIDA (*Willd.*) *Philipson*, comb. nov.

Plants of diverse habit and stature. Densely or loosely caespitose, with or without stolons, which may be short or long and trailing. *Leaves* usually flat and lax, sometimes rolled and rigid. *Panicle* diffuse. *Lemma* 3-nerved, unawned or 5-nerved and awned. Heaths, moorland, and pastures, especially in hilly districts and on dry soil.

Type.—Willdenow's specimen is in the Herbarium of the Botanical Museum, Berlin.

Synonymy.—'*A. capillaris*' With. Bot. Arr. ed. 2, 1, p. 73 (1787) *. *A. tenuis*

* *A. capillaris* Linn. (Sp. Pl. ed. 1, p. 62; 1753) is of uncertain application. Of the diagnosis the words 'capillari, patente' are original, 'flosculis muticis' are taken from Linnaeus's *Flora Succica* (p. 23; 1745), and the remainder is copied from Royen's *Flora*

Sibth. Fl. Oxon. p. 36 (1794). *A. vulgaris* With. Bot. Arr. ed. 3, II, p. 132 (1796). *A. hispida* Willd. Sp. Pl. I, p. 370 (1798). *Decandolia vulgaris* (With.) Bast. Fl. Maine et Loire, p. 28 (1809). *Agrostris vulgaris* var. *hispida* (Willd.) Gaudin, Fl. Helv. I, p. 191 (1828); Schur in Oestr. Bot. Zeitschr. IX, p. 46 (1859). *Vilfa vulgaris* (With.) S. F. Gray, Brit. Pl. II, p. 146 (1821). *Agrostis vulgaris* var. *mutica* Sinclair, Hort. Gram. Wob. ed. 2, p. 269 (1824). *A. vulgaris* var. *plena* Meyer, Fl. Kön. Hanov. III, sig. 22* (1842). *A. vulgaris* var. *genuina* Schur in op. cit. p. 45 (1859). *A. alba* var. *vulgaris* (With.) Plues, Brit. Grass. p. 151 (1867); Thurb. ex S. Wats. Bot. Calif. II, p. 272 (1880). *A. polymorpha* var. *brevi-ligulata* Neilr. Fl. Wein, ed. 2, I, p. 26 (1868). *A. stolonifera* var. *vulgaris* (With.) Čelak. Fl. Böhm. IV, p. 710 (1881). '*A. stolonifera* Linn.' Farw. in Mich. Acad. Rep. for 1919, p. 350 (1920). *A. stolonifera* var. *hispida* (Willd.) Farw. in op. cit. p. 351 (1920). *A. alba* var. *tenuis* (Sibth.) Fiori, Fl. Anal. d'Ital. I, p. 97 (1923).

Figures.—Sowerby & Smith, Eng. Bot. XXIV, pl. 1671 (1807): Host, Gram. Aust. IV, pl. 59 (1809); Sinclair, Hort. Gram. Wob. facing p. 269 (1824): Parnell, Grass. Scot. pl. 12 (1842).

Representative specimens.—**K.** CHANNEL ISLES: Sark, *Ballard* 421. SURREY: Oxshott Heath, *Philipson* 119; Box Hill, *Philipson* 123; Richmond Park, *Philipson* 115. HERTFORDSHIRE: Hadley Wood, *Hubbard* G 56. NORFOLK:

Leydenensis (p. 59; 1740). After the habitat is appended a further, original, descriptive sentence: 'Panicula vere capillaris, tenuissimisque pedicellis singularis'. The diagnosis is evidently based on that of Royen, although emended and extended; the reference to Dalibard is of little importance, as his diagnosis is taken direct from the *Flora Succica* of Linnaeus. Royen's diagnosis, with the words 'panicula compressa', is not applicable to *A. tenuis* Sibth., and his reference to Scheuchzer (Agrost. p. 129; 1719) is to a grass with a long, rather pointed ligule. Of the other authors cited by Royen, the description of Bauhin (Theatri Bot.; 1658) is unidentifiable, that of Monti (Gram. p. 52; 1719) is based on Petiver (Conc. Gram. p. 120; 1716), as is that of Ray (Syn. p. 402; 1724), and these probably refer to *A. tenuis* Sibth. It seems certain that Linnaeus has taken Royen's diagnosis and, after emending it, applied it to another grass. The identification of this grass is uncertain, but it is most probably *A. tenuis* Sibth. There are two specimens in the Linnaean Herbarium written up as *Agrostis capillaris* by Linnaeus. The number of *A. capillaris* is underlined in his own copy of the *Species Plantarum* (ed. 1), which implies that a specimen was in the herbarium about 1753, and perhaps earlier. One specimen is *A. delicatula* Pourr., a plant of southern Spain. The other sheet was sent to Linnaeus by Seguier with a reference to his book—*Plantae Veronenses, Supplementum*—which was published in 1754. This specimen is *A. stolonifera* Linn. If there was a specimen named *A. capillaris* in the herbarium when the *Species Plantarum* was written it must have been the Spanish plant, which Linnaeus had confused with the Lapland plant. The name *A. capillaris* cannot be used for *A. delicatula* Pourr., and the confusion has been increased by the application of the name *A. capillaris* to four other distinct Spanish species. Nor can it be used for *A. tenuis* Sibth., as it is impossible to be certain that this was the plant Linnaeus had in mind, and because his diagnosis is largely taken from another author who was describing a different species. *A. capillaris* Huds. (1762) and *A. polymorpha* var. *capillaris* Huds. (1778) are identifications of a British plant with that of Linnaeus, and no original description is given.

Appleton, *Hubbard*, 9288. YORKSHIRE : Richmond, *Philipson* 105. WESTMORLAND : Patterdale, *Philipson*, 107. NORTHUMBERLAND : Wolsington, *Philipson* 111. **B.** MIDDLESEX : Finchley Road, *Thiselton Dyer*. N. STAFFORDSHIRE : between Trentham and Clayton, *Rendle*. CAERNARVON : Bardsey, *Butler*. W. YORKSHIRE : Ilkley, *Middleton* **W.** GLAMORGAN : Caerphilly, *Wade*. CARDIGAN : Devil's Bridge, *Wade*. CARMARTHEN : Llandovery, *Jones*. **E.** MIDLOTHIAN : Queensferry, *Greville*. **D.** DORSET : Studland Bay, *Palmer*. NORTHUMBERLAND : Otterburn, *Fox*. **C.** DERBYSHIRE : Matlock, *Spencer*. KENT : High Barns, *Miller*. HEREFORDSHIRE : Hitchin, *Little*. 760 sheets have been examined.

Distribution.—Throughout the British Isles.

Minor variations.

1. The lemma in some or all the spikelets 5-nerved, and the median nerve excurrent near the middle as a dorsal awn of variable length. Probably co-extensive in distribution with the unawned form.—*A. canina* With.* Bot. Arr. ed. 3, II, p. 126 (1796) : Sinclair, Hort. Gram. Wob. fol. 146 (1816) : S. F. Gray, Brit. Pl. II, p. 147 (1821). *A. vulgaris* var. *β*, Smith, Fl. Brit. I, p. 80 (1800). '*A. dubia* Leers', Lam. & DC. † Fl. Fr. III, p. 21 (1805). *A. laxa* S. F. Grey, Brit. Pl. II, p. 147 (1821). *A. vulgaris* var. *canina* Sinclair, Hort. Gram. Wob. p. 271 (1824). *A. vulgaris* var. *aristata* Hook. Brit. Fl. p. 34 (1830) : Hartm. Skand. Fl. ed. 2, p. 19 (1832) : Parnell, Grass. Scot. p. 34 (1862). *A. vulgaris* var. *vinealis* ‡ Schur, Enum. Plant. Transsilv. p. 734 (1866). *A. tenuis* var. *aristata* (Parn.) Druce, Brit. Pl. List, p. 79 (1908). *A. vulgaris* var. *dubia* (DC.) Rouy, Fl. Fr. XIV, p. 64 (1931). *A. capillaris* var. *aristata* (Parn.) Druce, Fl. Oxford., ed. 2, p. 474 (1927). *A. capillaris* var. *dubia* (DC.) Druce in Bot. Exchange Club Rep. for 1928, p. 765 (1929).

Representative specimens.—**K.** MIDDLESEX : Teddington, *Sandwith* and *Milne-Redhead* 38. SURREY : Kew, *Turrill* ; Richmond Park, *Hubbard*. WESTMORLAND : Grasmere : *Philipson* 142. **B.** SURREY : Field between Long Ditton and Claygate, *Britton* 744.

2. Culm long and trailing ; leaves flat, broad. Panicle large, pyramidal, branches often rough. Glumes pale green. In damp humus, under shade. When grown in the open it becomes identical with the normal form.—*A. umbrosa* Schur in Oestr. Bot. Zeitschr. IX, p. 47 (1859). *A. vulgaris* var. *umbrosa* Schur, loc. cit. (1859). *A. vulgaris* var. *umbracola* Schur, Enum. Plant. Transsilv. p. 734 (1866).

Representative specimen.—**K.** SURREY : Box Hill, *Philipson* 149, 150.

* Withering cites *A. canina* Leers, which agrees in every respect with *A. canina* Linn. Smith and Sinclair, however, both interpret Withering's plant as *A. vulgaris* With., and certain parts of the description support this view.

† The figure given by Leers for *A. dubia* agrees best with *A. canina* without awns. *A. compressa* Willd. and *A. signata* var. *aristata* Schur are both based on *A. dubia* Leers.

‡ This plant is based on *A. vinealis* Schreb., but the description refers to *A. tenuis* Sibth. without awns.

3. Leaves lax and narrow, sometimes rolled, pale green. Culms fine. Panicle with few spikelets. In dry soil under shade. When grown in the open it becomes identical with the normal form.—'*A. stolonifera* Linn.' Leers, Fl. Herb. p. 20 (1789). *A. tenella* Hoffm.* Deutschl. Fl. I, p. 36 (1800). *A. vulgaris* var. *tenella* (Hoffm.) Gaudin, Agrost. Helv. p. 84 (1811). *A. vulgaris* var. *parviflora* Schur, Enum. Plant. Transsilv. p. 734 (1866).

Representative specimens.—**K.** SURREY : Richmond Park, *Hubbard* and *Summerhayes* ; Box Hill, *Philipson* 146–7. **B.** MIDLOTHIAN : Hawthornden, *Shuttleworth*.

4. Spikelets over 3 mm. in length. Moorland in Ireland, Scotland, and the north of England.

Representative specimens.—**D.** CUMBERLAND : Skinburness, *Fox*. ABERDEENSHIRE : Callater, *Druce*. W. INVERNESS : Aonach Mhor, *Druce*. KERRY : Brandon Mts., *Druce* as var. *grandiflora*.

Diseased states.

1. Infection with *Anguillina agrostis* (Steinbuch) Goodey. The outstanding effects of the nematode are the unequal elongation of the glumes, the elongation of the lemma and an increase in the number of its nerves, and the development of the ovary into a spindle-shaped, purple gall.—*A. vulgaris* var. *sylvatica* (Huds.) With.† Bot. Arr. ed. 3, II, p. 133 (1796) ; Gaud. Fl. Helv. I, p. 192 (1828). *A. vulgaris* var. δ Smith, Fl. Brit. ed. 1, I, p. 80 (1800). *A. vulgaris* var. *vivipara* Reichb. Ic. Agrost. Germ. I, p. 12 (1834).

Representative specimens.—**K.** CORNWALL : St. Agnes Beacon, *Borlase*. SURREY : Chobham Heath, *Clarke*. **B.** ESSEX : Walthamstow, *Forster*. No localities : ex Herb. *Banks* and *Pulteney*.

2. Infection with *Tilletia decipiens* (Pers.) Körn. The chief symptoms are the dwarf caespitose habit with numerous culms, the panicle usually compact, with undulating branches, and the glumes often shorter and broader than in healthy specimens. Throughout Britain on poor soils.—*A. pumila* Linn. Mant. p. 31 (1767) ; Lightf. Fl. Scot. II, p. 1081 (1777). *A. polymorpha* var. *pumila* (Linn.) Huds. Fl. Angl. ed. 2, I, p. 31 (1778) ; Neilr. Fl. Wein, ed. 2, I, p. 26 (1866). *A. vulgaris* var. γ Smith, Fl. Brit. I, p. 80 (1800). *Decandolia pumila* (Linn.) Bast. Fl. Maine et Loire, p. 28 (1809). *Agrostis vulgaris* var. *pumila* (Linn.) Gaudin, Agrost. Helv. p. 85 (1811). *Vilfa divaricata* var. *pumila* (Linn.) S. F. Gray, Brit. Pl. II, p. 147 (1821). *Agrostis laxa* var. *pumila* (Linn.) S. F. Gray, op. cit. p. 148 (1821). *A. alba* var. *pumila* (Linn.) Plues, Brit. Grass. p. 150 (1867). *A. tenuis* var. *pumila* (Linn.) Druce, Brit. Pl. List, p. 79 (1908). *A. capillaris* var. *pumila* (Linn.) Druce in Bot. Exchange Club Rep. for 1927, p. 423 (1928).

* Based on *A. stolonifera* Leers.

† The specific name *A. sylvatica* was applied by Hudson to a diseased state of *A. stolonifera* ; when the disease was found in *A. tenuis* Sibth. the name was applied to it, or it was reduced to varietal rank.

Representative specimens.—**K.** Sussex : Amberley, *Salmon*. Middlesex : between Twickenham and Hounslow, *Lambert*. **B.** Somerset : Blackdown, *Thompson*. Hereford : Moccas Hills, *Ridley*. W. Mayo : Mallaranny, *Marshall*.

Var. humilis (*Aschers. & Graebn.*) *Druce*, Brit. Pl. List. p. 79 (1908).

Plants low, forming a loose turf, usually with extensive underground rhizomes, which may frequently branch ; stolons absent. Culms usually not over 15 cm. high. Ligule of sterile shoots very short. All the leaves usually stiff and closely rolled, often deeply tinged with purple. Panicle usually narrow and spike-like, sometimes more diffuse. Lemma frequently 5-nerved, a dorsal awn sometimes present. On sand, inland and by the sea, and stony ground.

Type.—No type was indicated by Ascherson and Graebner.

Synonymy.—*A. vulgaris* var. *humilis* Aschers. & Graebn. Syn. II, p. 181 (1899). *A. vulgaris* var. *curvata* Hack. ex Linton, Fl. Bournemouth, p. 249 (1900) ; name only.

Representative specimens.—**K.** S. Hampshire : Bournemouth, *Clark* CC 129. Bedfordshire : Hatchend, *Valentine*. Shropshire : Ragleth, *Bentham*. Yorkshire : Kingsdale, *Milne-Redhead* and *Shaw*. **W.** S. Hampshire : Mudeford, *Stuart*. **E.** Orkney : Black Holm, *Johnston* 4772. **D.** Channel Isles : Jersey, *Druce*. **C.** Hampshire : Christchurch Bay, *Gray*. 14 sheets have been examined.

Distribution. Incompletely known ; probably throughout the British Isles in suitable localities.

4. Agrostis gigantea *Roth*, Fl. Germ. I, p. 31 (1788).

Diagnosis.—Palea $\frac{1}{2}$ *length of lemma or longer* ; lemma 3- *or 5-nerved, rarely awned* ; glumes *usually smooth* ; panicle *remaining open in fruit* ; radical leaf *with its blade broadest above the base, and its ligule longer than broad, rounded* ; *spreading by rhizomes, sometimes also with overground stolons.* Anthers 1–1·5 mm.

Description.—A perennial forming an open tuft with erect shoots or trailing with decumbent shoots, spreading underground by numerous rhizomes. *Culms* usually 4–8 dm., but up to 12 dm. long, erect or geniculate, often procumbent and branching at the lower nodes, green or tinged with purple below the panicle, smooth, with 5–6 brown or purple nodes. *Sterile shoots* not compactly tufted, the intravaginal rarely becoming elongated as stolons, the extravaginal spreading as long, often much-branched underground rhizomes, with obtuse straw-coloured or dark brown scale-leaves which split at the apex. *Leaf-sheaths* split to near the base, terete, striate, smooth or rough, close fitting, green or frequently tinged with purple, the sheaths of the lower nodes of the culm longer than the internodes, of the upper usually shorter. *Ligule* of the sterile shoots 1·5 mm. or usually longer, of the culm-leaves longer, rounded, membranaceous. *Blade* up to 15 cm. long, and 8 mm. broad, broadest above the base, rolled in the bud, usually grey-green or green, often very rough on both surfaces, strongly furrowed above, flat. *Panicle* up to 25 cm. long, erect, pyramidal or cylindrical, spreading, the spikelets of adjacent verticils distinct ; in fruiting the main branches remain spreading and the branchlets close against them ; rhachis straight, its upper internodes rough, reddish purple or green, first or second internode the longest, up to 6 cm. long ; branches semi-verticillate, up to 12 cm. long, triangular, rough or rarely smooth, the main branches dividing at $\frac{1}{3}$ to $\frac{1}{2}$ their length, striate ; branchlets usually in unequal pairs, rough ; pedicels rough. *Spikelets* lanceolate. *Glumes* 2–3 mm. long, the lower slightly the longer, lanceolate, with acute apices, green or, more usually, purple, colourless at the apex and margins, the keel of the lower glume toothed on the upper half at least, of the upper glume less strongly toothed ; the hairs of the callus short. *Lemma* $\frac{2}{3}$ the length of the glumes, broadly ovate when flattened, truncate, with a slight scabridity towards the base, 3- or 5-nerved, the two marginal nerves shortly excurrent, usually with a minute lobe between each and the mid-nerve, into which the inner lateral nerves run when present, the mid-nerve usually ending blindly beneath the apex, or excurrent as a short mucro or occasionally as a long bent awn. *Palea* $\frac{1}{2}$–$\frac{2}{3}$ the length of the lemma, bifid, faintly 2-nerved. *Lodicules* about 0·4 mm. long. *Anthers* 1·0–1·5 mm., frequently tinged with purple. *Ovary* ovoid, about 0·5 mm. long. *Caryopsis* about 1·1×0·38 mm.

Type.—Roth's specimen is in the Herbarium of the Botanical Museum, Berlin.

Distribution.—Europe (except the north), central and southern Russia, China, Japan, North America ; introduced into Australia and New Zealand. Throughout the British Isles from the Channel Isles to the Orkneys.

Flowering period.—From late June until August. Maximum in mid-July.

Var. ramosa (*Gray*) *Philipson*, comb. nov.

Plants with culms procumbent and branching below. The sterile shoots often extensively trailing as stolons. Panicle usually much branched, with very numerous spikelets. Woods and banks in damp loam, often in damp or shaded arable land.

Type.—No specimens have been preserved.

Synonymy.—*A. gigantea* Roth, Fl. Germ. I, p. 31 (1788) : Gaudin, Agrost. Helv. p. 81 (1811). '*A. alba* Linn.' * With. vars. 2, 3, and 4, Bot. Arr. ed. 3,

* *A. alba* Linn. Sp. Pl. ed. 1, I, p. 63 (1753) is based on 'Agrostis panicula laxa, calycibus membranaceis muticis aequalibus' of Royen (Lugdb. p. 59 ; 1740), who cites 'Gramen nemorosum, paniculis albis' of Vaillant (Bot. Paris (1727), pl. 17, fig. 5). This figure is undoubtedly of *Poa nemoralis* Linn. Later authors have applied the name to species of *Agrostis*, but as the distinction between *A. stolonifera* Linn. and *A. gigantea* Roth, has not always been upheld, and as the descriptions are usually very incomplete, it is not always possible to determine to what plant it has been applied. Many of the synonyms cited here under *A. gigantea* include part of *A. stolonifera*.

II, p. 130 (1796); Sinclair, Hort. Gram. Wob. p. 342 (1824). *A. varia* Host ex Bess. Fl. Gal. Austr. I, p. 68 (1809). *A. sylvatica* Host ex Bess. loc. cit. (1809), non Huds. *A. diffusa* Host ex Bess. loc. cit. (1809). *A. decumbens* Host, Gram. Austr. IV, p. 31 (1809). '*A. stolonifera* Linn.' Host, op. cit. p. 32 (1809). *Vilfa gigantea* (Roth) Beauv. Agrost. p. 181 (1812). *V. alba* S. F. Gray, Brit. Pl. II, p. 145 (1821), with the varieties *conferta*, *ramosa*, and *nuda*. *Agrostis alba* var. *major* Gaud. Fl. Helv. I, p. 189 (1828) *. *A. alba* var. *gigantea* (Roth) Meyer, Chlor. Hanov. p. 655 (1836). '*A. alba* var. *stolonifera* Smith', Meyer, loc. cit. (1836) †. *A. vulgaris* var. *gigantea* (Roth) Meyer, loc. cit. (1836), in synon. *A. stolonifera* var. *gigantea* (Roth) Koch, Syn. Fl. Germ. ed. 1, p. 781 (1837). *A. alba* var. *vulgaris* Meyer, Fl. König. Hanov. III, sig. 22 (1842). *A. alba* var. *genuina* Godr. Fl. Lorraine, ed. 1, III, p. 138 (1844). *A. vulgaris* var. *stolonifera* Buckman ‡, Brit. Grass. p. 38 (1858). *A. vulgaris* var. *sylvatica* (Host) Schur in Oestr. Bot. Zeitschr. IX, p. 46 (1859). *A. flavida* Schur, loc. cit. (1859). *A. signata* var. *flavida* Schur, loc. cit. (1859). *A. signata* var. *gigantea* (Gaud.) Schur, op. cit. p. 48 (1859). *A. signata* var. *varia* (Host) Schur, op. cit. p. 48 (1859). *A. signata* var. *decumbens* (Host) Schur, op. cit. p. 48 (1859). *A. polymorpha* var. *diffusa* (Host) Neilr. Fl. Wein, ed. 2, I, p. 27 (1868). *A. alba* var. *alba* Thurb.§ ex S. Watson, Bot. Calif. II, p. 271 (1880). *A. alba* var. *compressa* Aschers. & Graebn. ‖ Syn. Mittel-europ. Fl. II, p. 173 (1899). *A. alba* var. *flavida* (Schur) Aschers. & Graebn. op. cit. p. 174 (1899). *A. alba* var. *diffusa* (Host) Aschers. & Graebn. op. cit. p. 174 (1899). *A. alba* var. *sylvatica* (Host) Aschers. & Graebn. op. cit. p. 174 (1899). *A. alba* var. *Hostiana* Rouy, Fl. Fr. XIV, p. 61 (1913). *A. stolonifera* var. *major* (Gaud.) Farw. in Mich. Acad. Sci. Rep. XXII, p. 351 (1919).

Figures.—Host, Ic. Gram. Austr. iv (1809), pls. 54–58 : Sinclair, Hort. Gram. Wob. (1824), facing p. 342 : Meyer, Fl. König. Hanov. III (1842), pl. 8.

Representative specimens.—**K.** SURREY : Box Hill, *Philipson* 210 ; Mortlake, *Sprague* ; between Byfleet and Pyrford, *Gilmour*, *Turrill*, and *Williams* ; Oxshott, *Philipson* 231. HERTFORDSHIRE : Hadley Wood, *Hubbard* G 57. **B.** HAMPSHIRE : Highfield, Southampton, *Rayner*. SURREY : Richmond, Manor Road, *Jackson*. GLOUCESTER : Bristol, *Thompson*. **E.** ORKNEY : Sanday, *Johnston* 3304 C. **D.** ESSEX : Dovercourt, *Sherrin*. HEREFORDSHIRE : Hildersley, *Pearson*. KINCARDINE : Maryculter, *Boswell*. 35 sheets have been examined.

Distribution.—This grass has not been clearly distinguished from *A. stolonifera* Linn. by British botanists so that very little is known of its distribution.

* Gaudin cites *A. gigantea* Gaud. in synonymy with this name, stating that *A. gigantea* Roth, differs in the more spreading panicle and the more frequently awned spikelets.

† The figure shows Meyer to have applied this name, in error, to *A. gigantea*.

‡ Called Black Quitch, and described as having rhizomes, but probably includes *A. stolonifera* var. *stolonifera*.

§ Includes *A. stolonifera*.

‖ The description does not agree with the citation of *A. compressa* Willd.

It was evidently abundant in the time of Withering, and is probably present in all the lowland districts of the British Isles.

Var. DISPAR (*Michx.*) *Philipson*, comb. nov.

Plants with culms erect or geniculate. The sterile shoots erect or shortly procumbent as stolons. Panicle variable, but frequently with few branches, bearing rather scattered spikelets. On waste land and as a weed in arable land.

Type.—The specimen of Michaux is in the Herbarium of the Muséum National d'Histoire Naturelle, Paris.

Synonymy.—*A. repens* Curtis, Obs. Brit. Grass. ed. 2, p. 35 (1790) ; Sinclair, Hort. Gram. Wob. folio 230 (1816). *A. nigra* With.* Bot. Arr. ed. 3, II, p. 131 (1796). *A. dispar* Michx. Fl. Bor.-Amer. I, p. 52 (1803). *A. seminuda* Knapp †, Gram. Brit. p. 115 (1804). *Vilfa dispar* (Michx.) Beauv. Agrost. p. 181 (1812). *V. nigra* (With.) S. F. Gray, Brit. Pl. II, p. 145 (1821). *V. divaricata* (Hoffm.) S. F. Gray, loc. cit. (1821). *Agrostis vulgaris* var. *seminuda* Knapp ex S. F. Gray, op. cit. p. 147 (1821), in synon. *A. alba* var. *dispar* (Michx.) A. Wood, Class-book Bot. U.S. & Canada, p. 774 (1861). *A. vulgaris* var. *nigra* (With.) Druce, Fl. Berks. p. 562 (1897). *A. tenuis* var. *nigra* (With.) Druce, Brit. Plant List, p. 79 (1908). *A. capillaris* var. *nigra* (With.) Druce, Comital Fl. Brit. p. 350 (1932). '*A. alba* Linn.' Hitchcock, Manual Grass. U.S. p. 331 (1935).

Figures.—Dodonaeus, Stirp. Hist. Pempt. (1583) p. 548 ; Knapp, Gram. Brit. (1804), pl. 115 ; Bagnall in Journ. Bot. XX, (1882), pl. 227 ; Malte in Rep. Nat. Mus. Canada for 1926 (1928), fig. 1 ; Hitchcock, Manual Grass. U.S. (1935), fig. 665.

Representative specimens.—**K.** HAMPSHIRE : Sherfield English, *Goddard*. ESSEX : Dagenham Dock, *Melville*. CAMBRIDGESHIRE : Quy, *Philipson* 215 ; Chesterton, *Philipson* 218, 226. OXFORDSHIRE : between Woodstock and Shipton, *Montford*, *Summerhayes*, and *Turrill* 2248. WORCESTERSHIRE : Malvern Wells, *Towndrow*. CARDIGAN : Aberystwyth, *Hubbard* 1762. DURHAM : Bishop Auckland, *Clouston* 346. FIFE : Balmuto, *Boswell*. **B.** SURREY : Dorking, *Groves*. WARWICKSHIRE : Berkswell, *Bagnall*. HEREFORDSHIRE : Wellington College, *Sutton*. CHESHIRE : Heatley, *Holt*. **W.** GLAMORGAN : Cardiff, *Vachell*. LANCASHIRE : Abbeystead, *Wheldon*. **E.** WORCESTERSHIRE : Newland, *Bickham*. **D.** OXFORDSHIRE : Dorchester, *Druce* ; waste ground, no locality, *Druce* in 1909. GLAMORGAN : Port Talbot,

* The references to Scheuchzer and Leers are in error. This species is probably based on a specimen in the British Museum collected by Stokes (who had collaborated in the second edition) in 1791, i.e. before the publication of the third edition. The label bears the following note :—' This summer (1791) I discovered that there are two kinds of couch grass (called squitch or scutch etc.). These are *Triticum repens* as mentioned in English botanical works, and *Agrostis capillaris* ' (erased in different ink to *vulgaris*). 'The *Agrostis capillaris*' (also erased) 'is the couch grass of ploughed fields, which gives the farmer so much trouble to extirpate. Johnathan Stokes.'

† The description and figure agree with *A. nigra*, but a specimen apparently sent by Knapp to H. Davies, now in the British Museum, is of *A. tenuis* With.

Druce. WARWICKSHIRE : Kenilworth, *Bagnall.* STAFFORDSHIRE : Alstonfield, *Pearson.* C. CHANNEL ISLES : Guernsey, *Marquand.* WARWICKSHIRE : Berkswell, *Bagnall.* 112 sheets have been examined.

Distribution.—Throughout England, but not completely known. Recorded from Monmouth, Glamorgan, Caernarvon, Denbigh, and Anglesey in Wales, and from Midlothian, Fife, Perth, Forfar, and Inverness in Scotland.

5. AGROSTIS STOLONIFERA *Linn.* Sp. Pl. ed. 1, I, p. 62 (1753).

Diagnosis.—Palea ½ *the length of the lemma or longer* ; lemma 5-*nerved, rarely awned* ; glumes *smooth or slightly rough* ; panicle *closing in fruit* ; radical leaf *with its blade broadest above the base, or linear, and its ligule rounded* ; *usually spreading by overground stolons, rhizomes absent.* Anthers 1–1·5 mm. long.

Description.—A perennial of very variable stature. Tall or low trailing plants or forming a compact turf, spreading by overground stolons. Culms from 1–14 dm. long, geniculate-erect, or frequently procumbent and branching and rooting at the lower nodes, green or tinged with purple, smooth, with 4–5 nodes. *Sterile shoots* numerous and tufted or very few, the intravaginal frequently becoming elongated as often very widely creeping stolons, the extravaginal at once ascending, with only 2–3 scale-leaves at their base. *Leaf-sheaths* split to near the base, terete, striate, smooth or slightly rough, rather loose-fitting, green or frequently tinged with purple, the sheaths of the lower nodes of the culm longer than the internodes, of the upper about equal in length. *Ligule* of the sterile shoots 1 mm. on very small leaves, or usually longer, of the culm-leaves longer, rounded, membranaceous. *Blade* from 0·8–20 cm. long and 0·5–8 mm. broad, usually broadest above the base, rolled in the bud, pale to dark green, glaucous or purple, rough on both surfaces, furrowed above, lax or sometimes rigid, flat or rolled. *Panicle* 1–30 cm. long, erect, pyramidal or cylindrical, the branches spreading horizontally during flowering, the spikelets of adjacent verticils distinct, in fruiting the branches of all or all but the lowest verticils raised against the rhachis, with the branchlets closed against them ; rhachis straight, rough or smooth, green or purple, first or second internode longest, up to 5 cm. long ; branches semi-verticillate, up to 11 cm. long, triangular, rough or smooth, the main branches dividing at ⅓–½ their length, straight, usually several short branches in each verticil, branchlets usually in unequal pairs, rough or smooth ; pedicels rough or rarely smooth. *Spikelets* lanceolate. *Glumes* 1·75–3 mm. long, the lower slightly the longer, broadly or narrowly lanceolate, with acute apices, green or more usually tinged with purple, frequently colourless at the apex and margins, smooth or minutely rough, the keel of the lower glume toothed on the upper half at least, of the upper glume less strongly toothed, the hairs of the callus short. *Lemma* about ⅔ the length of the glumes, broadly ovate when flattened, truncate, with a slight scabridity towards the base, 5-nerved, the marginal nerves uusally shortly excurrent, and a minute lobe usually opposite each

inner lateral nerve, the mid-nerve usually ending blindly beneath the apex or excurrent as a short mucro or occasionally as a long bent awn. *Palea* ½–⅔ the length of the lemma, bifid, faintly 2-nerved. *Lodicules* up to 0·5 mm. long. *Anthers* 1–1·5 mm. long, sometimes tinged with purple. *Ovary* ovoid, about 0·4 mm. long. *Caryopsis* about 1·0 by 0·4 mm.

Type.—There are two specimens written up as *A. stolonifera* in the Linnaean Herbarium ; and since the number of *A. stolonifera* is underlined in Linnaeus's own copy of the *Species Plantarum*, he probably had a specimen of this plant at the time of publication. One specimen having a reference to Allioni's *Flora Pedemontana* (1785) cannot have been written up until after the publication of the *Species Plantarum*. It was, therefore, probably the other specimen which he had in 1753. This specimen is referable to *A. semiverticillata* Christens. It does not agree with Linnaeus's definition of *A. stolonifera*, and cannot be accepted as the type. There is apparently no type-specimen of this species in existence, and the species is here interpreted from the synonyms cited by Linnaeus *, all of which refer to a plant agreeing with his definition.

Distribution.—Throughout Europe, central Asia, reaching Siberia, Japan, and North America. Introduced into New Zealand, Australia, the Cape, and the Falklands. Throughout the British Isles, especially in lowlying districts ; Channel Islands.

Flowering period.—From July until August. Maximum in mid-July.

Var. STOLONIFERA (*Linn.*) *Koch*, Fl. Germ. et Helv. ed. 1, p. 781 (1837).

Innovations numerous, forming a tuft at the centre of the plant, and frequently a close turf. Leaves close together on the stolens, with short blades (0·8–8 cm.). Culms usually several on a plant, low (1–2·5 dm. above the ground). Panicle short (1–10 cm.), usually dense, pyramidal or cylindrical, frequently lobed.

Type.—The variety was based on the Linnaean species.

Synonymy.—*A. stolonifera* Linn. Sp. Pl. ed. 1, I, p. 62 (1753) : Huds. Fl. Angl. ed. 1, p. 27 (1762) : With. Bot. Arr. ed. 1, I, p. 42 (1776) : Knapp, Gram. Brit. p. 116 (1804) : S. F. Gray, Brit. Pl. II, p. 145 (1821) †. *A. polymorpha* var. *stolonifera* (Linn.) Huds. op. cit. ed. 2, I, p. 31 (1778). *Decandolia stolonifera* (Linn.) Bast. Fl. Maine et Loire, p. 29 (1809). *Agrostis alba* var. *stolonifera* (Linn.) Smith, Eng. Fl. I, p. 93 (1824) : Meyer, Chlor. Hanov. p. 655 (1836). *A. vulgaris* var. *stolonifera* (Linn.) Meyer, op. cit. p. 157 (1836) : Koch, Fl.

* There are three citations. The first, up to the word ' *ventricosa* ', is taken from Linnaeus's *Flora Suecica*, p. 23 (1745), sp. 61 ; the remainder, i.e. ' *flosculis muticis.* Roy. lugdb. 59. Fl. Suec. 62 ', has been copied in error from sp. 62, and should read ' Fl. Suec. 61 '. The definition in the *Flora Suecica* is a modification of that of Royen in *Flora Leydenensis*, p. 59 (1740), sp. 2, to which the second citation of the *Species Plantarum* refers. The third citation is to Scheuchzer, whose description is good, and who refers to a figure originally given by Lobel (1581).

† *A. pubescens* Gray, op. cit. p. 148 (1821), is perhaps a variation of *A. stolonifera* with rough glumes, but the description is not sufficiently complete to diagnose the plant.

Germ. et Helv. ed. 1, p. 782 (1837). *A. stolonifera* var. *prorepens* Koch, op. cit. ed. 2, p. 902 (1844). *A. signata* var. *genuina* Schur in Oestr. Bot. Zeitschr. IX, p. 46 (1859). *A. signata* var. *prorepens* Schur, loc. cit. (1859). *A. vulgaris* var. *repens* Schur, loc. cit. (1859). *A. vulgaris* var. *prorepens* Schur, Enum. Plant. Transsilv. p. 734 (1866), in synon. *A. alba* var. *prorepens* (Koch) Aschers. & Graebn. Syn. Mittel-europ. Fl. II, p. 175 (1899).

Figures.—Lobel, Kruydtboeck (1581), p. 21 : Knapp, Gram. Brit. (1804), pls. 27 and 116 (1824) : Sinclair, Hort. Gram. Wob. facing p. 346 : Reichb. Agrost. Germ. I (1834), figs. 1431 and 1436 : Lowe, Brit. Grass. (1858), pl. 17 B : Jansen & Wachter in Nederl. Kruid. Archiv. (1933), pp. 149 & 152.

Representative specimens.—See under each ecad. 730 sheets have been examined.

Distribution.—Throughout the British Isles.

Ecas 1. STOLONIFERA (*Linn.*) *Philipson*, comb. nov.

Leaves about 3–4 mm. broad, flat, usually pale green, sheaths often a reddish purple. Stolons usually numerous and widely creeping. Culms becoming erect. Panicle usually dense and lobed. Growing as isolated plants as a weed in farmland, and waste places, frequent on sea-cliffs.

Type.—The ecas is based on the Linnaean species.

Synonymy.—*A. coarctata* Ehrh. ex Hoffm. Deutschl. Fl. ed. 2, I, p. 37 (1800), *A. brevis* Knapp *, Gram. Brit. p. 116 (1804). *Decandolia stolonifera* var. *coarctata* (Ehrh.) Bast. Fl. Maine et Loire, p. 29 (1809). *Vilfa coarctata* (Ehrh.) Beauv. Agrost. p. 181 (1821). *V. stolonifera* var. *brevis* (Knapp), S. F. Gray. Brit. Pl. II, p. 146 (1821). *Agrostis stolonifera* var. *angustifolia* Sinclair, Hort. Gram. Wob. ed. 2, p. 346 (1824). *A. alba* var. *coarctata* (Ehrh.) Reichb. Agrost. Germ. I, p. 12 (1834). *A. signata* var. *coarctata* (Ehrh.) Schur in Oestr. Bot. Zeitschr. IX, p. 46 (1859). *A. stolonifera* var. *coarctata* (Ehrh.) Čelak. Fl. Böhm. IV, p. 710 (1881). *A. depressa* Vasey in Bull. Torrey Bot. Club, XIII, p. 54 (1886). *A. exarata* var. *stolonifera* Vasey, loc. cit. (1886). *A. alba* var. *condensata* Hack. ex Druce in Rep. Bot. Exchange Club for 1913, p. 343 (1914). *A. replans* Rydb. Fl. Rocky Mountains, p. 54 (1917).

Representative specimens.—**K.** GUERNSEY : Fermain Bay, *Dawson* H 2050. ISLE OF WIGHT : Blackgang, *Sprague*. SURREY : Headly, *Fraser* ; Ham, *Hubbard*. ESSEX : Dagenham, *Hubbard, Summerhayes*, and *Turrill*. CARDIGAN : Aberystwyth, *Philipson* 377, 378. SOMERSET : Berrow Church, *Summerhayes* G 62 A. YORKSHIRE : Richmond, *Philipson* 332. NORTHUMBERLAND : Tynemouth, *Philipson* 336, 338, 339. ORKNEY : Stromness, *Johnston* 3678. **B.** GLAMORGAN : Aberfam, *Riddelsdell*. SUFFOLK : Aldeburgh, *Druce*. ISLE OF MAN : Douglas Head, *Holt*. W. MEATH : Belvedere Lake, *Dyer*. **W.** ISLE OF WIGHT : Mersley Down, *Melville*. GLAMORGAN : Cardiff, *Wade*. **E.** BERWICKSHIRE : Berwick, *Maclagan*. ORKNEY : *Johnson* 2368 B. DUBLIN : Dublin, *Munro*. **D.** HAMPSHIRE : Warnborough, *Palmer* 1656. MIDDLESEX : Alperton, *Loydell*. ESSEX : Kirby-le-Soken, *Druce*. CARNARVON : Nevin, *Druce*. FIFE : Burntisland, *Templeman*. SHETLAND : Fitfull Head, *Druce* ; Lerwick, *Druce*. UNST : Balta, *Druce*. **C.** YORKSHIRE : Richmond, *Ward*.

* Includes forms of *A. gigantea* as it ' throws out suckers, as is observable in all the genus '.

Ecas 2. SALINA (*Jansen & Wachter*) *Philipson*, comb. nov.

Leaves narrow, flat, frequently glaucous. Stolons few and usually short. Culms becoming erect. Panicle usually not lobed, often rather lax. Forming a close turf in salt marshes.

Type.—In Herbarium Jansen and Wachter ; no. 1399.

Synonymy.—*Vilfa stolonifera* var. *marina* S. F. Gray, Brit. Pl. II, p. 146 (1821). *Agrostis glaucescens* Don ex Hook. Fl. Scot. p. 26 (1821). *A. stolonifera* subvar. *salina* Jans. & Wacht. in Nederl. Kruid. Archiv. XLIII, p. 154 (1933).

Representative specimens.—**K.** KENT : Gravesend, *Hubbard*. SUFFOLK : Benacre Broad, *Horwood*. CARDIGAN : Ynys-las, *Philipson* 345–350. INVERNESS : Beauley, *Gamble* 28998. **D.** DURHAM : Castle Eden, *Burdon*.

Ecas 3. ARENARIA (*Jansen & Wachter*) *Philipson*, comb. nov.

Leaves short, folded, sheaths usually purple. Stolons numerous and widely creeping. Culms usually much inclined. Panicle usually dense and lobed. Glumes broad and short. Growing as isolated plants in loose sand.

Type.—In Herbarium Jansen and Wachter ; no. 1715.

Synonymy.—*A. stolonifera* var. β Linn. Fl. Suec. ed. 2, p. 22 (1755). *A. maritima* Lam. Encycl. Méth. I, p. 61 (1783). *Milium maritimum* (Lam.) Clem. Ensayo de la Vid. p. 285 (1807). *Vilfa maritima* (Lam.) Beauv. Agrost. p. 181 (1812). *Agrostis straminea* Hartm. Skand. Fl. ed. 1, p. 45 (1820). *Vilfa stolonifera* var. *maritima* S. F. Gray, Brit. Pl. II, p. 146 (1821). *Agrostis lobata* Sinclair *, Hort. Gram. Wob. ed. 2, p. 273 (1824). *A. bryoides* Dumort. Florula Belg. p. 152 (1827). *A. alba* var. *minor* With. in With. Bot. Arr. ed. 7, II, p. 157 (1830). *A. stolonifera* var. *compacta* Hartm. Skand. Fl. ed. 2, p. 19 (1832). *A. alba* var. *maritima* (Lam.), Meyer, Chlor. Hanov. p. 655 (1836). *A. stolonifera* var. *maritima* (Lam.) Koch, Fl. Germ. et Helv. ed. 1, p. 781 (1837). *A. maritima* var. *Clementei* Willk. in Willk. & Lange, Fl. Hisp. I, p. 52 (1861). *A. maritima* var. *pseudopungens* Lange in Vidensk. Medd. Kjobenh. for 1860, p. 31 (1861). *A. alba* var. *subrepens* Bab. Brit. Pl. ed. 5, p. 396 (1862). *A. salina* Dumort. in Bull. Soc. Bot. Belg. VII, p. 366 (1868). *A. alba* var. *subjungens* Hack. in H. C. Wats. Bot. Exchange Club, p. 7 (1887). *A. alba* var. *salina* (Dumort.) Richter, Pl. Europ. I, p. 43 (1890). *A. alba* var. *Clementei* (Willk.) Aschers. & Graebn. Syn. Mittel-europ. Fl. II, p. 176 (1899). *A. alba* var. *pseudopungens* (Lange) Aschers. & Graebn. loc. cit. (1899). *A. stolonifera* subvar. *arenaria* Jans. & Wacht. in Nederl. Kruid. Archiv. XLIII, p. 154 (1933).

Representative specimens.—**K.** CARDIGAN : Borth, *Philipson* 374–7. IRELAND : Mayo, *Gamble*, 27812. **B.** DEVON : Braunton Burrows, *Lagan* ; Northam,

* Previously published invalidly by Curtis, Obs. Brit. Grass. ed. 4, p. 36 (1804).

Forster's herbarium. **W.** MERIONETH : Harlech, *Barton*. ARRAN : Kildonan, *Travis*. **E.** ARRAN : Machire Bay, *Summerville*. **D.** MERIONETH : Harlech, *Barton*. CAERNARVON : Abersoch, *Druce*. ANGLESEY : Aberffraw, *Druce*. Co. DOWN : Strangford Lough, *Waddell*. **C.** LANCASHIRE : Hightown, *Wheldon*. CUMBERLAND : Maryport, *Gisbourne*. FIFE : St. Davids, *McT. Cowan*.

Ecas 4. CALCICOLA *Philipson*, ecas nov. *

Leaves flat or folded, grey-green. Stolons numerous and short or absent, and the plant caespitose. Culms erect or geniculate. Panicle narrow and meagre. Forming a close turf on chalk downs.

Type.—In the Kew Herbarium ; Wiltshire : Winterbourne, *H. J. Goddard*.

Representative specimens.—**K.** HAMPSHIRE : Lobscombe Corner, *Goddard*. SURREY : Redham : *Philipson* 351, 352. KENT : Folkestone, *Gamble* 20250. WILTSHIRE : Winterbourne, *Goddard* ; Martin, *Goddard*. CAMBRIDGESHIRE : Gog-Magog Hills, *Philipson* 357–360 ; Quy, *Philipson* 361, 362. **C.** CAMBRIDGESHIRE : Gog-Magog Hills, *Linton*.

Minor variations.

1. The lemma shortly awned.—*A. stolonifera* var. *subaristata* Čelak. Fl. Böhm. IV, p. 710 (1881).

A specimen of *A. stolonifera* var. *stolonifera* ecas *arenaria* has shortly awned lemmas ; Cardigan : Borth, *Philipson* 366.

2. The whole plant pale yellowish green.

A single example seen ; Surrey : Merstham chalk-pits, *Fraser*.

Var. PALUSTRIS (*Huds.*) *Farw.* in Mich. Acad. Rep. for 1919, XXI, p. 351 (1920).

Innovations few, with no indication of a tuft at the centre of the plant. *Leaves* more distant on the stolons, with longer blade (6–20 cm.). *Culms* usually few on a plant, higher (2–5 dm. above the ground). *Panicle* longer (8–30 cm.), usually narrowly pyramidal.

Type.—Hudson's specimens have not been preserved.

Synonymy.—*A. palustris* Huds. Fl. Angl. ed. 1, p. 27 (1762) : Hitchcock, Manual Grass. U.S. p. 330 (1935). *A. polymorpha* var. *palustris* (Huds.) Huds. Fl. Angl. ed. 2, p. 129 (1778). *A. alba* var. 1 With. Bot. Arr. ed. 3. II, p. 129 (1796). *A. alba* Smith, Fl. Brit. ed. 1, I, p. 81 (1800). *A. mutabilis* Knapp, Gram. Brit. p. 28 (1804), non Sibth. *Decandolia alba* Bast. Fl. Maine et Loire, p. 29 (1809). *Apera palustris* (Huds.) S. F. Gray, Brit. Pl. II, p. 148 (1821). *Agrostis stolonifera* var. *latifolia* Sinclair, Hort. Gram. Wob. ed. 2, p. 225 (1824). *A. alba* var. *pallens* Gaudin, Fl. Helv. I, p. 187 (1828). *A. vulgaris* var. *alba*.

* Gramen estoloniferum vel stolonibus numerosis brevibus praeditum, caespites continuos in pascuis collinum calcareorum efformans ; foliorum laminae planae vel conduplicatae, cinereo-virides ; culmi erecti vel geniculati ; panicula angusta et exigua.

Buckman, Brit. Grass. p. 38 (1858). *A. stolonifera* var. *flagellare* Neilr. Fl. Nieder Oesterr. p. 43 (1858). *A. densissima* Druce in Rep. Bot. Exchange Club for 1913, p. 343 (1914). *A. alba* var. *typica* Fiori, Fl. Anal. d'Ital. I, p. 97 (1923). *A. Robinsonii* Druce * in Rep. Bot. Exchange Club for 1924, p. 457 (1925). '*A. nigra* With.' Hitchcock, Manual Grass. U.S. p. 330 (1935).

Figures.—Smith, Engl. Bot. XVII (1803), pl. 1189 ; and XXII (1805), pl. 1532 : Knapp, Gram. Brit. (1804), pl. 28 : Oeder, Fl. Danica X (1819), pl. 1623. Sinclair, Hort. Gram. Wob. (1824), facing pp. 225 and 345.

Representative specimens.—**K.** SARK : Beau Regard, *Ballard* 455, 474, 475. DEVON : Clawton, *Harvey*. HAMPSHIRE : Marchwood, *Goddard* K 2. SURREY : Ham, *Hubbard* G 57 A. MIDDLESEX : between Richmond and Twickenham, *Hubbard* G 55 A. CAMBRIDGESHIRE : Chesterton, *Philipson* 322 ; Cambridge, The Backs, *Philipson* 330. NORFOLK : Heacham, *Hubbard* 9250 ; Leziate Fen, *Hubbard* 9190. WESTMORLAND : Windermere, *Clouston* 223. NORTHUMBERLAND : Chevington, *Philipson* 369–370. ABERDEENSHIRE : Scotston, *Clouston* ; Aberdeen, *Clouston* 744. **B.** HAMPSHIRE : Winchester, *Corfe* (2 sheets). GALWAY : Headford, *Shuttleworth*. **W.** HAMPSHIRE : Keyhaven, *Comber*. KENT : Smeeth, *Marshall*. MONMOUTH : Marshfield, *Wade*. NORFOLK : Thompson, *Horwood*. **E.** No locality, in arable lands, *Brodie*. **D.** HAMPSHIRE : Alton, *Vaughan*. GLAMORGAN : Port Talbot, *Druce*. PERTH : Forteviot, *Druce*. ELGIN : Brodie, *Druce*. **C.** KENT : Tonbridge, *Little* ; Smeeth, *Marshall*. ESSEX : Walton, *Lemman*. 240 sheets have been examined.

Distribution.—Throughout the British Isles, on river banks and in ditches.

Minor variation.

With the lemma awned.—*A. stolonifera* var. *aristata* Sinclair, Hort. Gram. Wob. p. 345 (1824). *A. alba* var. *aristata* A. Gray, Manual, ed. 1, p. 578 (1848). *A. stolonifera* var. *longiaristata* Janka in Linnaea, XXX, p. 618 (1859) : Plues †, Brit. Grass. p. 151 (1867).

Representative specimens.—**K.** HAMPSHIRE : Southampton, *Rayner* ; *Jackson*.

Diseased states.

1. Infection with *Anguillina agrostis* (Steinbuch) Goodey. Symptoms as in *A. tenuis*.—*A. sylvatica* Huds. Fl. Angl. ed. 1, p. 28 (1762). *A. polymorpha* var. *sylvatica* (Huds.) Huds. Fl. Angl. ed. 2, I, p. 32 (1778). *A. alba* var. δ Smith, Fl. Brit. ed. 1, I, p. 81 (1800). *Vilfa alba* var. *sylvatica* (Huds.) S. F. Gray, Brit. Pl. II, p. 145 (1821). *Agrostis polymorpha* var. *vivipara* Trin. Unifl. p. 200 (1824). *A. stolonifera* var. *vivipara* Reichb. Agrost. Germ. I, p. 13 (1834).

* These supposed hybrids show no indication of *A. semiverticillata* as a parent, and can be matched with plants of *A. stolonifera* from the English coast where *A. semiverticillata* is quite absent.

† Probably includes awned forms of any species in the Sect. *Vilfa*.

Representative specimens.—K. SUFFOLK: Aldeburgh, *Druce* 9806. BUCKINGHAMSHIRE: Seer Green, *Stapf*. B. SUFFOLK: Aldeburgh, *Druce*. D. NORFOLK: Wells-next-the-Sea, *Robinson* 196. SUFFOLK: Aldeburgh, *Druce*. OXFORDSHIRE: Menmarsh, *Druce*.

2. Infection with *Tilletia decipiens* (Pers.) Körn. Symptoms as in *A. tenuis*. —*A. divaricata* Hoffm. Deutschl. Fl. ed. 1, 1, p. 37 (1800).

Representative specimen.—D. DURHAM: High Force, *Druce* (the lowest of the specimens).

6. AGROSTIS SEMIVERTICILLATA (*Forssk.*) *Christens.* in Dansk. Bot. Archiv, IV. p. 12 (1922).

Diagnosis.—Palea *as long as the lemma*; lemma *5-nerved, unawned*; glumes *rough*; panicle *always dense*; radical leaf *with its blade broadest above the base and its ligule obtuse, lacerate*; *spreading by overground stolons, rhizomes absent.* Anthers less than 0·75 mm. long.

Description.—A perennial growing in loose tufts or with long trailing stolons. *Culms* 1–10 dm. long, geniculate or prostrate below, often branching and rooting at the lower nodes, finally becoming upright or inclined, greyish green or tinged with purple below the panicle, smooth, with four or more brown or purple nodes. *Sterile shoots* not numerous, the intravaginal often becoming elongated as stolons, the extravaginal ascending at once, with two or three crowded scale-leaves at the base, never elongating as underground rhizomes. *Leaf-sheaths* split to near the base, terete, striate, smooth, rather loose-fitting, greyish green or tinged purple, those of the lower nodes only slightly longer than the internodes, of the upper much shorter. *Ligule* 1·5-5 mm. long, truncate or obtuse, toothed, membranaceous. *Blade* up to 15 cm. long, usually much shorter, 2–10 mm. broad, broadest above the base, rolled in the bud, usually greyish green, sometimes tinged with purple, rough, especially above, flat. *Panicle* up to 15 cm. long, erect, pyramidal, lobed, dense; rhachis straight, smooth or slightly rough above, green or tinged with purple; branches semi-verticillate, up to 4 cm. long, the larger branches rounded and often smooth, the smaller triangular and rough, the main branch of each verticil naked for half its length, the numerous smaller branches crowded with spikelets to the base; branchlets usually in unequal pairs, crowded with spikelets; pedicels usually rough. *Spikelets* lanceolate. *Glumes* 2–2·5 mm. long, subequal or the lower slightly the longer, broadly or narrowly lanceolate with acute apices, usually tinged with purple, but sometimes only slightly, and towards the tips, the keels of both glumes toothed, and the glumes rough, at least near the keel, spikelets readily falling off in fruit. *Lemma* about half the length of the glumes, broadly ovate when flattened, truncate, smooth, 5-nerved, the median, and often the laterals, running into very short teeth. *Palea* equal to the lemma, with two parallel nerves which reach the apex, distant from the margins. *Lodicules* narrow, about 0·5 mm. long. *Anthers* 0·5–0·7 mm. long. *Ovary* ovoid, about 0·3 mm. long. *Caryopsis* obovoid, about 0·75×0·5 mm.

Type.—In Forsskål's Herbarium, Botanical Museum of the University of Copenhagen.

Synonymy.—*Phalaris semiverticillata* Forssk. Fl. Aegypt.-Arab. p. 17 (1775). *A. verticillata* Vill. Prosp. p. 16 (1779). *A. aquatica* Pourr. in Mem. Toul. III, p. 306 (1788). *A. rivularis* Brot. Fl. Lusit. 1, p. 75 (1804). *A. alba* var. *verticillata* (Vill.) Pers. Syn. 1, p. 76 (1805): Fiori, Fl. Anal. d'Ital. 1, p. 97 (1923). *A. densa* M. Bieb. Fl. Taur. et Cauc. p. 56 (1808). *Decandolia stolonifera* var. *verticillata* (Vill.) Bast. Fl. Maine et Loire, p. 29 (1809). *Agrostis Villarsii* Poir. in Lam. Encyc. Méth. Suppl. 1, p. 251 (1810). *Vilfa verticillata* (Vill.) Beauv. Agrost. p. 182 (1812). *Agrostis decumbens* Muehl. ex Elliot, Fl. S. Carolina and Georgia, 1, p. 136 (1816). *A. stolonifera* Presl *, Cyp. et Gram. p. 22 (1820). *A. alba* var. *densiflora* Guss. Fl. Sicul. Syn. 1, p. 133 (1842); Fiori, Fl. Anal. d'Ital. 1, p. 97 (1923). *A. anatolica* Koch in Linnaea, XXI, p. 379 (1848). *A. adscendens* Lange, Pug. Pl. Hisp. in Vidensk. Meddel. Kjoebh. 1860, p. 33. *Nowodworskya verticillata* (Vill.) Nevski in Acta Inst. Bot. Acad. Sci. U.S.S.R. ser. 1, p. 143 (1936).

Figures.—Trin. Spec. Gram. 1 (1882), p. 36; Reichb. Agrost. Germ. (1834), pl. xxxv, fig. 1435: Cusin & Ansberque, Herb. de la Fl. Fr. xxiv (1874), p. 86: Husnot, Gram. (1896–99) pl. IX.

Representative specimens.—K. GUERNSEY: St. Sampson's and Port Peter, *Robinson*. B. GUERNSEY: Vale, *Druce*. W. GLAMORGAN: Barry Docks, *Wade*. D. CORNWALL: Falmouth, *Hamilton Davey*; Charleston, *Miss Todd*. SUSSEX: Southwick, *Cottes*. STAFFORDSHIRE: Burton, *Druce*. GLAMORGAN: Cardiff, *Druce*. YORKSHIRE: Meanwood, Leeds, *Butcher*. C. CHANNEL ISLES: Guernsey, *Barton*; *Evans*.

Distribution.—Southern Europe, SW. Asia, N. India, N. Africa, and the Canaries. Introduced into W. France, N. and S. America, Cape Colony, and S. Australia.

An alien on waste land in southern England. Established in Guernsey. Recorded from vice-countries 1, 2, 13, 19, 39, 41, and 64.

Flowering period.—June and July.

THE HYBRIDS.

1. A. CANINA×TENUIS.

All the specimens are caespitose, with rhizomes. *Ligule* short and truncate or oblong. *Lemma* 5-nerved, awned or unawned, asperulence thinly scattered on the back. *Palea* ⅓–½ the length of the lemma.—*A. canino-vulgaris* Mercier in Reut. Cat. Genev. ed. 2, p. 300 (1861). *A. vulgaris*×*canina* Sanio, Verh. Bot. Brand. XXXII, p. 107 (1890); Murb. in Bot. Notiser, 1898, p. 10. *A. vulgaris*×*canina* a. *Sanionis* and b. *Mercieri* Aschers. & Graebn. Syn. Mitteleurop. Fl. II, pp. 191, 192 (1899).

* A specimen of *A. semiverticillata* is named *A. stolonifera* in the Linnaean Herbarium.

Specimens.—K. HAMPSHIRE: Lyss, *Gamble* in 1906. ABERDEENSHIRE: near Banchory, *Clouston* 726 *b* in 1934. CORK: Rathcormack, *Bond* in 1927. W. UIST: *Shoolbred* in 1891.

2. A. CANINA × STOLONIFERA.

Culms decumbent at the base. *Leaves* flat, up to 3 mm. broad; ligule tapering, up to 3 mm. long. *Panicle* dense, pyramidal. *Lemma* 5-nerved, scabrid on the back, awned. Palea minute.—*A. canina* × *stolonifera* Murbeck in Bot. Notiser, 1898, p. 9.

Specimen.—CORNWALL: Truro, *Borlase* in 1932.

3. AGROSTIS STOLONIFERA × POLYPOGON MONSPELIENSIS *Desf.*

A perennial with procumbent culms. *Glumes* with long awns. *Lemma* awned from the back. Palea shorter than the lemma. *Anthers* about 1 mm. long. This plant has usually been known as *Agrostis littoralis* With. (Bot. Arr. ed. 3, II, p. 129; 1796), or as *Polypogon littoralis* (With.) Smith (Comp. Brit. Fl. ed. 3, p. 13; 1818). But the plant Withering described and figured was *P. maritimus* Willd. (since it is an annual and the glumes are awned from near the middle, etc.). The grass to which Smith applied Withering's name is almost certainly a hybrid. It has often been considered conspecific with an annual species which ranges from Abyssinia through southern Asia to China and Japan. But recently Hubbard (Fl. Trop. Afr. X, p. 162; 1937) has revived the name *P. fugax* Nees ex Steud. Syn. Pl. Glum. I, p. 184 (1854) for the annual which also differs in being fertile, in having deciduous pedicels and in the proportions of the glumes.

Specimens.—K. DORSET: Littlesea, *Salmon*. KENT: Erith, *Lambert*. NORFOLK: Cley, *Babington*. B. HAMPSHIRE: Portsea Island, *Trimen*; Porchester, *Trimen*. KENT: Woolwich, *French*; Plumstead, *French*. GLAMORGAN: Cardiff Docks, *Melville*.

THE ALIENS.

1. AGROSTIS MUELLERI *Presl*, Bot. Bemerk. p. 120 (1844).—*A. pallida* Lam. & DC. Fl. Fr. VI, Suppl. p. 251 (1815), non With.

Diagnosis.—*Lemma* $\frac{2}{3}$ the length of the glumes, 5-nerved, awned, the lateral nerves shortly, and the marginal nerves markedly excurrent as short awns; *palea* very minute; glumes smooth, with acute apices; *panicle* diffuse; *leaf-blades* linear; *ligule* oblong, 1–2 mm. long; apparently growing as an annual. *Anthers* about 1·5 mm. long.

Native of southern Europe.

Specimens.—D. EDINBURGH: Leith, *Fraser* and *Grierson* in 1920.

2. AGROSTIS HIEMALIS (*Walt.*) *Britton, Sterns & Poggenb.* Prelim. Catal. p. 68 (1888).

Diagnosis.—*Lemma* $\frac{2}{3}$ the length of the glumes, 5-nerved, unawned; *palea* very minute; *glumes* slightly rough, with acute apices; panicle with long branches, naked for $\frac{2}{3}$ their length; *leaf-blades* linear; ligule tapering, 2–3 mm. long; apparently growing as an annual. *Anthers* about 0·5 mm. long.

Native of North America.

Specimens.—K. GLOUCESTERSHIRE: Avonmouth Docks, *Sandwith*, in 1928. B. MIDDLESEX: Finchley, *Cooper* in 1910. D and C. W. INVERNESS: Fessit, *Marshall*, in 1896.

3. AGROSTIS OLIVETORUM *Gren. & Godr.* Fl. Fr. III, p. 483 (1856).

Diagnosis.—*Lemma* $\frac{2}{3}$ the length of the glumes, 3-nerved, unawned; *palea* $\frac{1}{3}$ the length of the lemma; *glumes* smooth; panicle diffuse, delicate; *leaf-blade* linear; ligule oblong, 1–2 mm. long; caespitose, erect. *Anthers* about 1 mm. long.

Native of southern Europe. Not previously recorded from the British Isles.

Specimens.—K. HAMPSHIRE: Marchwood, *Goddard* K 1, in 1934. W. GLOUCESTERSHIRE: Clifton, *Wade*, in 1924. D. GLAMORGAN: Port Talbot, *Druce* 20902, in 1904.

The British specimens agree more closely with the type-specimen than do some of the type-gathering. It is probable that this species is a hybrid between *A. tenuis* and *A. canina*, for the characters are intermediate and specimens with five nerves in the lemma and awns have been seen from the type-locality. The localities, however, suggest that the British specimens are introduced. (A sheet of the type-collection is in the Kew Herbarium; France: Grasse, *Duval-Jouve*, in 1844.)

4. AGROSTIS SEMIVERTICILLATA *Christens.* in Dansk. Bot. Archiv, IV, p. 12 (1922).

Diagnosis.—See p. 100.

Well established in the Channel Islands; sporadic on waste land in England.

5. AGROSTIS NEBULOSA *Boiss. & Reut.* Diagn. p. 26 (1842).

Diagnosis.—*Lemma* $\frac{1}{3}$ the length of the glumes, 1-nerved, unawned; *palea* equal to the lemma in length; *glumes* smooth, with obtuse apices; *panicle* diffuse, with very fine branches; *leaf-blades* linear, ligule oblong, about 2–3 mm. long; annual. *Anthers* about 1 mm. long.

Native of southern Spain.

Specimens.—K. EDINBURGH: Slateford, *Fraser*, in 1910. B and D. OXFORDSHIRE: Osney, *Druce*, in 1913.

Frequently cultivated as an ornamental grass. Distinguished from other southern European annual Agrostides by the very short lemma.

6. AGROSTIS LACHNANTHA *Nees* in Ind. Sem. Hort. Bot. Vratisl. (1834).

Diagnosis.—*Lemma* $\frac{3}{4}$ the length of the glumes, 3-nerved, with hairs on the

back of the lateral nerves, unawned; *palea* very nearly equal to the lemma in length; *glumes* smooth, with acute apices; *panicle* narrow, lax; *leaf-blades* linear, ligule tapering, 3–4 mm. long; plants loosely trailing. *Anthers* about 0·75 mm. long.

Native of South Africa.

Specimens.—**K, D,** and **C.** SELKIRK: Galashiels, *Hayward*, in 1909.

7. AGROSTIS AVENACEA *J. F. Gmel.* Syst. II, p. 171 (1791).—*Deyeuxia Fosteri* Kunth, Rev. Gram. I, p. 77 (1829); *Agrostis retrofracta* Willd. Enum. Hort. Berol. p. 94 (1809).

Diagnosis.—*Rhachilla* produced, hairy; *lemma* about ½ the length of the glumes, densely hairy, 5-nerved, awned, the lateral and marginal nerves excurrent, the latter as short awns; palea ⅔ the length of the lemma; *glumes* smooth, finely tapered; *panicle* lax, branches long, naked for half their length; *leaf-blade* linear, ligule tapering, 3–4 mm. long; plants trailing. *Anthers* about 1 mm. long.

Native of Australia and New Zealand.

Specimen.—**K.** SELKIRK: Galashiels, *Hayward*, in 1909.

Recorded as *A. retrofracta* (Rep. Bot. Exchange Club for 1921, p. 548; 1922).

A. elegans Thore (S. Europe) and *A. eriantha* Hack. (S. Africa) are recorded by Druce, Brit. Pl. List, ed. 2, p. 126 (1928), but I have seen no specimens.

KEY TO THE NATIVE AND ALIEN SPECIES.

Rhachilla not produced.
  Palea minute.
    Anthers 1 mm. or longer.
      Marginal awns of lemma about 0·5 mm.; annual ..... *A. Muelleri.*
      Marginal awns of lemma about 0·25 mm.; perennial.
        Radical leaves with a single ventral groove..... *A. setacea.*
        Radical leaves with four or more ventral grooves ..... *A. canina.*
    Anthers less than 0·75 mm. long ..... *A. hiemalis.*
  Palea more than ½ the length of the lemma.
    Lemma not hairy on the back.
      Lemma about ⅔ the length of the glumes, palea shorter than the lemma, anthers 1 mm. or longer.
        Rhizomes present, panicle open in fruit.
          Ligule of sterile shoots shorter than broad ..... *A. tenuis.*
          Ligule of the sterile shoots longer than broad.
            Palea ½ the length of the lemma, leaves narrow ..... *A. olivetorum.*
            Palea ½ the length of the lemma, leaves broad ..... *A. gigantea.*
        Rhizomes absent, panicle closed in fruit ..... *A. stolonifera.*
      Lemma ½ the length of the glumes or less, palea and lemma subequal, anthers less than 0·75 mm. long.
        Lemma 5-nerved; perennial ..... *A. semiverticillata.*
        Lemma 1-nerved; annual..... *A. nebulosa.*
    Lemma hairy on the back ..... *A. lachnantha.*
Rhachilla produced, lemma hairy ..... *A. avenacea.*

VARIATION, FLUCTUATION, AND FIXITY OF CHARACTERS.

Variations within the species.—The study of the taxonomy of a genus such as *Agrostis*, in which polymorphy is considerable and affects most characters of the plants, must be begun by gathering together into groups individuals which resemble each other closely. When it is attempted to separate these groups on absolute morphological characters it is often found to be impossible, because of the occurrence of a few plants which cannot be placed more certainly in one group than in another. These intermediate individuals indicate that we are dealing with the range of variation of a larger and more comprehensive group, of which the smaller groups are but the clustering of the individuals found in nature about some particularly favoured variation.

Fortunately this process of the 'lumping' of groups has its limits; eventually groups are found in the genus which do not show overlapping, but whose distinctness becomes more abundantly proved the more the material examined.

These well-defined groups have been treated as species and have been given binary names. Having by this process of synthesis arrived at our concept of the species in the genus, each species must be analysed to resolve it into its component varieties and minor variations. A species has been divided into two or more varieties only when these subdivisions of the species are clearly and almost constantly separable by a combination of characters. In practice the varieties can be diagnosed by the characters given in the key, but as these characters may involve differences merely of degree, in exceptional cases the naming of the variety may become uncertain by means of the key-characters alone. Under these circumstances the additional characters mentioned in the descriptions should be taken into account. It is equally important to note that the varieties are in the main ecologically distinct; in the table below are given the characteristic habitats of each of the varieties described in this paper:—

Species.	Variety 1.	Habitat.	Variety 2.	Habitat.
A. canina	*fascicularis.*	Damp acid soil.	*arida.*	Dry acid soil.
A. tenuis	*hispida.*	A variety of dry soils.	*humilis.*	Loose sand.
A. gigantea	*ramosa.*	Damp or shade.	*dispar.*	Dry and exposed.
A. stolonifera ...	*stolonifera.*	Chiefly dry alkaline soil.	*palustris.*	Damp alkaline soil.

In contrast to these well-marked varieties are the innumerable minor variations which can be found in all the species. Reference to the paragraphs on 'Variation within populations' (p. 111 forward) will indicate how numerous these variations are even among individuals of the same population; for

instance, in a sample of *A. stolonifera* var. *stolonifera* from a chalk-down no two plants were identical. It is evident that it is impracticable, if not impossible, to give names to all these variations, and names which have been given to them in the past should no longer be used.

These minor variations may appear quite at random among the individuals of a species, and then appear to be unrelated in any way to ecological conditions or geographical distribution. Several of these variations afford very easily scored and therefore convenient characters, and have frequently been used for the separation of varieties. When they are critically examined they show such fine gradations and occur in such an apparently casual way among otherwise homogeneous populations that little taxonomic significance can be given them. As an example of such a variation the length of the awn in *A. canina* is taken ; awnless or almost awnless plants are found in most populations of *A. canina*, and have been referred to the variety *mutica* Gaud. The length of the awn, the height of its insertion, and the length of the lemma were measured in twelve spikelets from each of twenty gatherings of *A. canina*. When the awn was absent the height to which the mid-nerve ascends in the lemma was taken as the height of insertion. Maximum, minimum, and mean values of these measurements are set out in Table I. It is evident that the awn is very variable in length even in plants in which it is constantly present. In plants in which the mid-nerve often runs to the top of the lemma, awns are usually entirely absent, but are nevertheless sometimes present. It is difficult to understand what factors could influence the appearance of the awn in such a way.

TABLE I.—The length of the lemma, and the awn, and the height of its insertion, in twenty gatherings of *A. canina*.

(Twelve spikelets were measured from each gathering : 22 units =1 mm.)

	Lemma.	Awn.	Insertion.
Max.	33·0	73·0	4·0
Min.	28·0	50·0	3·0
Mean ...	29·6	63·0	3·1

1. Lyss, Hants. Awn always longer than lemma, insertion low.

	Lemma.	Awn.	Insertion.
Max.	35·0	50·0	14·0
Min.	30·0	26·0	9·0
Mean ...	33·3	39·4	11·1

2. Sheen, Surrey. Awn often longer than lemma, insertion below middle.

	Lemma.	Awn.	Insertion.
Max.	39·0	80·0	10·0
Min.	34·0	58·0	7·0
Mean ...	36·8	69·1	8·7

3. Farnham, Surrey. Awn always longer than lemma, insertion low.

	Lemma.	Awn.	Insertion.
Max.	45·0	47·0	20·0
Min.	40·0	24·0	12·0
Mean ...	41·9	35·2	17·0

4. Sweethope, Northumberland. Awn usually shorter than lemma, insertion below middle.

	Lemma.	Awn.	Insertion.
Max.	40·0	63·0	20·0
Min.	39·0	18·0	13·0
Mean ...	39·8	45·0	15·9

5. Sweethope, Northumberland. Awn very variable, always present, insertion about middle.

	Lemma.	Awn.	Insertion.
Max.	43·0	34·0	21·0
Min.	37·0	23·0	16·0
Mean ...	40·3	29·5	19·5

6. Sweethope, Northumberland. Awn always present, shorter than lemma, insertion about middle.

	Lemma.	Awn.	Insertion.
Max.	40·0	36·0	17·0
Min.	36·0	22·0	14·0
Mean ...	38·4	27·7	15·0

7. Drybedd, Cardigan. Awn always present, shorter than lemma, insertion below middle.

	Lemma.	Awn.	Insertion.
Max.	36·0	25·0	16·0
Min.	33·0	15·0	13·0
Mean ...	34·8	22·0	14·4

8. Drybedd, Cardigan. Awn always present shorter than lemma, insertion below middle.

	Lemma.	Awn.	Insertion.
Max.	36·0	17·0	16·0
Min.	33·0	—	9·0
Mean ...	34·9	—	14·6

9. Drybedd, Cardigan. Only one short mucro, nerve not above middle.

	Lemma.	Awn.	Insertion.
Max.	40·0	15·0	24·0
Min.	35·0	—	12·0
Mean ...	37·7	—	15·0

10. Borth, Cardigan. Only one short mucro, nerve not above middle.

	Lemma.	Awn.	Insertion.
Max.	40·0	82·0	13·0
Min.	35·0	66·0	9·0
Mean ...	38·6	76·4	11·2

11. Borth, Cardigan. Awn always longer than lemma, insertion low.

	Lemma.	Awn.	Insertion.
Max.	33·0	60·0	12·0
Min.	28·0	22·0	8·0
Mean ...	30·2	43·9	9·6

12. Borth, Cardigan. Awn usually longer than lemma, insertion low.

	Lemma.	Awn.	Insertion.
Max.	41·0	29·0	20·0
Min.	36·0	—	15·0
Mean ...	38·3	—	17·0

13. Sandhurst, Hants. Awn short or often absent, nerve not above middle.

	Lemma.	Awn.	Insertion.
Max.	42·0	—	39·0
Min.	36·0	—	9·0
Mean ...	39·7	—	25·6

14. Oakmere, Cheshire. Awn short or usually absent, nerve often to near apex.

	Lemma.	Awn.	Insertion.
Max.	40·0	—	39·0
Min.	37·0	—	12·0
Mean ...	38·5	—	24·9

15. Oakmere, Cheshire. Awn absent, nerve often to near apex.

	Lemma.	Awn.	Insertion.
Max.	41·0	22·0	39·0
Min.	38·0	—	15·0
Mean ...	39·7	—	26·0

16. Oakmere, Cheshire. Awn absent, nerve often to near apex.

	Lemma.	Awn.	Insertion.
Max.	40·0	—	38·0
Min.	35·0	—	15·0
Mean ...	38·7	—	22·8

17. Oakmere, Cheshire. Awn absent, nerve often to near apex.

	Lemma.	Awn.	Insertion.
Max.	43·0	31·0	28·0
Min.	38·0	—	7·0
Mean ...	39·0	—	16·6

18. Killin, Perth. Awn rarely present, short, nerve often above middle.

	Lemma.	Awn.	Insertion.
Max.	34·0	62·0	10·0
Min.	30·0	46·0	8·0
Mean ...	32·0	50·9	9·0

19. Richmond, Surrey. Awn longer than lemma, insertion low.

	Lemma.	Awn.	Insertion.
Max.	39·0	69·0	10·0
Min.	37·0	53·0	7·0
Mean ...	38·3	60·0	8·2

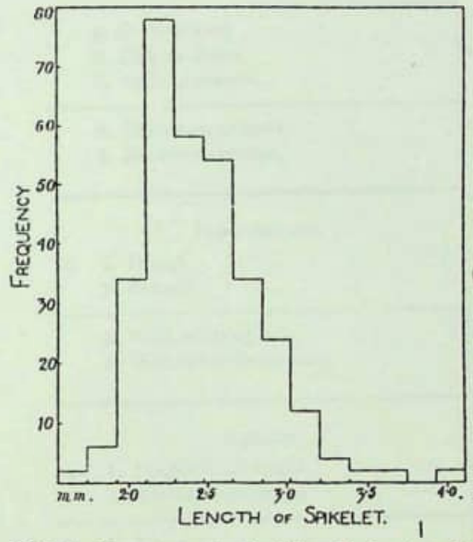
20. Porlock, Somerset. Awn always longer than lemma, insertion low.

On the other hand, the minor variations may be correlated in some way with the environment of the plants in which they are found. As an example of such a character the length of the spikelet in *A. canina* may be quoted ; this character has also been employed to separate varieties, as by Druce in this country. When abundant material was examined it became evident that there is a certain correlation between spikelet-size and geographical distribution in the British Isles. Larger spikelets become more frequent towards the north and west ; the correlation might be fundamentally an ecological one, as moorland and mountainous country is frequent in those parts of the British Isles.

In the first place the plants with large spikelets were examined morphologically to determine if any other characters were associated constantly with this one. Having by this means failed to establish the distinctness of these plants as a variety, all the available material of *A. canina*, amounting to over three hundred gatherings, was measured for spikelet-length ; and the frequency of the different lengths was plotted. The graph (fig. 1) shows a well-marked peak at the normal length of the spikelets in the southern parts of the country, but no second peak indicates the presence of a well-defined variety with longer spikelets. There seems to be a continuous series of forms, gradually becoming less numerous as the length of the spikelet increases. However, when graphs were constructed for material from selected districts, the distinction became very obvious. In the second graph (fig. 2) there are two curves, one representing the frequency of the different spikelet-lengths for all the Scottish material, the other the frequency for the south-east of England (from the Wash to Southampton Water). The latter material varies little about a strongly marked mode, whereas the Scottish material shows a much higher mode, maintains a good frequency at the upper limit of the English material, and a few plants occur with extremely long spikelets.

Although in this instance there is an undoubted relationship between distribution and the length of the spikelet, it does not seem possible to draw an arbitrary line of separation, for though the extremes are well defined, they are connected by a continuous series.

Since the variations may be correlated in their appearance with their environmental conditions, they would not be expected to be combined at random in the plants in nature. Combinations of characters which are unsuited to a given set of habitat-conditions may be eliminated, and a continual selection of more suited plants would result. Extremes in environmental conditions



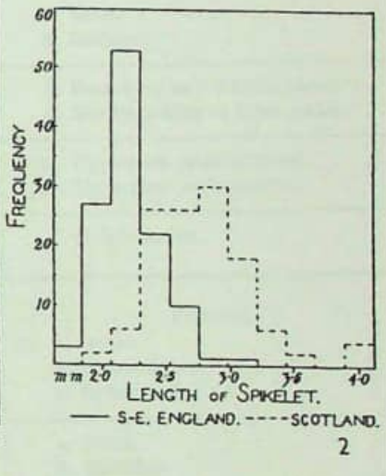


FIG. 1.—Frequency of spikelet-lengths in *A. canina* throughout the British Isles.

FIG. 2.—Frequency of spikelet-lengths in *A. canina* in Scotland and the south east of England. Twice as many gatherings were available from the south-east of England as from Scotland, and, therefore, the Scottish frequencies have been doubled to make the graphs more comparable.

may involve more rigorous selection, and result in more uniform populations. Thus there would be formed ecological groups within the species which would be more or less distinct according as the range of habitats in which the species is able to flourish is great or small. *A. stolonifera* var. *stolonifera* is able to grow in very diverse habitats, as, for example, sand-dunes, chalk downs, salt marshes, and as a weed on farmland. In each of these habitats a distinct phenotype of the plant grows, but just as there are intermediate habitats, so there are intermediate phenotypes, and the more material of these forms that is studied, the less distinct they will appear to be. These phenotypes are in reality part of a continuous range of variation within the variety *stolonifera*, and are the result of the favouring of particular combinations of variations by particular habitats. In *A. stolonifera* var. *stolonifera* these phenotypes are sufficiently

distinct and of such economic importance as to warrant the application of names. They are given the status of ecads (Clements, 1905), but it is not meant to imply that they are of any more significance than other groups which are due to the action of the environment, but which have not had names applied to them in this revision.

Apart from this selective action, the conditions of the environment may have a more direct effect in moulding the form of the plants which grow in it. Experiments were carried out by transplanting roots of the species, not only from their typical habitats, but from as diverse situations as could be found, and growing them under uniform conditions at Kew. These transplant experiments brought to light several interesting points which are of importance in the taxonomy of these species.

The habit of the plant in most species may become profoundly influenced by the conditions of the habitat. Dampness induces increased production of stolons in stoloniferous plants, and a light soil produces a similar increase in the length of the rhizomes in rhizomatous plants. Plates 14 and 15 are photographs of two herbarium sheets of plants of *A. canina* var. *fasciculatis*, one (Plate 14) from a plant growing in a very wet situation in shade, and the other (Plate 15) from the same plant after cultivation for two years at Kew. The long stolons and lax leaves have disappeared and the culms are less than ½ the length found in the natural habitat. The influence of shade depends in part on the edaphic factors combined with it. On damp soil a lengthening or etiolation of all the parts results, but on dry soil shade only accentuates the stunting and depauperation (Plate 16). On cultivation both these forms revert to the normal habit of the species, as is shown in Plate 17, which is of the same depauperated plant of *A. tenuis* after a season's growth in the experimental plots.

Transplantation does not always bring about such great changes, even though the change in conditions may be as great. Dwarf plants of *A. tenuis* growing on very dry soil usually increase their vigour on cultivation, but the variety *humilis* when transplanted from sand retains its low habit. In the same way plants of *A. stolonifera* var. *stolonifera* transplanted from sand or chalk will increase only slightly in vigour, retaining the low habit characteristic of this variety.

While cultivation on the whole tends to make plants of a species or a variety more uniform, it is quite without power to alter those very numerous and minute differences which make the natural populations so diverse. Indeed, the very fact that such diversity can persist under such uniform conditions after so many years of natural growth proves how little any one environment can affect those variations. Such characters as the degree of roughness, coloration of the sheaths and panicle, the relative vigour of stolon and rhizome production remain constant in a given plant under cultivation. This is of very important application because by vegetative propagation it is possible for economic botanists to perpetuate the strains they have selected and be certain that the desirable qualities will be retained.

Variations within populations.

Populations were studied in the field in order to determine the nature and amount of variation that occurs under uniform natural conditions. A list of characters was drawn up and numbered (Table II), and twenty plants from

TABLE II.—List of characters used in scoring populations of *Agrostis*.

HABIT.	CULMS.
H. 1. Densely caespitose.	C. 1. Numerous.
2. Loosely caespitose.	2. Few.
3. Densely matted.	
4. Loosely matted.	
5. Stolons long.	3. Straight.
6. Stolons short.	4. Geniculate.
7. Stolons absent.	5. Procumbent.
8. Rhizomes present.	6. Erect.
9. Rhizomes absent.	7. Inclined.
	8. Branching at the lower nodes.
	9. Not branching at lower nodes.
LEAF-SHEATH.	10. Uppermost node exserted.
S. 1. Rough.	11. Uppermost node inserted.
2. Smooth.	Height in cm.
3. With anthocyanin.	
4. Without anthocyanin.	
LIGULE.	PANICLE.
L. 1. Longer than broad.	P. 1. Ovoid.
2. Shorter than broad.	2. Pyramidal.
	3. Cylindrical.
3. Acute.	4. Erect.
4. Rounded or truncate.	5. Nodding.
	6. Diffuse.
	7. Dense.
LEAF-BLADE.	Length in cm.
B. Length in cm.	Breadth in cm. (longest branch).
Breadth in mm.	10. Contracting in fruit.
3. Broadest near base.	11. Not contracting in fruit.
4. Broadest near middle.	12. Rhachis rough throughout.
5. Flat.	13. Rhachis rough above.
6. Rolled or filiform.	14. Rhachis smooth.
7. Medium green.	15. Rhachis with anthocyanin.
8. Pale green.	16. Rhachis without anthocyanin.
9. Greyish or glaucous.	
10. Purple or reddish.	

TABLE III *a*.—Scoring of twenty plants of a population of *A. setacea*.
Bagshot, Surrey, 25 June 1934.

1..	H. 1	7	9	C. 1	3	6	9	10	30	S. 2	3	L. 1	3	B. 10	0·3	3	6	9	P. 3	4	7	6	3	10	12	16
2..	1	7	9	2	3	6	9	10	28	2	3	1	3	9	0·3	3	6	9	3	4	7	7	4	10	12	16
3..	1	7	9	1	3	6	9	10	28	2	3	1	3	12	0·2	3	6	7	3	4	7	9	3	10	12	16
4..	1	7	9	1	4	6	9	10	32	2	4	1	3	10	0·4	3	6	9	3	4	7	7	2	10	12	15
5..	1	7	9	2	3	6	9	10	54	2	3	1	3	8	0·3	3	6	7	3	4	7	6	3	10	12	16
6..	1	7	9	2	3	6	9	10	20	2	3	1	3	14	0·2	3	6	7	3	4	7	7	3	10	12	16
7..	1	7	9	1	3	6	9	10	40	2	3	1	3	11	0·3	3	6	7	3	4	7	8	3	10	12	15
8..	1	7	9	1	3	6	9	10	28	2	3	1	3	6	0·3	3	6	9	3	4	7	5	3	10	12	16
9..	1	7	9	2	3	6	9	10	19	2	3	1	3	9	0·4	3	6	9	3	4	7	6	4	10	12	16
10..	1	7	9	2	4	6	9	10	20	2	3	1	3	15	0·3	3	6	9	2	4	7	9	3	10	12	15
11..	1	7	9	1	4	6	9	10	45	2	3	1	3	9	0·3	3	6	9	3	4	7	6	3	10	12	16
12..	1	7	9	1	3	6	9	10	36	2	4	1	3	10	0·3	3	6	7	3	4	7	7	2	10	12	15
13..	1	7	9	1	3	6	9	10	30	2	3	1	3	10	0·4	3	6	9	3	4	7	8	2	10	12	16
14..	1	7	9	1	3	6	9	10	28	2	3	1	3	8	0·3	3	6	9	2	4	7	6	3	10	12	15
15..	1	7	9	2	3	6	9	10	15	2	4	1	3	11	0·3	3	6	7	3	4	7	9	3	10	12	15
16..	1	7	9	1	3	6	9	10	20	2	4	1	3	12	0·2	3	6	7	3	4	7	5	2	10	12	15
17..	1	7	9	1	4	6	9	10	15	2	4	1	3	6	0·2	3	6	7	3	4	7	5	2	10	12	15
18..	1	7	9	2	3	6	9	10	25	2	3	1	3	7	0·4	3	6	9	3	4	7	7	3	10	12	16
19..	1	7	9	2	3	6	9	10	20	2	3	1	3	10	0·3	3	6	7	3	4	7	6	3	10	12	16
20..	1	7	9	1	3	6	9	10	42	2	3	1	3	9	0·3	3	6	7	3	4	7	6	2	10	12	15

TABLE III *b*.—Scoring of twenty plants of a population of *A. canina* var. *fascicularis*.
Richmond Park, Surrey, 1 July 1934.

1..	H. 3	6	9	C. 2	4	6	8	10	25	S. 2	3	L. 1	3	B. 4	1	3	5	8	P. 2	4	6	5	3	11	13	16
2..	3	6	9	2	4	6	8	10	30	2	3	1	3	4	1	3	5	8	2	4	6	8	4	11	13	15
3..	4	5	9	2	4	6	8	10	50	2	4	1	3	11	5	3	6	8	2	4	6	11	4	11	13	15
4..	4	5	9	2	5	6	8	10	45	2	4	1	3	3	1	3	5	8	2	4	6	9	3	11	13	16
5..	4	5	9	2	4	7	8	10	40	2	4	1	3	10	5	3	5	8	2	4	6	8	4	10	13	16
6..	4	5	9	2	5	6	8	11	56	2	3	1	3	3	1	3	5	8	2	4	6	10	5	11	13	16
7..	1	5	9	2	4	6	8	10	40	2	4	1	3	4	5	3	6	7	1	4	6	5	3	11	13	16
8..	3	6	9	2	4	6	8	10	30	2	3	1	3	4	5	3	6	8	2	4	6	5	2	11	13	15
9..	3	6	9	2	4	6	8	10	35	2	3	1	3	13	1	3	6	8	2	4	6	5	3	10	13	16
10..	4	5	9	2	5	6	8	11	45	2	3	1	3	6	1	3	6	8	2	4	6	10	4	11	13	16
11..	4	5	9	2	5	7	8	10	48	2	3	1	3	6	1	3	6	8	2	4	6	11	5	11	13	15
12..	2	5	9	2	4	7	8	10	30	2	3	1	3	4	1	3	5	8	2	4	6	5	3	11	13	15
13..	2	5	9	2	4	6	8	10	24	2	4	1	3	3	5	3	5	8	2	4	6	4	2	11	13	16
14..	1	5	9	2	4	6	8	10	25	2	4	1	3	5	1	3	6	7	2	4	6	5	2	11	13	16
15..	4	5	9	2	5	6	8	10	40	2	4	1	3	5	1	3	6	8	2	4	6	8	4	11	13	16
16..	4	5	9	2	5	6	8	10	37	2	3	1	3	10	5	3	6	8	1	4	6	7	3	11	13	16
17..	3	6	9	2	5	6	8	10	24	2	4	1	3	8	1	3	5	8	2	4	6	4	2	10	13	16
18..	3	6	9	2	5	6	8	10	30	2	4	1	3	4	5	3	5	8	2	4	6	6	3	11	13	15
19..	4	5	9	2	5	6	8	10	36	2	3	1	3	3	1	3	5	8	2	4	6	6	3	11	13	16
20..	4	5	9	2	5	6	8	10	30	2	4	1	3	3	1	3	6	8	2	4	6	5	3	11	13	16

TABLE III. *c*.—Scoring of twenty plants of a population of *A. canina* var. *arida*.
Richmond Park, Surrey, 1 July 1934.

1..	H. 1	7	8	C. 2	4	6	9	10	30	S. 1	4	L. 1	3	B. 5	1·0	3	5	7	P. 1	4	6	8	3·5	10	13	16
2..	1	7	8	2	4	6	9	10	24	1	4	1	3	4	1·0	3	5	7	1	4	6	7	2·5	10	13	16
3..	1	7	8	1	4	6	9	10	36	1	4	1	3	6	1·5	3	6	7	1	4	6	4	1·5	10	13	16
4..	1	7	8	1	4	6	9	10	30	1	4	1	3	5	1·0	3	5	7	2	4	6	9	3·5	10	14	16
5..	1	7	8	1	4	6	9	10	30	1	3	1	3	6	1·0	3	6	7	1	4	6	7	3·5	10	13	16
6..	1	7	8	2	4	6	8	10	30	1	4	1	3	4	0·5	3	6	7	1	4	6	7	2·5	10	13	15
7..	2	7	8	1	3	6	9	10	36	1	4	1	3	6	1·0	3	6	7	2	4	6	8	3·0	10	13	16
8..	1	7	8	1	4	6	9	10	36	1	3	1	3	5	1·0	3	6	7	1	4	6	7	2·5	10	13	16
9..	1	7	8	1	4	6	9	10	42	1	3	1	3	9	2·0	3	5	7	2	4	6	7	3·0	10	13	16
10..	1	7	8	2	4	6	9	10	50	1	4	1	3	9	2·0	3	5	7	2	4	6	9	4·0	10	13	16
11..	2	7	8	2	3	6	9	10	24	1	4	1	3	4	1·0	3	6	7	2	4	6	6	3·0	10	13	16
12..	2	7	8	1	4	6	9	10	30	1	4	1	3	4	1·0	3	5	7	1	4	6	9	3·5	10	13	15
13..	1	7	8	2	4	6	8	10	36	1	4	1	3	4	1·0	3	6	7	2	4	6	7	3·0	10	13	16
14..	1	7	8	1	4	6	9	10	25	1	4	1	3	3	0·5	3	5	7	2	4	6	5	2·0	10	13	15
15..	1	7	8	1	4	6	9	10	22	1	4	1	3	3	1·0	3	5	7	1	4	6	4	2·0	10	13	16
16..	1	7	8	1	4	6	9	10	24	1	3	1	3	4	1·0	3	5	7	1	4	6	9	4·0	10	13	16
17..	1	7	8	1	4	6	9	10	26	1	4	1	3	4	0·5	3	6	7	1	4	6	7	2·5	10	13	16
18..	1	7	8	1	4	6	8	10	36	1	4	1	3	4	1·0	3	6	7	2	4	6	6	2·5	10	13	16
19..	1	7	8	2	4	6	9	10	30	1	4	1	3	5	0·5	3	5	7	1	4	6	8	3·0	10	13	15
20..	1	7	8	1	4	6	9	10	30	1	4	1	3	5	1·0	3	6	7	1	4	6	7	2·5	10	13	16

TABLE III *d*.—Scoring of twenty plants of a population of *A. tenuis*.
Richmond Park, Surrey, 12 July 1934.

1..	H. 2	7	8	C. 2	4	6	9	11	25	S. 2	3	L. 2	4	B. 6	1	3	6	7	P. 1	4	6	6	2·5	11	14	16
2..	2	7	8	2	4	6	9	11	25	2	3	2	4	5	1	3	6	7	1	4	6	11	4·0	11	14	16
3..	1	7	8	1	3	6	9	11	20	2	4	2	4	4	1	3	6	7	1	4	6	9	3·5	11	14	16
4..	2	6	8	2	4	7	9	11	24	2	4	2	4	5	1	3	5	10	1	4	6	5	2·0	11	14	16
5..	1	7	8	1	4	6	9	11	20	2	4	2	4	5	1	3	6	7	1	5	6	7	3·5	11	13	15
6..	1	7	8	2	4	6	9	10	40	2	3	2	4	3	1	3	6	7	1	4	6	9	2·5	11	14	16
7..	1	6	8	2	3	7	8	11	30	2	3	2	4	3	1	3	6	10	1	4	6	6	2·5	11	14	16
8..	2	6	8	1	3	6	9	11	25	2	3	2	4	6	2	3	5	10	3	4	6	6	2·5	11	14	16
9..	1	6	8	1	3	6	9	10	34	2	4	2	4	4	1	3	5	7	1	5	6	7	2·0	11	14	16
10..	1	7	8	1	4	6	9	10	38	2	3	2	4	4	1	3	6	10	1	5	6	4	2·5	11	13	16
11..	2	7	8	2	3	6	8	10	34	2	3	2	4	6	1	3	6	7	1	4	6	7	2·0	11	13	15
12..	2	5	8	2	3	7	9	11	25	2	3	2	4	6	1	3	6	7	3	4	6	5	2·5	11	14	15
13..	2	7	8	2	4	7	9	11	24	2	3	2	4	6	1	3	6	7	3	4	6	6	4·0	11	14	16
14..	1	7	8	2	4	6	9	11	25	2	3	2	4	7	2	3	5	7	1	4	6	10	2·5	11	13	16
15..	1	6	8	1	3	6	9	11	27	2	3	2	4	5	1	3	5	7	1	4	6	6	3·0	11	14	16
16..	1	7	8	2	3	6	9	11	22	2	4	2	4	6	1	3	6	10	1	5	6	9	3·0	11	14	16
17..	1	6	8	2	4	6	9	11	30	2	3	2	4	4	1	3	5	7	1	4	6	8	2·5	11	14	16
18..	2	7	8	2	3	6	9	10	38	2	4	2	4	3	1	3	6	7	1	4	6	6	2·5	11	14	16
19..	1	7	8	1	4	6	9	11	24	2	3	2	4	4	1	3	6	7	1	4	6	7	2·0	11	13	16
20..	1	7	8	2	4	6	9	11	27	2	3	2	4	6	1	3	6	7	1	4	6	6	2·5	11	14	16

TABLE III *e*.—Scoring of twenty plants of a population of *A. gigantea* var. *dispar*.
Growing as a weed in the experimental plots, Kew, Surrey, 11 July 1934.

1..	H. 2	6	8	C. 1	4	6	9	11	65	S. 1	4	L. 1	4	B. 14	3·5	4	5	7	P. 2	4	6	16	5·5	11	13	15
2..	2	6	8	1	4	6	9	11	60	1	4	1	4	9	3·0	4	5	7	2	4	6	16	6·5	11	13	15
3..	2	7	8	1	4	6	8	11	50	1	4	1	4	9	5·5	4	5	7	2	4	6	13	5·5	11	13	15
4..	2	6	8	1	4	6	9	10	69	1	4	1	4	6	2·5	4	5	7	2	4	6	12	3·5	11	13	15
5..	2	6	8	2	3	6	9	11	50	1	3	1	4	7	3·0	4	5	7	2	4	6	17	6·0	11	13	15
6..	4	6	8	1	4	6	9	11	50	1	4	1	4	11	4·0	4	5	7	2	4	6	17	6·0	11	13	15
7..	2	5	8	1	4	6	9	11	58	1	4	1	4	10	5·0	4	5	7	2	4	6	18	7·0	11	13	15
8..	2	6	8	2	4	6	8	11	56	1	4	1	4	8	3·0	4	5	7	2	4	6	19	5·0	11	13	15
9..	4	6	8	1	4	6	9	10	56	1	4	1	4	6	2·5	4	5	7	2	4	6	14	4·5	11	13	15
10..	2	6	8	1	3	6	9	10	48	1	3	1	4	7	3·0	4	5	7	2	4	6	17	7·0	11	13	15
11..	2	7	8	1	4	6	8	11	65	1	4	1	4	7	2·5	4	5	7	2	4	6	16	6·0	11	13	15
12..	2	7	8	1	4	6	9	11	60	1	4	1	4	8	3·0	4	5	7	2	4	6	14	4·5	11	13	15
13..	2	5	8	1	4	6	9	10	64	1	4	1	4	12	3·5	4	5	7	2	4	6	18	6·5	11	13	15
14..	2	7	8	2	3	6	9	11	74	1	3	1	4	15	6·0	4	5	7	2	4	6	17	3·5	11	13	15
15..	2	6	8	1	4	6	9	11	60	1	4	1	4	9	3·5	4	5	7	2	4	6	18	7·0	11	13	15
16..	2	5	8	1	4	6	9	11	60	1	4	1	4	11	4·0	4	5	7	2	4	6	16	5·5	11	13	15
17..	2	6	8	1	4	6	8	11	50	1	4	1	4	19	6·0	4	5	7	2	4	6	15	4·5	11	13	15
18..	2	6	8	2	4	6	9	11	60	1	4	1	4	12	5·0	4	5	7	2	4	6	14	4·0	11	13	15
19..	2	6	8	1	4	6	9	11	69	1	4	1	4	9	4·0	4	5	7	2	4	6	12	3·0	11	13	15
20..	2	7	8	1	4	6	9	11	74	1	4	1	4	8	4·5	4	5	7	2	4	6	15	5·5	11	13	15

TABLE III *f*.—Scoring of twenty plants of a population of *A. stolonifera* var. *stolonifera*.
Chalk Down, Redham, Surrey, 2 July 1934.

1..	H. 3	6	9	C. 1	5	7	8	10	10	S. 2	3	L. 1	4	B. 3	1·5	3	6	9	P. 2	5	7	4	1·0	10	13	16
2..	3	5	9	1	5	7	8	10	12	2	3	1	4	4	2·0	3	6	9	2	5	7	6	2·0	10	13	16
3..	3	6	9	1	5	7	9	10	18	2	4	1	4	5	2·0	3	6	9	2	5	7	8	3·0	10	13	16
4..	3	6	9	1	4	7	8	11	10	2	4	1	4	2	1·5	3	6	9	2	5	7	4	1·0	10	13	16
5..	3	6	9	1	5	7	8	10	15	2	4	1	4	3	1·5	3	6	7	2	5	7	4	1·5	10	13	16
6..	4	5	9	2	5	7	8	11	13	2	3	1	4	3	1·5	3	6	9	2	5	7	5	1·5	10	13	16
7..	3	5	9	1	5	7	8	11	9	2	4	1	4	4	2·0	3	6	9	2	5	7	4	1·5	10	13	16
8..	3	5	9	1	5	7	8	10	12	2	4	1	4	4	2·0	3	6	7	2	5	7	4	1·0	10	14	16
9..	3	6	9	2	4	7	8	11	18	2	3	1	4	3	1·5	3	5	7	2	5	7	3	0·5	10	13	16
10..	4	5	9	1	5	7	8	11	17	2	3	1	4	3	1·5	3	6	9	2	5	7	3	0·5	10	13	16
11..	3	5	9	1	4	7	8	11	10	2	3	1	4	2	1·5	3	6	9	2	5	7	6	2·0	10	13	16
12..	3	5	9	1	5	7	8	11	14	2	4	1	4	2	1·5	3	6	9	2	5	7	6	1·5	10	13	16
13..	3	5	9	1	5	7	8	10	10	2	4	1	4	3	1·5	3	6	9	2	5	7	7	2·5	10	13	16
14..	3	5	9	1	5	7	8	11	13	2	3	1	4	3	1·5	3	6	9	2	5	7	4	2·0	10	13	16
15..	3	5	9	1	5	6	8	10	8	2	4	1	4	3	1·5	3	6	9	2	5	7	4	2·0	10	13	16
16..	3	6	9	2	4	7	8	10	12	2	4	1	4	2	1·5	3	6	9	2	5	7	5	2·5	10	13	16
17..	3	5	9	1	5	7	8	11	20	2	3	1	4	4	1·5	3	6	7	2	5	7	4	2·5	10	13	16
18..	3	5	9	1	5	7	8	10	10	2	3	1	4	2	1·5	3	5	9	2	5	7	3	2·0	10	13	16
19..	3	5	9	1	4	7	8	10	10	2	3	1	4	3	1·5	3	6	9	2	5	7	4	2·0	10	13	16
20..	3	6	9	1	5	7	8	10	16	2	4	1	4	4	2·0	3	6	9	2	5	7	4	2·5	10	13	16

TABLE III *g*.—Scoring of twenty plants of a population of *A. stolonifera* var. *stolonifera*.
Sand Dunes, Borth, Cardigan, 5 July 1934.

1..	H. 4	5	9	C. 2	5	7	11	5	S. 1	3	L. 1	4	B. 2	1·0	3	6	9	P. 2	4	7	3	1·0	—	13	15
2..	4	5	9	2	5	7	11	8	2	3	1	4	3	1·0	3	6	9	2	4	7	2	1·0	—	13	15
3..	3	5	9	1	5	7	11	8	2	3	1	4	2	0·5	3	6	9	2	4	7	3	1·0	—	13	15
4..	3	6	9	1	5	7	11	9	2	3	1	4	1	0·5	3	6	9	2	4	7	3	1·0	—	14	15
5..	3	6	9	2	5	7	10	9	2	3	1	4	2	1·0	3	6	10	2	4	6	2	0·5	—	13	15
6..	3	6	9	1	5	7	11	10	2	3	1	4	2	1·0	3	6	9	2	4	7	3	1·0	—	13	15
7..	4	5	9	2	5	7	11	7	2	3	1	4	2	1·0	3	6	10	2	4	7	4	1·5	—	13	16
8..	4	5	9	2	5	7	11	10	1	3	1	4	3	1·0	3	6	10	2	4	6	3	1·5	—	13	15
9..	4	5	9	2	5	7	10	12	2	3	1	4	4	1·0	4	5	9	2	4	6	5	2·0	—	13	15
10..	3	5	9	1	5	7	10	6	2	3	1	4	2	1·0	3	6	9	2	4	7	4	2·0	—	14	15
11..	3	6	9	1	5	7	11	5	2	4	1	4	2	1·0	3	6	9	2	4	7	3	1·5	—	13	15
12..	3	5	9	1	5	7	11	8	2	3	1	4	2	1·0	3	6	9	2	4	7	3	1·0	—	13	15
13..	3	6	9	2	5	7	11	10	2	3	1	4	2	0·5	3	6	10	2	4	6	4	1·5	—	13	15
14..	3	6	9	2	5	7	11	8	2	3	1	4	1	1·0	3	6	9	2	4	7	3	1·5	—	13	15
15..	4	5	9	2	5	7	11	10	2	3	1	4	2	0·5	3	6	9	2	4	7	2	1·0	—	13	16
16..	4	5	9	2	5	7	10	10	2	3	1	4	2	1·0	3	6	10	2	4	6	2	1·0	—	13	15
17..	4	5	9	2	5	7	11	12	1	3	1	4	3	1·0	3	6	10	2	4	6	3	1·0	—	13	15
18..	3	6	9	1	5	7	11	8	2	3	1	4	2	0·5	3	6	9	2	4	7	3	1·5	—	13	15
19..	3	6	9	1	5	7	11	10	2	4	1	4	2	1·0	3	6	9	2	4	7	3	1·5	—	13	15
20..	3	5	9	1	5	7	11	7	2	3	1	4	1	1·0	3	6	9	2	4	7	2	1·0	—	13	15

TABLE III *h*.—Scoring of twenty plants of a population of *A. stolonifera* var. *palustris*.
On the Thames bank at Kew, Surrey, 15 July 1934.

1..	H. 4	5	9	C. 2	5	7	8	10	85	S. 1	4	L. 1	4	B. 10	5	4	5	7	P. 2	4	7	15	4	10	13	14
2..	4	5	9	2	5	7	8	10	76	1	4	1	4	18	7	4	5	7	2	4	7	14	4	10	13	14
3..	4	5	9	2	5	7	8	11	97	1	4	1	4	15	4	4	5	7	2	4	7	17	5	10	13	14
4..	4	5	9	2	5	7	8	10	72	1	4	1	4	11	4	4	5	7	2	4	7	10	5	10	13	14
5..	3	5	9	2	5	7	8	10	53	1	3	1	4	13	6	4	5	9	2	4	7	13	4	10	13	14
6..	4	5	9	2	5	7	8	10	99	1	4	1	4	14	3	4	5	7	2	4	7	14	4	10	13	14
7..	4	5	9	2	5	7	8	11	90	1	4	1	4	11	4	4	5	7	2	4	7	14	4	10	13	14
8..	4	5	9	2	5	7	8	11	86	1	3	1	4	17	3	4	5	7	2	4	7	15	4	10	13	15
9..	4	5	9	2	5	7	8	10	77	1	4	1	4	10	4	4	5	9	2	4	7	17	5	10	13	14
10..	4	5	9	2	5	7	8	10	92	1	4	1	4	12	5	4	5	7	2	4	7	12	5	10	13	14
11..	4	5	9	2	5	7	8	10	99	1	3	1	4	16	5	4	5	7	2	4	7	14	4	10	13	14
12..	3	5	9	1	5	6	8	11	45	1	4	1	4	7	3	4	5	7	2	4	7	6	3	10	13	14
13..	3	5	9	1	5	7	8	11	52	1	4	1	4	7	3	4	5	7	2	4	7	8	2	10	13	14
14..	4	5	9	2	5	7	8	10	97	1	4	1	4	14	6	4	5	7	2	4	7	10	3	10	13	14
15..	4	5	9	2	5	7	8	10	92	1	4	1	4	12	4	4	5	7	2	4	7	12	4	10	13	15
16..	4	5	9	2	5	7	8	11	76	1	3	1	4	11	5	4	5	7	2	4	7	15	3	10	13	14
17..	4	5	9	2	5	7	8	10	76	1	3	1	4	18	4	4	5	7	2	4	7	16	4	10	13	14
18..	4	5	9	2	5	7	8	10	90	1	4	1	4	16	3	4	5	7	2	4	7	13	4	10	13	14
19..	4	5	9	2	5	7	8	10	80	1	4	1	4	10	5	4	5	7	2	4	7	14	5	10	13	14
20..	4	5	9	2	5	7	8	10	58	1	4	1	4	12	4	4	5	7	2	4	7	16	4	10	13	14

each population were scored. The characters of the spikelets were not taken into account as it was impracticable to examine these in the field. The amount of variation shown by these figures therefore falls short of that actually present, since the characters of the spikelets are also variable.

The results of the scoring of eight populations are reproduced in Table III. The apparent uniformity of the plants may be supported by a cursory glance at the tables, several of the characters being constant throughout each of the populations, but on closer study an astonishing diversity is discovered. In the case of *A. stolonifera* var. *stolonifera* growing on a chalk down (Table III, *f*) some of the characters, such as the shape of the ligule and of the panicle and the absence of rhizomes, are constant throughout this sample of the population. Other characters, such as the length of the stolons, the coloration of the sheath, and the length of the uppermost internode of the culm, show two alternative characters in about equal proportions. Still other characters appear only rarely in the sample—these are inclined culms, flat blades, and roughness on the rhachis.

The result of this variation is that not one pair of plants is identical, quite apart from the characters which are merely measurements. This amount of variation is no doubt exceptional in the genus, but in the very stable species, *A. setacea* (Table III, *a*), in which only five characters were found to vary (apart from the measurements of culm, blade, and panicle), eight of the twenty plants cannot be matched exactly, and the remaining twelve are grouped into four different combinations of characters, each with three plants. That is, twelve different combinations of characters were found in twenty plants selected at random from a superficially uniform population of this well-defined and stable species. In the face of such diversity the application of names to these variations becomes an absurdity.

Parallel variation.

Many of the parts of the plants may vary in the same way in the different species. Each species may not show the whole range of variation possible, but each will have its own characteristic part of the range, which will overlap more or less extensively with the range of the other species. The following are a few of the characters which vary in the same way in different species :—

The presence or absence of the awn.

The coloration and degree of roughness of the glumes.

The shape and density of the panicle.

The length of stolons and the compactness of the innovations.

Perhaps parallel variation is most striking when two species grow together and approach each other very closely in habit. A list of six localities is given where this convergence was particularly noticeable between the two species mentioned in each case :—

Locality.	Habitat.	Species.	
Bournemouth, Hants	Sand dunes.	*A. stolonifera* var. *stolonifera.*	*A. tenuis* var. *humilis.*
Box Hill, Surrey	Leaf mould, in shade.	*A. stolonifera* var. *palustris.*	*A. gigantea* var. *ramosa.*
Ben Lawers, Perth	Alpine grassland.	*A. tenuis.*	*A. canina.*
Lobscombe corner, Wiltshire.	Chalk down.	*A. stolonifera* var. *stolonifera.*	*A. tenuis* var. *hispida.*
Borth, Cardigan	Old sand dunes.	*A. stolonifera* var. *stolonifera.*	*A. tenuis* var. *hispida.*
Borth, Cardigan	Ditch in acid bog.	*A. stolonifera* var. *palustris.*	*A. canina* var. *fasciculariis.*

Photographs are given of herbarium sheets of two of the pairs of plants, those from Box Hill (Plates 18 & 19) and Borth dunes (Plates 20 & 21). The direct effect of the environment plays its part in the production of plants with similar habits because when plants from such localities have been brought into cultivation the two species have reacted differently to the new conditions. This is, for instance, the case with plants of *A. canina* var. *fascicularis* growing in very wet places. On removal to drier soil the long stolons are lost and the resemblance to *A. stolonifera* vanishes. The convergence may, however, be deeper and more permanent than mere fluctuation due to the environment, and must in some instances be due to similar genotypic variations in the two species. This is perhaps the case in the plants of *A. tenuis* and *A. canina* from Ben Lawers which show convergence in the larger spikelets and short broad leaves ; it is certainly true of the resemblance between *A. tenuis* var. *humilis* and *A. stolonifera* var. *stolonifera* ecas *arenaria*. These two plants are found in sandy soil, and resemble each other in the low compact habit, with rolled leaves, and the narrow panicle.

It therefore appears that the different species not only show the same variations, but that these are related in the same way to the environment. This is not only true of the characters, such as stolon-production, which are obviously of ecological importance, but also of characters, such as spikelet-size, which are not so obviously of ecological significance.

Abnormalities.

A well-known, but rare, abnormality of the vegetative parts of *A. canina* consists of the plant being entirely of a pale yellow colour. There is a specimen of *A. stolonifera* var. *stolonifera* in the Kew Herbarium showing the abnormality

(Surrey : Merstham Chalk pits, *Fraser*). Sinclair (1816), p. 152, gives the following account of this mutation in *A. canina* (under the name *A. nivea*) : 'The whole plant, except the panicle, of a light straw-colour. The branches are numerous and when in flower the panicle assumes that appearance which it would have after a shower of snow, being then almost white. The above characters have remained constant after the third time raised from seed on different soils (i.e.) on light siliceous soil in Aspley Wood, where trees have been thinned ; on a heath soil, and on a clayey loam.'

Specimens of *A. stolonifera* and *A. tenuis* with leaves variagated with stripes of yellow and green are preserved at Woburn Abbey in a collection of grasses made by Sinclair in 1824.

Jansen and Wachter (in Nederl. Kruid. Archiv, XLIII, p. 153 (1933)) record plants of *A. stolonifera* var. *major* (Gaud.) Farw. (=*A. gigantea* Roth) in which the branch system of the panicle is more complex than in normal plants ; they have applied to the specimen in their herbarium the word *composita*. The main branch of each semi-verticil resembles a complete panicle, itself possessing alternate semi-verticils of branches.

I have only twice seen British specimens with a well-developed bract at the base of the panicle—on a specimen of *A. stolonifera* in Druce's herbarium (Shetland : Fitfull Head, *Druce*) and on a specimen of *A. tenuis* infected with *Tilletia* (Orkney : Hoy, *Johnston* 2637). The branches of the lowest semi-verticil are closely enwrapped by a brown scarious bract which is over 1 cm. long.

In the herbarium of Jansen and Wachter there are specimens of both *A. tenuis* and *A. canina* with well-developed branches of the panicle in the axil of the uppermost leaf of the culm. They have been written up as f. *bracteata*.

The abnormalities of the spikelets have been made the subject of a separate paper (Philipson in Journ. Bot. 1935, p. 65) ; they may be grouped under four heads, the first two of which are due to disease :—

1. Infection with *Anguillina agrostis* (Steinbuch) Goodey : *Agrostis sylvatica* Huds. The nematode produces a galled ovary with enlarged glumes and lemma. The disease has been seen in *A. stolonifera*, *A. gigantea*, *A. tenuis*, and *A. canina*. Since the publication of the paper on these abnormalities a specimen sent by Hudson to Linnaeus has been found in the Linnaean Herbarium. The specimen was unnamed by Hudson, but is no doubt from the gathering upon which he founded his species. It is a specimen of *A. stolonifera* with nematode galls.

2. Infection with *Tilletia decipiens* (Pers.) Körn. : *Agrostis pumila* Linn. The spores of the fungus are produced in the enlarged ovary and the plant is dwarfed and the panicle becomes compact. The disease has been seen in *A. stolonifera*, *A. tenuis*, and *A. canina*.

3. Proliferation. The production of leaf-like structures in the place of the lemmas has only once been seen in living material. The abnormal spikelets were on a plant of *A. stolonifera* in the experimental plots at Kew, which had been transplanted from Tynemouth, Northumberland, a year previously.

There is a specimen of *A. stolonifera* in the British Museum Herbarium (ex Herb. Thos. Moore) which shows proliferation slightly. G. F. W. Meyer (Fl. König. Hanov. III, sig. 21½ ; 1842) records *A. alba panicula germinante*, which is later named by Ascherson and Graebner (Syn. Mittel-europ. Fl. II. p. 174 ; 1899) *A. alba* var. *prolifera*. In the 'Prodromus Florae Batavae' (Nederl. Bot. Vereen. ed. 3, p. 2191 ; 1916) *A. vulgaris* var. *stolonifera* m. *vivipara* is recorded from Rotterdam, and Jansen and Wachter (l.c. 153) record *A. stolonifera* var. *major* f. *prolifera* from Amsterdam.

4. Two-flowered spikelets. Spikelets with rudiments of a second floret are rare in most of the species of the genus, but are found frequently in a few species. Only three instances have been met with in British material : a plant of *A. tenuis* in Hooker's herbarium (now incorporated in the general collection at Kew) which he mentioned in his 'Flora of Britain', p. 34 (1830) ; a plant probably of *A. canina* in the British Museum herbarium ; and a plant of *A. tenuis* in Druce's herbarium (Aberdeen : Loch-na-Gar, *Druce* 1899), which was given the epithet forma *sesquitertia* by Hackel. Kloos (Nederl. Kruid. Archiv, 1921, p. 113) gives a two-flowered form of *A. stolonifera* the epithet *subbiflora*.

THE VEGETATIVE ANATOMY.

Introduction.—The investigation of the anatomy of *Agrostis* was undertaken to complement the work on the taxonomy of the British species of that genus. It is not intended to give an exhaustive account of the anatomy of the whole plant, but rather a comparative treatment of the characters which are most readily observed, that is, primarily the transverse sections of the root, stem, and leaf. The sections were mostly cut by hand and mounted direct in a mixture of glycerine jelly and saffranin, a rapid and semi-permanent process which is essential when very numerous sections are being cut for future comparison.

The anatomy of eight varieties, classified under five species, was investigated and compared. These varieties include all the common forms and all those of interest to the agriculturalist and horticulturalist. At least twelve plants of distinct origin of each variety were cut when investigating each part of the plant. The eight varieties are listed below :—

1. *A. setacea* Curtis.
2. *A. canina* var. *fascicularis* (Curtis) Sinclair.
3. *A. canina* var. *arida* Schlecht.
4. *A. tenuis* var. *hispida* (Willd.) Philipson.
5. *A. gigantea* var. *ramosa* (S. F. Gray) Philipson.
6. *A. gigantea* var. *dispar* (Michx.) Philipson.
7. *A. stolonifera* var. *stolonifera* (Linn.) Koch.
8. *A. stolonifera* var. *palustris* (Huds.) Farw.

The transverse section of the root.

The earliest roots and the finer branches of the later roots are monarch or diarch (fig. 3 A). The larger roots of well-developed plants have usually six

to eight groups of protoxylem and in all the species except *A. setacea* the number of protoxylem-groups rarely exceeds twelve. In *A. setacea*, however, much larger roots are found.

The xylem-groups are embedded in a ground-tissue which usually consists of very much thickened fibres (fig. 3 B). In the centre of the stele there is usually a single large duct, but there may be as many as four of these ducts, or in *A. setacea* many more (fig. 3 C). The endodermis surrounds the fibrous stele and its cells are thickened on their inner and radial walls, passage-cells being apparently absent.

There are three regions in the cortex of the root. Immediately outside the endodermis are a few layers of flat, closely fitting cells. After two or three layers the cells become spherical and are arranged in radial rows, only being

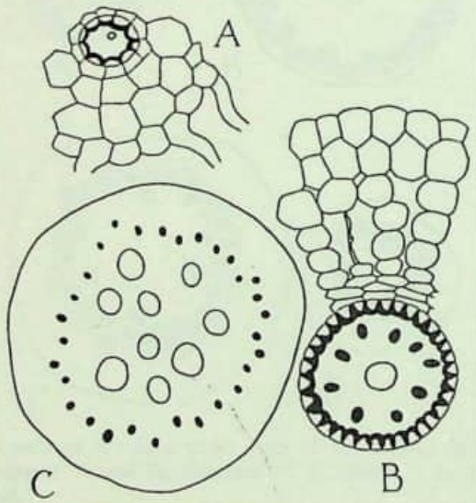


Fig. 3.—Transverse sections of roots. A, of part of a monarch root of *A. tenuis*; B, of part of a large root of *A. gigantea*; and C, the stele of a large root of *A. setacea*.

connected with other cells on their outer and inner sides. The outermost region of the cortex consists of two or three layers of large close-fitting cells, the outermost of which form the piliferous layer.

In old roots the rows of cells in the middle region of the cortex collapse, leaving the outer and inner cortex separated by a large air-space, across which stretch cellulose strands formed by the walls of the dead cells.

The roots of the various species are indistinguishable in cross-section, except in the case of the larger roots of *A. setacea*. Steles of *A. setacea* with as many as seventeen central ducts and twenty-nine xylem-groups have been examined.

The transverse section of the culm.

All sections were taken through the culm above the insertion of the uppermost leaf. In nearly all cases sections were cut near to the base, about the middle, and close to the first panicle branch, but it was found that, although higher in the culm the amount of fibrous tissue might become slightly less, the disposition of the bundles remained the same throughout.

When the culm is of small diameter the disposition of the bundles and fibres conforms to a very regular plan (fig. 5 A). The surface of the culm has regular ridges and furrows; opposite each ridge is a small vascular bundle and opposite each furrow a large bundle which runs deeper in the cortex. A ring of fibrous tissue encircles the culm, reaching the epidermis opposite each bundle, but being separated from it between them by a patch of mesophyll. At the centre of the culm the ground-tissue breaks down to form a central air-space.

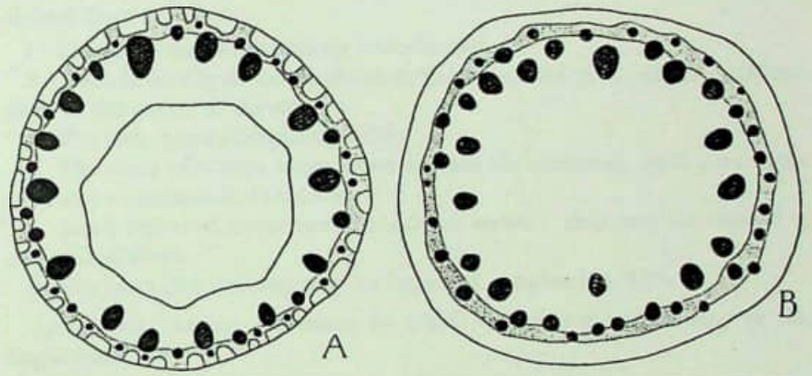


Fig. 4.—Transverse sections of: (A) a large culm and (B) a large stolon of *A. stolonifera*.

In larger culms more bundles are present, and aberrations from the original plan are introduced (fig. 4 A). Bundles of a third order appear, alternating with the large and small bundles; in some culms there are only a few of these bundles appearing irregularly around the stem, but in very large culms they are present uniformly all round the stem. When the bundles become crowded the patches of mesophyll may be absent between them. The band of fibres becomes more clearly marked from the ground-tissue and the patches of mesophyll smaller, though it is only rarely that they are completely absent. The large bundles frequently run in the pith, unenclosed by the fibrous band, and a very small bundle may be present on their inner side running in the band of fibres. In larger culms the patches of mesophyll on each side of the largest bundles may become united so that the fibrous tissue does not reach the epidermis opposite these bundles.

The culms of all the species conform to this plan and show the same variations with size. There are no characters that can be used to separate the species, although certain types of culm are found more frequently in some species than in others. Thus the small and perfectly regular culm is found in all the species except *A. gigantea* where no small culms were found, and the character of the absence of fibres opposite the largest bundles is found most frequently in *A. stolonifera* var. *palustris* and *A. gigantea*, which most often have large culms, but is also found in all the other species.

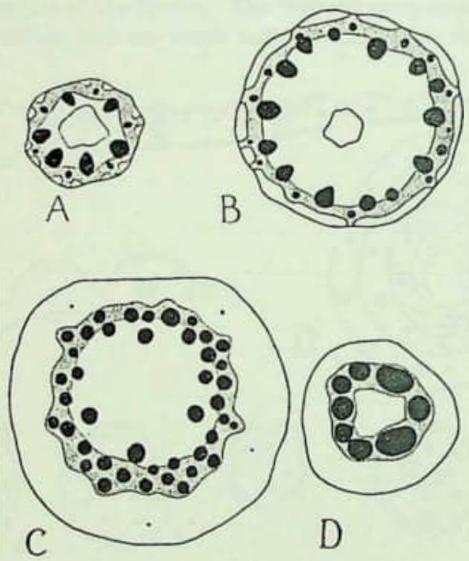


FIG. 5.—Transverse sections of: A, a small culm of *A. canina*; B, a small stolon of *A. stolonifera*; C and D, rhizomes of *A. canina*. In D the bundles are compound.

The transverse section of the stolon.

Stolons are present in all the varieties except *A. canina* var. *arida* and *A. setacea*. For cutting sections well-developed stolons were selected in which the internodes projected well beyond the leaf-sheaths, and sections were taken from internodes close to the apex and from older parts.

The arrangement of tissues is similar to that in the culm, and bundles of two or three orders alternate with a certain regularity (fig. 4 B), but the presence of leaf-traces complicates the pattern. The fibres in which the bundles are embedded may form a continuous ring as in the culm or may be present only near the bundles. The bundles are not always in so compact a ring as in the culm ; the larger bundles may be scattered in the pith and the smaller in the cortex.

The pith may be solid in the younger internodes, but is usually hollow. The ground-tissue between the epidermis and the vascular tissue may be wide or narrow. In the latter case the ring of fibres if present may reach the epidermis in places, but there is no regularity in this as there is in the culm (fig. 5 B).

The stolons of all the species have their tissues arranged in this way, and there is no means of distinguishing between them.

The transverse section of the rhizome.

Rhizomes are not present in any of the varieties of *A. stolonifera*, in *A. setacea*, or in *A. canina* var. *fascicularis*. In the other species and varieties they are constantly present, but developed to very varying degrees. The transverse sections of the rhizome are very similar to those of the stolon (fig. 5 C), and in some cases it would be impossible to distinguish between them. There are, however, a number of ways in which rhizomes tend to be anatomically distinct from stolons :—

1. The epidermis is more thinly cuticularized.
2. There is usually abundant starch in the cortex and pith. (There is chlorophyll in the cortex of the stolon.)
3. The pith is more frequently solid.
4. The circle of fibrous tissue never reaches the epidermis, as it does in the culm and sometimes in the stolon.
5. Small scale-leaf-traces run in the outer cortex ; they may be reduced to a cluster of fibres.
6. The individual bundles may be large and complex (fig. 5 D).

Again, there are no characters by which the various species may be distinguished.

The foliage leaf.

The disposition of the vascular bundles in the leaf is best understood if their development is traced. This can be done most readily by taking series of microtome sections through the apices of the sterile shoots, when sections of successively older leaves are obtained. The development is very similar to that in *Deschampsia* (Philipson, 1935 *b*). The order of appearance of the vascular strands is median, lateral, marginal, and intermediate (fig. 6 D). No other strands may appear in the narrower leaves of *A. canina* ; and in *A. setacea* not even so many are formed, for in this species there are never more than five nerves in the blade, and usually only three. All the strands in the sheath continue into the blade, none ending in the ligule. In the larger leaves additional nerves form in the blade, fusing above the base of the blade with one or another of the bundles which enter the sheath.

The transverse section of the blade is fundamentally the same in all the species. In all cases the sections were taken from well-developed blades of sterile shoots, and cut about one-third of the length of the blade above their

base. The lower surface is more or less flat, but the upper surface is furrowed (fig. 6 A, B). In each of the ridges between these furrows a nerve runs. The arrangement is quite different from that found in *Deschampsia*, where the smaller bundles run alongside the larger and are not isolated in separate ridges. Bands of fibres run below each bundle and a similar band is usually present above. Often the fibres completely surround the bundles and reach from one epidermis to the other. Other bands of fibres are found in most leaves running along the lower surface below the furrows—that is, between the bundles. Fibres are also present at the margins of the blades. The stomata are present in longitudinal bands on each surface, but are much more numerous on the upper surface.

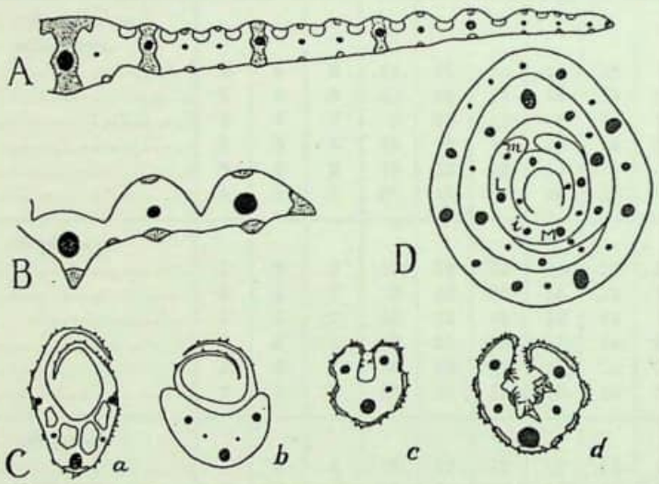


Fig. 6.—A and B, transverse sections of leaf-blades of *A. gigantea* and *A. canina* respectively. C (*a*, *b*, and *c*), sections through the ligule and blade of a radical leaf, (*d*) of the blade of a culm-leaf, of *A. setacea*. D, transverse section through the apex of a sterile shoot of *A. tenuis* showing successively older blades, the letters *M*, *L*, *m*, and *i* indicate the median, lateral, marginal, and intermediate nerves of the second leaf.

On the lower surface they are found on each side of the fibrous bands below the bundles ; on the upper surface they are found on each side of the furrows, the bottoms of the furrows being occupied by more or less bulbous motor cells.

The characters of the transverse section of the leaf-blade have been so frequently advocated as an aid to diagnosis that it was thought advisable to make a very thorough investigation of them. The material was not confined to the eight varieties listed above, but all the available smaller variations and forms were cut and the characters of each blade tabulated. Only by this means is it possible to assess the true value of these characters in the classification of this difficult genus.

A list of the characters which were taken into consideration is given, and a selection from a large number of the scorings for leaf-sections is set out in Table IV. *A. setacea* with its setaceous leaves (fig. 6 C) is so distinct that it could not be included.

Characters used in the scoring of leaf-sections.

A ...	Mid-keel.	1. Prominent. 2. Perceptible. 3. Absent.
B ...	Lateral keel.	4. Prominent. 5. Perceptible. 6. Absent.
C ...	Furrows on upper surface.	7. Deep. 8. Shallow.
D ...	Fibrous bands between the bundles.	9. Present. 10. Absent.
E ...	Fibrous bands of marginal bundles.	11. Above and below the bundles. 12. Only below.
F ...	Bundles in marginal ridge.	13. One. 14. Two.
G ...	Epidermal cells.	15. Regular. 16. Irregular.
H ..	Motor cells.	17. Well defined. 18. Ill defined.
I ...	Stomata on lower surface.	19. Rare (0–3 per trans. sect.). 20. Frequent (4 or more per trans. sect.).
J ...	Asperities.	21. Several. 22. Few.

From an examination of Table IV it can be seen that while some characters vary greatly within the species others are more constant. For example, two bundles in the marginal ridge are rare and asperities are rarely numerous, but the characters of the keels, ridges, and fibrous tissue may vary considerably. It is more important to note that none of the varying characters is both constant for a given species and constantly different in another. They may be more constant in one species than another, giving to each, on the average, a certain character. Thus stomata are more frequent on the lower surface of *A. stolonifera* than of *A. canina*, and the furrows are deeper in the latter species. The presence or absence of the fibrous strands between the bundles has been used to diagnose the British species of *Agrostis*, but as these strands are present in some plants and absent in others of all the species this character is worthless.

The species of *Agrostis* therefore may show differences in the frequency of occurrence of certain anatomical leaf-blade characters, but they all conform to the same plan and none of the characters investigated are diagnostic for a

TABLE IV.—The scoring of the characters of the transverse sections of the leaf-blades.

Name and plant no.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
A. stolonifera var. *palustris.*										
C 2 i	1	5	8	9	11	13	16	18	20	22
C 2 iii	2	5	7	9	12	13	15	18	20	22
C 14	1	5	8	10	12	13	16	18	20	22
D 1	2	6	8	10	11	14	16	18	20	22
D 7	3	5	8	9	11	13	16	17	20	21
J 6	1	5	7	10	12	13	16	18	19	22
A. stolonifera var. *stolonifera.*										
A 14	2	5	8	10	12	13	16	18	19	22
A 16	1	5	8	10	12	13	16	18	20	22
B 11	1	5	7	9	12	14	16	18	20	22
C 19	1	5	8	10	12	13	16	18	20	22
C 21	2	6	8	10	12	13	15	18	20	22
E 2	1	5	8	10	12	13	16	18	20	22
A. gigantea.										
B 34	1	5	7	10	12	13	16	17	20	22
C 13	2	5	7	9	12	13	16	18	20	22
C 24	1	5	7	10	12	13	16	18	20	22
D 2	1	5	8	9	11	13	15	18	20	22
D 4	1	5	8	10	12	13	16	18	20	22
E 31	2	6	8	10	11	13	16	18	20	22
A. tenuis.										
A 1	1	5	8	10	12	13	15	18	19	22
A 18	2	6	7	10	12	13	16	18	20	22
B 19	1	5	7	9	12	13	16	18	19	21
C 4	1	5	8	10	12	13	16	18	20	22
C 6	2	5	7	9	12	13	16	18	19	22
D 3	2	5	8	9	11	13	16	18	20	22
A. canina var. *arida.*										
A 9	1	6	7	9	12	13	16	18	19	22
A 10	1	5	7	10	12	13	16	18	19	22
B 9	1	5	7	9	12	13	16	18	19	22
B 36	1	5	7	10	12	13	16	18	19	22
C 5	1	6	7	9	12	13	16	18	19	22
E 39	3	6	7	10	12	13	16	18	20	22
A. canina var. *fascicularis.*										
A 13	1	6	7	9	11	13	16	18	19	21
B 6	2	5	8	9	12	13	16	18	19	22
B 13	1	5	7	9	12	13	16	18	19	22
B 18	1	5	7	9	12	13	16	18	19	22
E 13	1	5	7	10	11	13	16	18	19	22
E 28	2	5	8	10	12	13	16	18	20	22

species. It appears therefore that in the British species of this genus the anatomy of the leaves is of no taxonomic importance, except in the separation of *A. setacea*, a species which was known to be very distinct from gross morphological evidence.

In transverse sections the young sheath is seen to be closed for the greater part of its length (fig. 7), but it becomes open and its margins overlap towards the ligule. In older leaves the sheath may become split almost to the base. These transverse sections also show that the leaf-blade is rolled in the bud in most plants, one half of the blade completely enclosing the other, an arrangement which leads to a slight asymmetry. In the smaller leaves, particularly in *A. canina* (fig. 7), the rolling is reduced to a minimum, so that one margin is just overlapped by the other, which causes the leaf to appear folded in the bud. In *A. setacea* the leaves are never rolled, as the lamina is not sufficiently developed, but even in this species the asymmetry can be detected.

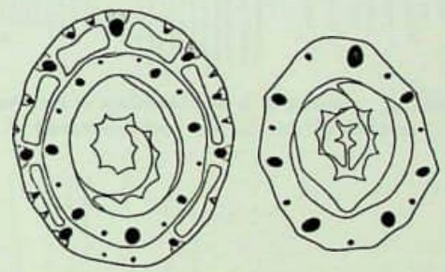


FIG. 7.—Transverse sections through sterile shoots of two plants of *A. canina*, showing the structure of the sheath and the vernation.

The bundles of the sheath show a more regular alternation of large and small bundles since the additional bundles of the blade are not present. The fibrous strands are only present on the outer side, never reaching their inner epidermis. In the sheaths of larger leaves air-spaces develop between the bundles, and these may unite above the smaller bundles.

The scale-leaf.

The scale-leaf may consist either solely of a sheath-like portion with no indication of the ligule and the blade, or it may have these regions more or less developed. When the rhizome emerges to grow as a sterile shoot, the successive leaves gradually develop a blade, unlike the leaves of an intravaginal shoot, which have strongly developed blades from the beginning of the shoot. In *A. gigantea* and *A. tenuis* the scales of well-developed rhizomes are short and obtuse, but in *A. canina* they are elongated and tapering. In the former two species the scales split at the apex with great regularity, but this is not found in *A. canina*.

A transverse section in the blade region (fig. 8 A) shows a series of alternating large and small bundles, with furrows on the upper surface between them. In the apex of most of the ridges, above the bundles, is a band of fibres, and a similar band is always present on the lower side of the bundles. These fibrous bands on the lower surface may be very broad and appear almost continuous, except for narrow breaks below the furrows. This scheme varies according as the blade is greatly or poorly developed, but its similarity to the blade of a foliage leaf is apparent.

In the sheath region the same alternation of bundles is seen (fig. 8 B). There are no additional bundles formed in the blade, as in the foliage leaf, so that the nerves of the sheath run straight into the blade without branching. Each bundle is accompanied by a band of fibres on the outer side only. The

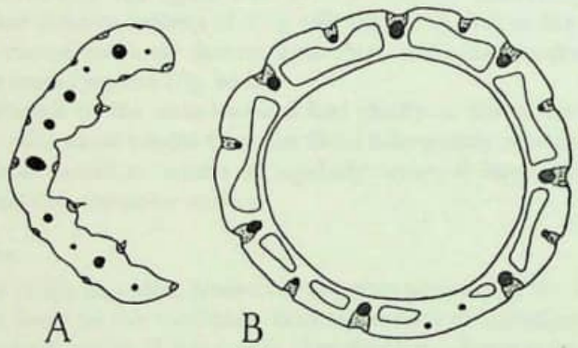


Fig. 8.—Transverse sections through a scale-leaf of *A. gigantea*.
A, through the blade, and B, through the sheath.

ground-tissue may be solid or hollow ; in the latter case the cavities form between the bundles and usually unite above the smaller bundles.

The epidermis.

The culm : The epidermis of the culm shows three types of cell-arrangement in a regular sequence (fig. 9 A). Where the fibrous tissue reaches the epidermis the surface-cells also are all elongate, narrow, and thick-walled. To the outside of the parenchymatous cortex the epidermis consists of rows of large cells and stomata in regular alternation. The stomata of one row are opposite the large cells of the adjacent row. Between these two types of epidermis a transitional arrangement is seen in which rather narrow long cells alternate with small cells, which take the place of the stomata.

The stolon : The cells of the epidermis of the stolons are usually very regularly arranged (fig. 9 B). They are in longitudinal rows with very long cells alternating with short cells. Sometimes the small cells are not present between all of the long cells. Stomata occasionally replace the small cells,

and their large size disarranges the regularity of the cells around them. Bands of narrow cells are not so frequent as in the culm, as the fibres of the cortex do not so often reach to the epidermis.

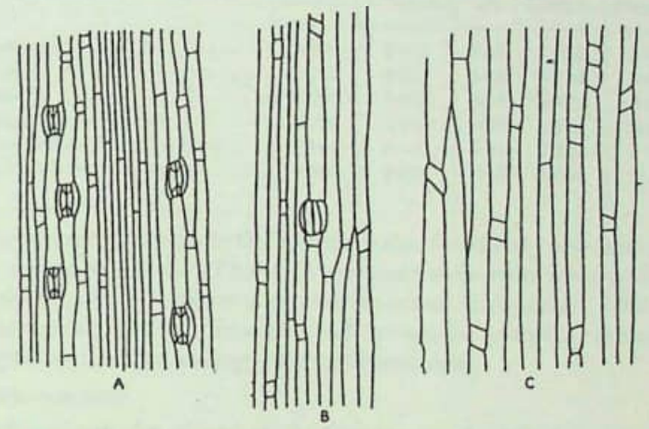


Fig. 9.—Surface-view of epidermal cells of *A. gigantea*. A, from the culm ;
B, from the stolon ; and C, from the rhizome.

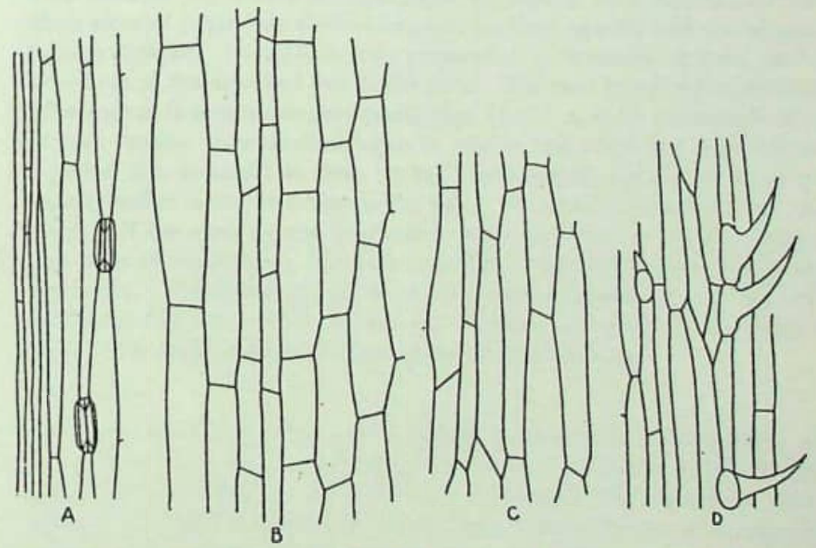


Fig. 10.—Surface-view of epidermal cells of *A. gigantea*. A, on the upper surface of the blade ; B, on the inner surface of the leaf-sheath ; and C and D, on the inner and outer surfaces of the ligule.

The rhizome : The epidermal cells of the rhizome are arranged as in the stolons (fig. 9 C), but their walls are thinner and the cells are relatively broader.

As can be seen from the figure, the regularity of the arrangement is not so strictly adhered to as in the stolons.

The leaf : The epidermis of the leaf-blade resembles that of the culm, in that bands of narrow cells alternate with bands of broader cells below the parenchyma (fig. 10 A). In the latter, large cells alternate with stomata, but the transitional type of arrangement found in the culm between these two bands is absent, as the small cells are not found alternating with the large cells in the epidermis of foliar structures. The upper and lower epidermis of the blade scarcely differ when the furrows of the upper have been flattened, except that stomata and asperities are more frequent on the upper surface.

The outer surface of the sheath resembles the lower surface of the blade. The inner surface of the sheath is devoid of stomata and consists of bands of long narrow cells alternating with bands of long and broad cells (fig. 10 B).

Both surfaces of the ligule have a very irregular cell-arrangement. The inner surface consists entirely of long cells (fig. 10 C), but on the outer surface numerous curved teeth are formed from short cells which make the arrangement even more irregular (fig. 10 D).

The epidermis of the scale-leaves differs chiefly in the rarity of the bands of narrow cells, which results from the fibres infrequently reaching the surface. Both surfaces therefore consist of regularly arranged large cells with rarely a few stomata on the outer surface.

Conclusions.

A review of the preceding account of the gross anatomy of the British species of *Agrostis* leads to the conclusion that this means of investigation is totally inadequate as a means of taxonomic identification. Apart from the structure of the root and leaf in *A. setacea*, no section of any part of the plant could be referred with any certainty to its species. It is true that the species have certain characters, of the culm and leaf for instance, that occur most frequently in them, but in no case have these characters been found truly diagnostic. The species all seem to be built to the same plan and show parallel variations about modes which are different for different species.

Life-histories.

Imbibition.

Approximate dimensions of the caryopses in each species are given at the end of the descriptions in the taxonomic section. The first stage of germination is the imbibition of water into the grain and a consequent increase in size. The following table, in which the average dimensions in mm. of ten grains from a plant of each species are given when dry and after twenty-four hours of imbibition, illustrates the order of this increase. The measurements were taken to within 1/100th of a mm. by means of a micrometre eye-piece, using the low power of the microscope :—

Species.	Before imbibition.			After imbibition.		
	Length.	Breadth.	*l/b.*	Length.	Breadth.	*l/b.*
A. setacea	1·435	0·372	3·05	1·555	0·440	3·52
A. canina	1·132	0·358	3·16	1·192	0·404	2·95
A. tenuis	1·007	0·362	2·78	1·124	0·424	2·65
A. gigantea var. *dispar*	1·134	0·382	2·96	1·260	0·439	2·87
A. stolonifera var. *stolonifera*	1·144	0·473	2·41	1·244	0·536	2·32
A. stolonifera var. *palustris*	0·910	0·371	2·45	1·024	0·440	2·32

The ratio of the length to the breadth is also tabulated; and it is seen to vary from species to species. This ratio was found to be more constant for different samples of grain of a species than were the actual dimensions. After imbibition the grains are relatively broader in all the species except *A. setacea*, in which the greatest increase is along the longitudinal axis.

Germination tests.

Different samples of seed of the four species *A. stolonifera*, *A. gigantea*, *A. tenuis*, and *A. canina* were tested for percentage of germination. The seeds were sown in petri-dishes on filter-paper kept moist by a cotton-wool wick. Each piece of paper was divided into one hundred squares and a seed placed in each division. Four plates were prepared of each sample of seed, and two were kept in the light and two in the dark. The number of seeds germinated after a given time is shown graphically (figs. 11 *a*, *b*, *c*, *d*) for one sample of seed of each species. Germination began in two to four days and extended over a period of a fortnight to three weeks. Germination appears to begin very slightly earlier in the dark than in the light. The germination is at first rapid, about half the seeds having germinated in the first five or six days after the first signs of imbibition; the rate then falls gradually until no more seeds germinate. The percentage of germination varied between 50 and 90, but no significant difference could be detected between the plates in the light and those in the dark, or between those of the different species.

The seedling.

The process of imbibition passes without a pause into germination. After twenty-four hours the small embryo at the base of the caryopsis begins to bulge outwards, and under favourable conditions the coleorhiza emerges before the end of the second day. It is closely followed by the emergence of the apex of the shoot, and both elongate until the young plant is about equal in length to the grain (fig. 12 *a*, *b*). Up to this stage the direction of growth is practically parallel to the long axis of the grain, no matter what its relation to the horizontal, but now gravitational responses are developed in the mesocotyl and primary root, the former growing vertically upwards and the latter

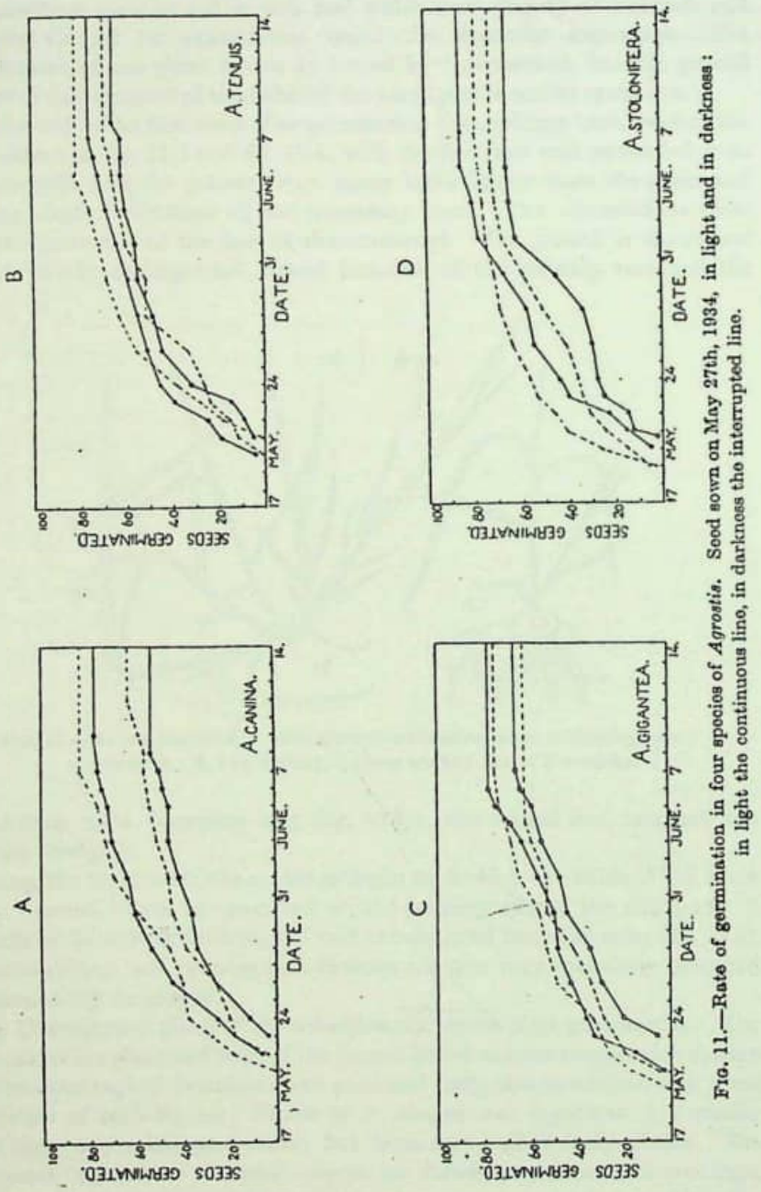


Fig. 11.—Rate of germination in four species of *Agrostis*. Seed sown on May 27th, 1934, in light and in darkness: in light the continuous line, in darkness the interrupted line.

vertically down. The coleorhiza is unaffected by gravity, the primary root bursting its lower side if the grain is lying horizontally and its tip if the grain is vertical. The upward growth of the shoot is due to the mesocotyl, which, in the light, elongates only sufficiently to bring the tip of the coleoptile vertical. Once this position has been attained growth ceases, and the shoot is no longer geotropic, its further growth being influenced only by the direction of the illumination to which the coleoptile is very sensitive. In the dark the mesocotyl elongates indefinitely in an endeavour to bring the coleoptile to the surface and the light; negative geotropism is therefore retained by the shoot in the dark, for the mesocotyl remains sensitive as long as it is actively growing. The primary root always retains its positive geotropism.

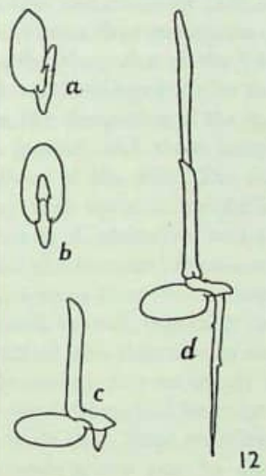


Fig. 12.—Germination of *A. stolonifera*: *a* and *b*, on the second day; *c*, on the third, and *d*, on the fourth after germination commenced.

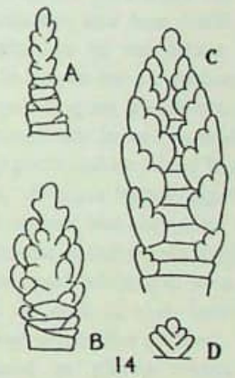


Fig. 14.—Development of the panicle of *A. stolonifera*. A, B, and C are successive stages; D is the lowest branch-system of C.

By the end of the third day after the first emergence of the root the coleoptile is vertical and two to three times the length of the grain (fig. 12 *c*); the primary root has burst the coleorhiza and may be nearly as long as the grain, though its growth is often arrested on filter-paper. During the fourth day the first leaf bursts the tip of the coleoptile and adventitious roots form as a ring of swellings around the junction of the mesocotyl and the coleoptile (fig. 12 *d*). In seedlings kept in the dark the leaf never emerges and roots do not form, the entire resources of the grain being spent in the great elongation of the mesocotyl.

The early development of the plant is most easily seen in plants which have been germinated on filter-paper; but, after a few days, development ceases to

be normal under these conditions, so that the further development is described from seedlings sown in soil in pots and which were dug up at intervals and carefully cleaned for examination under the binocular microscope. The development of one plant cannot be traced by this method, but the general scheme of development of the habit of the adult plants can be made out.

At the end of the first week after germination the seedlings have reached the stage shown in fig. 12 *d* and fig. 13 *a*, with the first leaf well protruded from the coleoptile and the primary root many times longer than the grain and showing slight indications of the secondary roots. The adventitious roots are just discernible at the base of the mesocotyl. The growth in the second week is chiefly underground, lateral branches of the primary root and the

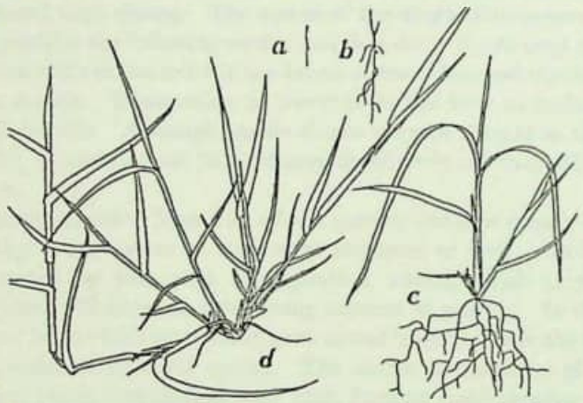


FIG. 13.—Young plants of *A. stolonifera* at successive stages of development : *a*, one week ; *b*, two weeks ; *c*, three weeks ; and *d*, six weeks.

adventitious roots becoming long (fig. 13 *b*) ; the second leaf becomes free from the coleoptile.

During the third week the seedlings begin to develop the habit of the adult plant. Several leaves are produced on the primary axis of the plant, and in the axils of these both intravaginal and extravaginal branches arise (fig. 13 *c*). The adventitious and primary root-systems are now very complexly branched and extensively developed.

Fig. 13 *d* shows a plant of *A. stolonifera* six weeks after germination. The main axis of the plant and some of the lateral branches have elongated as stolons and the extravaginal branches have produced leafy shoots without any great production of scale-leaves. Plants of *A. canina* var. *capillaris* at a similar stage show no stolon production, but numerous tufted leafy shoots. The differences in habit of the adult plants are foreshadowed in their seedlings, the ultimate habit depending on the frequency and mode of branching, the degree of elongation of the internodes, the inclination of the leaf-blades, etc., all of which are aspects of the development of the plant.

The two most important differences in habit met with in the British species of this genus—the presence or absence of stolons and rhizomes—are due to the degree of development of the two types of branching, i.e. intravaginal and extravaginal. The simplest habit is seen in *A. setacea*, in which all the branches are intravaginal with short internodes ; this is the truly caespitose habit. In *A. canina* the habit may be caespitose with slight extension by underground branches with scale-leaves, as in the variety *arida*, or, as in the variety *fasciculatis*, the intravaginal branches may become elongated as stolons, in which case rhizomes are absent. In *A. tenuis* and *A. gigantea* longer or shorter rhizomes are always present and stolons are occasional. In *A. stolonifera* stolons are present and though extravaginal shoots may be numerous they do not extend horizontally below the ground as rhizomes.

Since stolons and rhizomes have a taxonomic importance in the genus, it is necessary to have a clear conception of their morphological differences. Stolons result from the elongation of the internodes of intravaginal branches and bear leaves with well-developed blades to their base ; rhizomes, on the other hand, result from the elongation of the extravaginal branches and bear scale-leaves below the ground, and these scales show a transition to vegetative leaves at the surface of the soil. The number of scale-leaves on an extravaginal branch may vary up to an indefinite number, depending on the length of the rhizome, but in *A. stolonifera* and other non-rhizomatous forms, in which the extravaginal shoots ascend at once and are usually produced on aerial branches, there are not more than two or three scale-leaves. Stolons frequently become buried beneath the soil, especially in their second season, but they may always be distinguished from rhizomes by the withered remains of the vegetative leaves. Very rarely stolons may be deeply buried in loose sand while still in a young state, and the extravaginal branches produced in the axils of their leaves may then bear more than three scale-leaves before they reach the surface. These additional scale-leaves can be artificially induced in plants which never bear rhizomes by burying stolons in the soil. This shows that the essential difference between rhizomatous and non-rhizomatous plants is the geotropic response of the extravaginal branches.

The growth of the plant in its early stages is very uniform in all the species. Branches appear in the axils of all the foliage leaves of the main axis, and also in the axils of the prophylls and some of the leaves of the lateral branches. These branches may remain short, but in stoloniferous plants may elongate at once, so that the first leaf is separated from the prophyll by a long internode. The main axis itself may also elongate as a stolon, the first long internode appearing as early as between the second and third leaves.

Extravaginal branches may form in any of the leaf-axils, even those with an intravaginal branch. Often one bursts the sheath of each of the first two leaves, developing at the outside of the fan-shaped young plant. Their prophylls are followed by a scale-leaf and then transitional leaves, the fourth leaf usually having a well-developed blade. In older specimens of rhizomatous plants the extravaginal branches develop horizontally, and continue to bear scale-leaves.

Perennation.

All the British species of *Agrostis* are perennial, but they do not all survive the winter by quite the same means. The different species and the strains within these species differ in the amount of growth that takes place in the autumn after flowering and also in the earliness of the renewed growth in the spring. In mild winters the stoloniferous forms may never be quite dormant, and the same is true of rhizomes, which may continue to elongate under the ground during the greater part of the winter.

There are three chief means of perennation in the genus, and that which predominates in any given species depends on the habits of the plants. In a purely caespitose grass like *A. setacea* numerous sterile shoots and flowering culms are produced each spring. The apices of the sterile shoots survive the winter to form panicles the following season and then die. A new crop of sterile shoots forms from buds in the axils of the leaves of the culms and sterile shoots of the previous season. Perennation is therefore in the form of buds closely invested in leaf-sheaths. Although sterile shoots may be formed at the base of old culms, this process cannot be continued indefinitely, so that old clumps die in the centre.

This means of perennation is seen in all the species, but it is usually supplemented either by the presence of stolons or rhizomes or both. Stolons are often well protected by the mass of vegetation among which they creep, and in open winters will show an astonishing amount of growth. In the axils of their leaves are buds which may either grow out as leafy shoots in the autumn or may remain dormant until the spring. The shoots at the nodes of stolons may become very much branched in their turn, forming small rosettes at each internode. The rosettes become rooted to the soil and when growth begins in the spring they resemble young plants.

Rhizomes are formed throughout the growing period of the plants on which they are found, and may reach the surface and become aerial leafy shoots in the same season, or their growth may be arrested while they are still spreading horizontally beneath the soil. In the latter case, on the renewal of growth in the spring, they send up sterile shoots from their apices and also as lateral branches from their nodes.

The development of the panicle.

Panicles develop on young plants in their second year, and on older plants they form at the apices of shoots which were formed as sterile innovations the previous season. A short account of the development of the intricate branch system has already been published for the species *A. canina* (Philipson, 1936) ; in the other species the development is essentially the same.

Immediately after the formation of the rudiment of the uppermost leaf the stem-apex becomes transformed into the panicle primordium. The distichous arrangement of the vegetative leaves is continued upwards as a series of swellings on each side of the axis. These swellings are the bract-primordia in whose

axils the branches of the panicle arise and their distichous arrangement leads to the alternation of the semi-verticils in the mature panicle. These bract-primordia soon encircle the rhachis, giving to it a strongly noded appearance ; usually these bracts do not develop further and cannot be made out in the mature panicle ; but rarely that at the lowest verticil may become enlarged and form a distinct bract.

The primordium of the main branch of each verticil appears as a swelling in the axils of the bract-primordia in a succession from below upwards (fig. 14 A). As was stressed in the case of *A. canina*, although the branches appear in this basifugal order they do not continue to develop to maturity in it. There is a lag in the development of the verticils which is more marked the lower the branch is on the rhachis. The result is that the upper branches increase in size and divide at a very much quicker rate than the lower. Branchlets appear on each main branch in a distichous manner, and the verticils grow as a fan-shaped mass of branches which gradually half-surround the rhachis overlapping the verticils above and on the opposite side of the rhachis (fig. 14 C).

The apex of the rhachis continues growth for some time, giving rise to a regular sequence of branch-primordia in the axils of the minute bracts. Eventually its growth is arrested by the appearance of the rudiments of spikelets at the apex, and the branches immediately below are arrested and remain small for the same reason. It results that, at the stage when all the verticils have been laid down, the largest verticils are a short distance below the apex. The verticils above will always remain relatively small, giving a more or less pointed apex to the mature panicle. The development of the lower verticils may, however, vary in three ways, resulting in the three chief panicle-shapes found among the species. If the verticils continue to enlarge until the lowest has more than compensated for the lag in its development, there will result a downward succession of increasingly larger verticils—that is, the panicle will be pyramidal. If, however, the growth stops when all the verticils (except those at the apex) are equal in size, a cylindrical panicle will result. If the growth is stopped before the lag has been compensated for, the lower verticils will be smaller, giving an ovoid panicle. Reference to the systematic descriptions will show that the shape of the panicle is of some taxomomic importance.

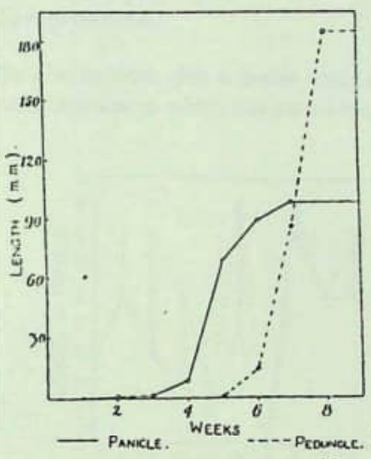
As the branches and the spikelets on their extremities develop, the internodes of the rhachis elongate, until the young panicle completely fills the protective uppermost leaf-sheath of the culm and the upper spikelets protrude. It is evident from the order of appearance that these spikelets will be the most advanced, and indeed those of the lowest verticil may still be very minute. The whole panicle is protruded from the sheath by the end of a fortnight, and the branches expand to a greater or less extent as flowering begins.

The rate of elongation of the panicle and the peduncle in ten plants is shown in Table V. The measurements were made at intervals of a week, and are expressed in millimetres. The earlier development of the panicle as compared

TABLE V.—Rate of elongation of the panicle and peduncle (in mm.).

Species.	Plant.		May 21.	May 28.	June 4.	June 11.	June 18.	June 25.	July 2.	July 9.	July 16.
A. canina	C 5	Pan.	7	15	40	83	93	117	—	—	—
		Ped.	—	—	1	3	11	42	72	190	—
	C 7	Pan.	11	20	104	150	—	—	—	—	—
		Ped.	—	—	8	12	25	70	150	272	—
A. tenuis	A 4	Pan.	4	9	11	86	143	—	—	—	—
		Ped.	—	—	—	2	5	50	130	—	—
	A 25	Pan.	1	2	13	72	92	100	—	—	—
		Ped.	—	—	—	2	3	22	85	112	—
A. stolonifera var. *stolonifera.*	A 5	Pan.	5	13	48	88	157	185	—	—	—
		Ped.	—	—	1	2	15	28	150	—	—
	D 5	Pan.	1	6	14	74	80	102	—	—	—
		Ped.	—	—	—	2	3	37	100	—	—
A. stolonifera var. *stolonifera.*	A 14	Pan.	1	2	3	8	35	112	—	—	—
		Ped.	—	—	—	—	1	7	50	250	—
	A 16	Pan.	0·5	1	1·5	2	8	68	89	100	—
		Ped.	—	—	—	—	—	0·5	14	86	185
A. stolonifera var. *palustris*	D 6	Pan.	1	5	16	80	106	134	—	—	—
		Ped.	—	—	—	3	8	90	181	—	—
	D 7	Pan.	5	12	40	55	110	—	—	—	—
		Ped.	—	—	1	2	4	12	62	111	—

with the peduncle is clearly shown. The development in both is at first slow, gradually becoming very rapid, but the panicle differs from the peduncle in showing a falling off of the growth-rate towards the end. These growth-rates of the panicle and the peduncle are shown graphically for the plant A 16 in fig. 15. Since the panicle elongates at a number of points—that is, at each of the nodes of the rhachis,—it will show its most rapid elongation when most of these growing points are active. As more and more of the meristems cease to function the growth-rate of the panicle will fall. It is probable that each individual meristem has the same type of growth-rate as has the peduncle.



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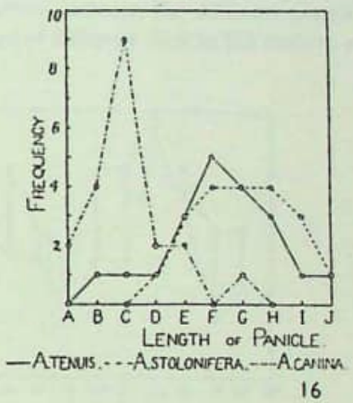

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FIG. 15.—The rate of elongation of the panicle and peduncle in a plant (A 16) of *A. stolonifera* var. *stolonifera*.

FIG. 16.—The length of young panicles in 20 plants of each of three species of *Agrostis* on June 17, 1935.

The rapid elongation of the peduncle does not begin until the panicle is nearly completely developed—that is, until the upper spikelets have protruded from the sheath and are nearly ready to flower.

The development of the spikelet.

The development of the individual spikelets has been made the subject of a separate paper (Philipson, 1936). The development was described for *A. canina* as seen both externally and by the aid of serial sections. Three other species (viz. *A. stolonifera*, *A. gigantea*, and *A. tenuis*) were investigated in this way, but, since the development in them all is so very similar, it is proposed only to indicate the few points of difference between the different species.

The tips of the branchlets become spikelet-primordia by the appearance of glume-rudiments, and the lemma, palea, androecium, and gynoecium appear and develop to maturity in that order. Since the characters of the mature lemma and palea are very useful in the diagnosis of the species, it is interesting to follow their development. There are typically five nerves in the lemma, which are laid down in the order—mid-rib, two laterals, and two marginals. In *A. tenuis*, in which there are only three distinct nerves in the lemma, it is not the marginal nerves which are absent but the laterals, and in the other species the laterals are not so strongly developed nor do they run so high into the lemma as do the marginal nerves, although the latter are developed last.

The presence or absence of the awn is of very dubious systematic value. It may be present in all the British species except *A. semiverticillata* and may also be absent in all the species except perhaps *A. setacea*. The awn-rudiment is formed by a division of the apex of the lemma tangential to the floral axis. The awn cannot be considered as an epidermal outgrowth, as it may receive the mid-rib, nor can it be the true apex of the blade-region of the lemma, as this is also represented in the apex of the lamina of the lemma. The awn must be considered as a dorsal outgrowth belonging to none of the classical morphological categories. In the section on 'Variation' the variation in awn-length in plants of *A. canina* is tabulated. It is difficult to understand what factors influence the appearance of an awn in some spikelets of a panicle and not in others. When the awn is present the back of the lemma is curved to accommodate it, and on each side of this curve the lemma is thickened, and it is here that the lateral nerves run. In spikelets of *A. tenuis* which are awned these thickened lines are present on each side of the awn, and it is interesting that the lateral nerves run in them as in the other awned species, while in unawned spikelets of *A. tenuis* the lateral nerves are absent.

The palea is enclosed by the lemma and occupies the space across the two anterior stamen-rudiments. In the early stages of its growth it is similar in all the species—that is, the minute size found in *A. canina* is not foreshadowed at its inception. As the stamen-filaments increase in length the palea keeps pace, but the growth is soon arrested in *A. canina*, so that it remains minute in the adult spikelet.

Flowering.

The earliest rudiments of the panicles can be found early in May, and rather more than a month later the panicles begin to protrude from the leaf-sheaths. From the protrusion of the first spikelet to the first flowering occupies on an average another fourteen days. The different plants of a given species come into flower over a considerable range of time, but it is possible to detect that some species come into flower and reach the maximum flowering-period earlier than others.

In order to obtain a clear conception of the relative flowering-periods of the three species *A. canina*, *A. tenuis*, and *A. stolonifera*, the length of the young

panicles was scored in twenty plants (all of the type-varieties) of each of these species growing in the Experimental Plots at Kew. The panicle-length relative to the uppermost leaf-sheath was divided into ten easily scored categories, listed below, which are used as abscisae in the diagram (fig. 16), and the frequencies of these categories in the twenty plants are used as ordinates:—

The characters used in the scoring of panicle-length.

A. Fully protruded.
B. More than ½ protruded.
C. ½ protruded.
D. Less than ½ protruded.
E. Just protruded.
F. Just included in the sheath.
G. More than ¼ length of the sheath.
H. ¼ length of the sheath.
I. Less than ¼ the length of the sheath.
J. Very young.

These categories give a better comparison between the different plants and different species, in which the panicles are of different sizes in the mature state,

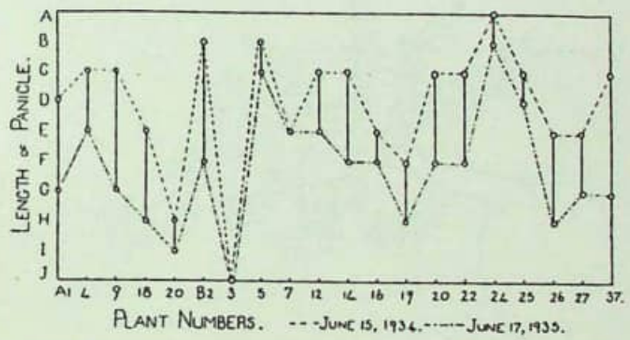

FIG. 17.—Diagram to show the correlation between the length of the panicle in 20 plants of *A. tenuis* in two seasons.

than would actual measurements. The degree of protrusion of the panicle is clearly proportionate to the earliness of flowering, and *A. canina* is clearly the earliest species to flower. Moreover, since this species shows a well-defined mode, its period of flowering will probably be short. *A. stolonifera* is slightly later to flower than *A. tenuis*, and both these species have ill-defined modes, indicating that the period of maximum flowering will be protracted.

The different plants of a species come into flower on different dates. From the data which were collected over two flowering seasons (1934–35) it is evident that the relative time of flowering remains more or less constant for a given plant. This is shown clearly for *A. tenuis* in fig. 17 which is a diagram to show the correlation between the panicle-length of individual plants on corresponding days of two seasons. The lengths of the panicles were scored by means of the same ten categories and the heavy vertical lines connect the lengths of each

panicle in the two seasons ; the two broken lines connect the panicle-lengths each of one season. It can be seen that there is a fairly constant difference between the two seasons, the panicles being more (or rarely equally) advanced in 1934, and that the same plants were early to flower in one season as in the next.

The time of flowering is also dependent to some extent on the degree of latitude. For example, in the low-lying parts of Westmorland in the summer of 1933 the first plants of *A. tenuis* did not come into flower until the last week of June, whereas in Cambridgeshire plants were flowering at least a week earlier. Altitude also affects the time of flowering, for in Cardigan in 1934 *A. canina* growing almost at sea-level in Borth Bog had all the panicles with open spikelets on the basal branches on July 3rd, but on the slopes of Drybedd at from 1200–1400 ft. (370–430 metres) two days later most of the panicles

TABLE VI.—Times of anthesis.

Species.	Godron *.	Splechtner *.	Fruwirth *.	Wright †.	Philipson †.
A. stolonifera	11·0 a.m.	—	12·0 a.m.	—	10.0 –11.30 a.m.
A. gigantea	—	6.30–7.30 p.m.	—	4.0–4.30 p.m.	2.30– 3.30 p.m.
A. tenuis	11.0 a.m.	—	—	4·0–4.30 p.m.	1.0 –2.30 p.m.
A. canina	11.0 a.m.	—	—	5.0–6.30 a.m.	4.0 – 5.0 a.m.
A. setacea	—	—	—	—	4.30– 5.30 a.m.

were not protruded, and were a week or more behind those at sea-level. Similar differences have been noted in South Wales, the Lake District, and Northumberland.

The process of flowering in a given plant takes place during a limited period each day. The different plants of a species have been found to flower at much the same time at Kew, and the species each have a distinct time at which anthesis is at a maximum. The results of other workers are tabulated (Table VI), and the discrepancies may be due to the alteration of flowering time by external conditions or to the uncertainty of taxonomy and nomenclature which is so frequent in this genus.

The time of flowering certainly varies with the conditions of weather and station ; but it has not been possible to analyse these effects in detail. The good

* See Bibliography (p. 150).

† Times are Greenwich Mean Time.

agreement between the results at Kew and those obtained by Wright at Bingley (who has kindly permitted me to use his unpublished data) show that the time of flowering is probably constant in a species within very narrow limits. The results obtained at Kew were all taken in the Experimental Plots with plants of very diverse origin. It is significant that on June 27, 1935, twelve plants of *A. canina* (that is, all that were in flower) began to shed their pollen within fifteen minutes of each other, though the plants belonged to different varieties and had been brought from Scotland, Ireland, Wales, and various parts of England.

Flowering in a given spikelet is begun by the anthers swelling and becoming prominently visible through the glumes. When the time of flowering arrives the glumes open slightly at first, probably merely by the slight protrusion of the anthers, but after a longer or shorter period of rest in this position, perhaps of minutes only or even hours, the gape of 10°–20° is quickly changed to one

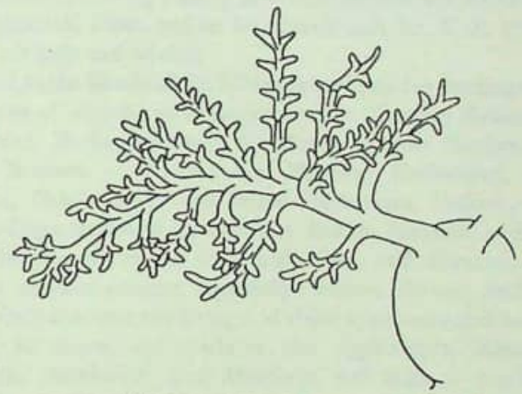

FIG. 18.—Stigma of *A. canina*.

of about 50°, and if a spikelet is dissected in this condition the swollen lodicules will be seen between the ovary and the lemma. During the few minutes required for this swelling of the lodicules the filaments elongate and the anthers protrude above the lemma. Dehiscence begins at the apex of each lobe and can be seen to move quickly to the base. The anthers usually become pendulous ; but on a still day they may remain jammed between the apices of the glumes. The pollen may be dispersed gently or in a sudden cloud if the plant is jolted. During dehiscence the stigmas bend slowly outwards, and about fifteen minutes after the swelling of the lodicules they are spread horizontally from the angle between the gaping glumes.

The diameter of fresh pollen was measured (Table VII) and the species have different but not distinct ranges of pollen-size. The stigmas are inserted below the apex of the ovary and are simply plumose (fig. 18) with papillose cells on the branches.

The closing of the spikelet is a more variable process than the opening. The glumes may close again shortly after dehiscence trapping the empty anthers or they may close more slowly when usually the anthers break off. Spikelets frequently open again on the second day when if the anthers are still present they may be confused with flowering spikelets, and since these spikelets are the first to open a mistaken flowering-time may be recorded. It was thought at first that these spikelets might have remained unpollinated on the first day, but since the stigmas were never seen exserted on the second day this does not seem probable. The glumes may remain gaping until the evening of the day of flowering, that is in *A. canina* for over twelve hours, and during all this time the stigmas may not be withdrawn but remain horizontal. It is usual, however, for the stigmas to become vertical within an hour of flowering and for the glumes to close.

Flowering in a panicle begins at the apex, and on the first day usually very few spikelets at the apices of the uppermost branches open, but on the second day the whole of the upper half or two-thirds of the panicle will be in flower,

TABLE VII.—Pollen-size.

A. setacea	1·8–2·8 μ	*A. gigantea*	3·4–4·6 μ
A. canina	1·8–2·8 μ	*A. stolonifera*	3·4–4·6 μ
A. tenuis	2·4–3·4 μ	*A. semiverticillata* ...	2·4–3·4 μ

and on the third day spikelets on the basal branches will open so that the whole panicle flowers in from three to five days.

The period over which anthesis takes place on a given day varies in the different species; but each has a clearly marked maximum period. In *A. canina* flowering is soon over, and all the plants flowered at much the same time In *A. tenuis*, on the other hand, flowering began more gradually, the maximum period being perhaps an hour after the first spikelets opened and the different plants did not flower so simultaneously. *A. stolonifera* and *A. gigantea* resembled *A. tenuis* in this respect.

In *A. canina* there was a tendency, especially on the later days of flowering, for the branchlets to close against the branches and for these to be raised slightly during the morning and late afternoon, to spread again before flowering the next morning. In *A. stolonifera* this closing was not so noticeable, but the panicles of both these species and of *A. setacea* become tightly closed and spike-like immediately after the panicle has finished flowering. Plants of both *A. canina* and *A. stolonifera* were observed to be flowering at the apex of the panicle before it had begun to expand, and rarely the panicle would remain spike-like throughout the flowering period. The panicles of *A. tenuis* and *A. gigantea* remain spreading after flowering, although the branchlets may close against the branches, especially in the latter species.

All the panicles of a plant do not begin to flower on the same day, but the last to flower is seldom more than two or three days after the first. The difference between different plants of the same species is more considerable, not only because of differences in their environment but because of an inherent difference which has already been shown to be constant in a plant from year to year. Similarly there is little or no appreciable difference between the time of day at which panicles of the same plant begin to flower, but there may be a difference of an hour or more between different plants of the same species.

ACKNOWLEDGMENTS.

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I am indebted to the Heads of the following herbaria for sending me collections of British species of *Agrostis* or type-specimens: Muséum National d'Histoire Naturelle, Paris; Berlin-Dahlem; the Royal Botanic Garden, Edinburgh; the National Museum of Wales; the Fielding Herbarium, Oxford; the Botany School, Cambridge; the Druce Herbarium, Oxford; and to the Keeper of the Department of Botany, the British Museum, and the Linnean Society for allowing me to use their collections and libraries, and also to the numerous private persons, especially Messrs. Jansen and Wachter of Amsterdam, who have sent me living and dried specimens and seeds.

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SUMMARY.

1. A taxonomic revision of the British species of *Agrostis* has been made and the forms arranged under the following species and varieties, to which a Key is given :—

1. *Agrostis setacea* Curtis.
2. —— *canina* (Linn.) var. *fascicularis* Sinclair.
3. —— —— var. *arida* Schlecht.
4. —— *tenuis* (Sibth.) var. *hispida* (Willd.) Philipson.
5. —— —— var. *humilis* (Aschers. & Graebn.) Druce.
6. —— *gigantea* (Roth) var. *ramosa* (S. F. Gray) Philipson.
7. —— —— var. *dispar* (Michx.) Philipson.
8. —— *stolonifera* (Linn.) var. *stolonifera* (Linn.) Koch.
9. —— —— var. *palustris* (Huds.) Farw.
10. —— *semiverticillata* (Forssk.) Christens.

Each of these species and varieties are described and a complete synonymy is given. Representative specimens from several British herbaria are cited and notes on distribution, flowering, etc., are included. Variations of less than varietal rank are recorded, and in the case of *A. stolonifera* var. *stolonifera* four ecads are recognized.

One inter-generic and two inter-specific hybrids are described.

Short diagnoses are given of the alien species, and a Key to all the species, native and alien, is provided.

2. The phenomena of variation and fluctuation are examined as they occur within the species and in natural populations, and upon this data a discussion of the status of the taxonomic categories is based.

3. The anatomy of the species and more important varieties is described, and its relationship to taxonomy is discussed.

4. The development of the plants from germination to flowering is described, especial emphasis being given to those characters which are of taxonomic importance.

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PHILIPSON

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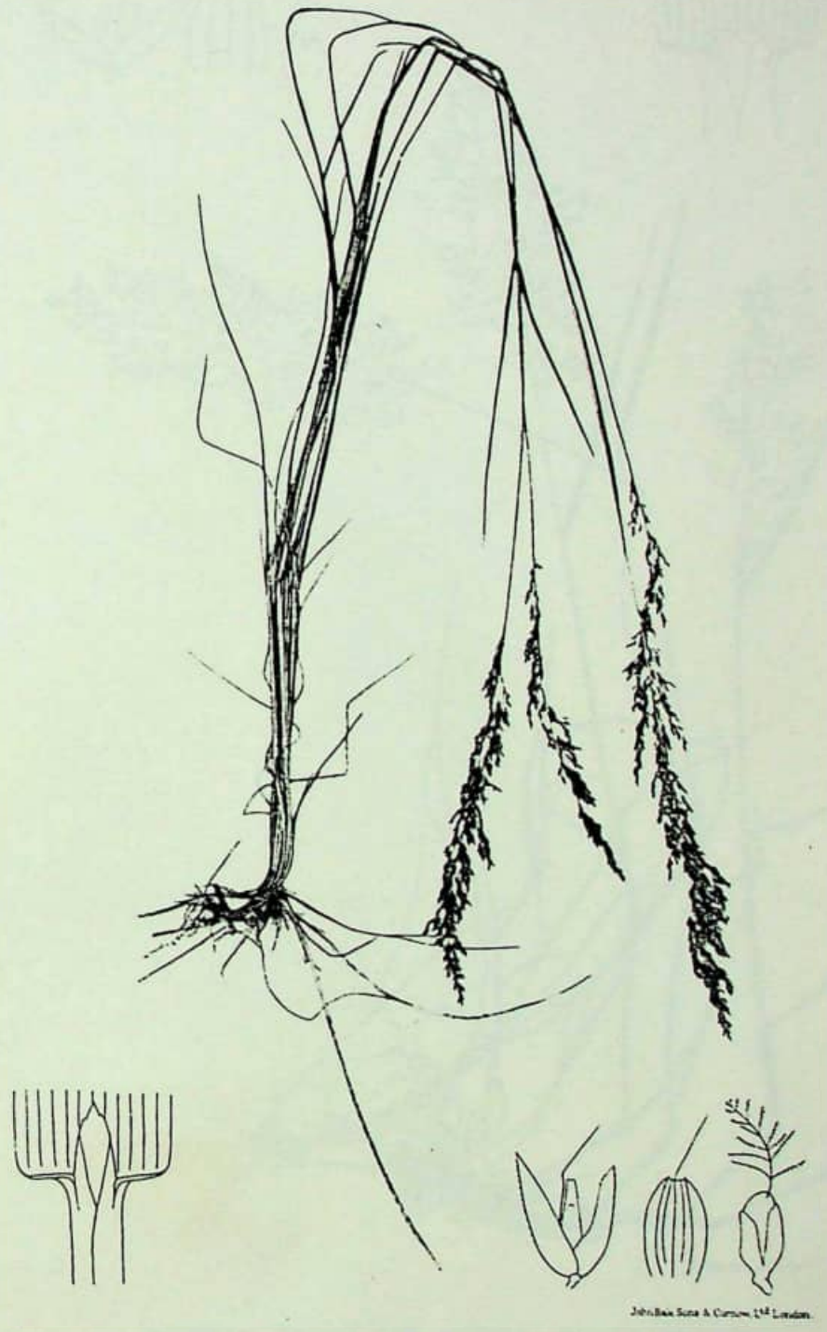
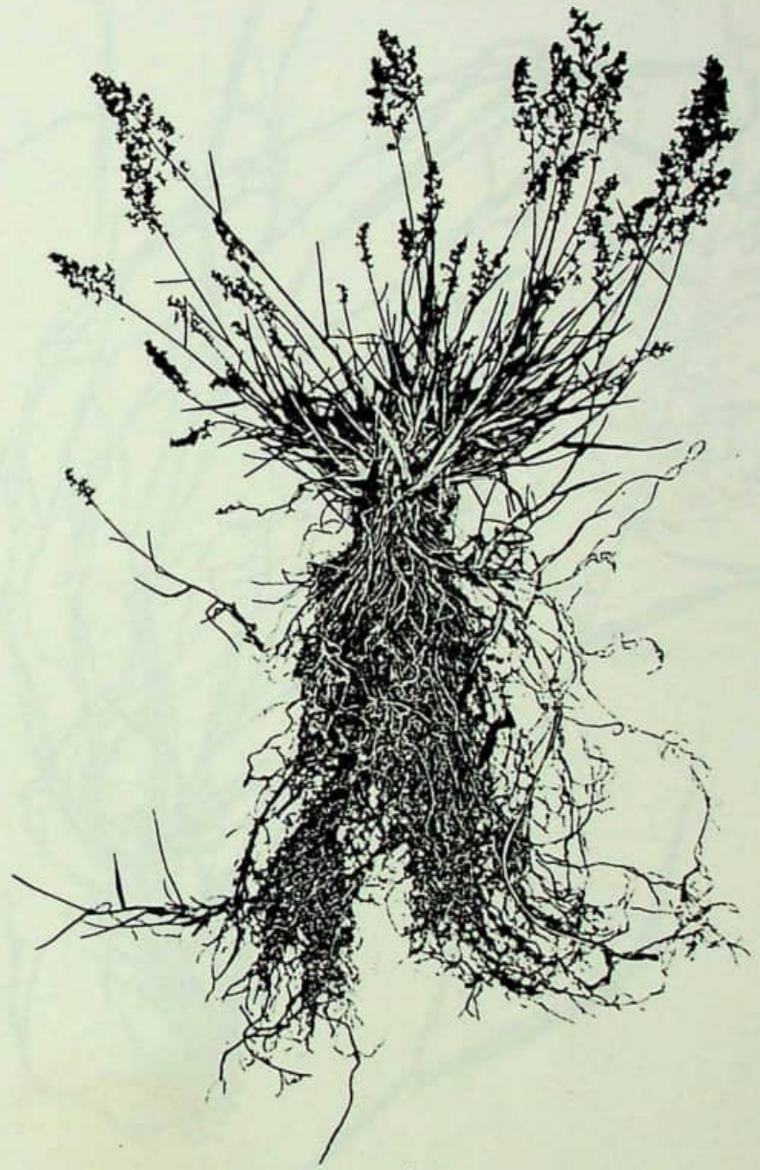
AGROSTIS SETACEA CURT.

AGROSTIS CANINA VAR. FASCICULARIS SINCLAIR



AGROSTIS CANINA VAR. ARIDA SCHLECHT.

AGROSTIS TENUIS VAR. HISPIDA (WILLD.) PHILIPSON



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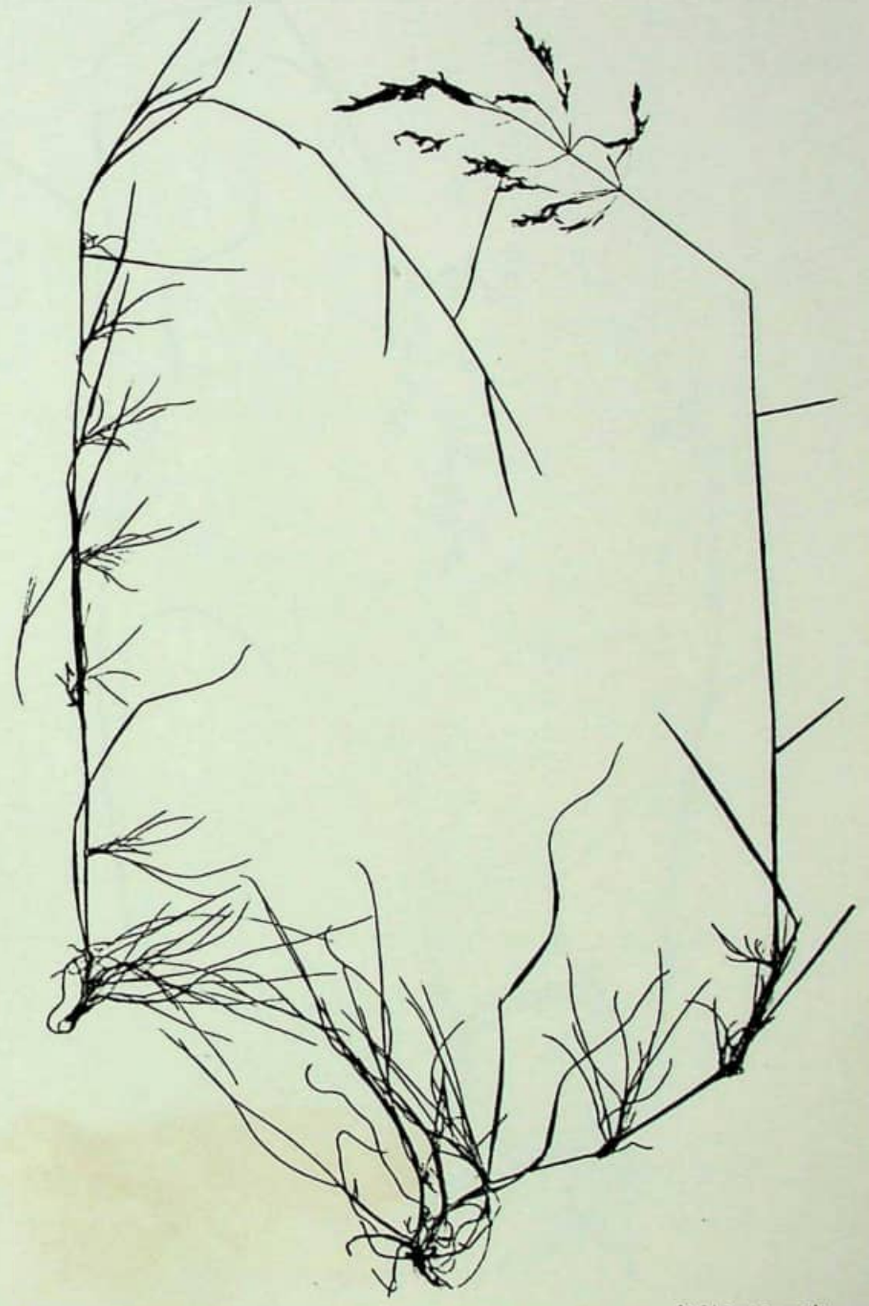

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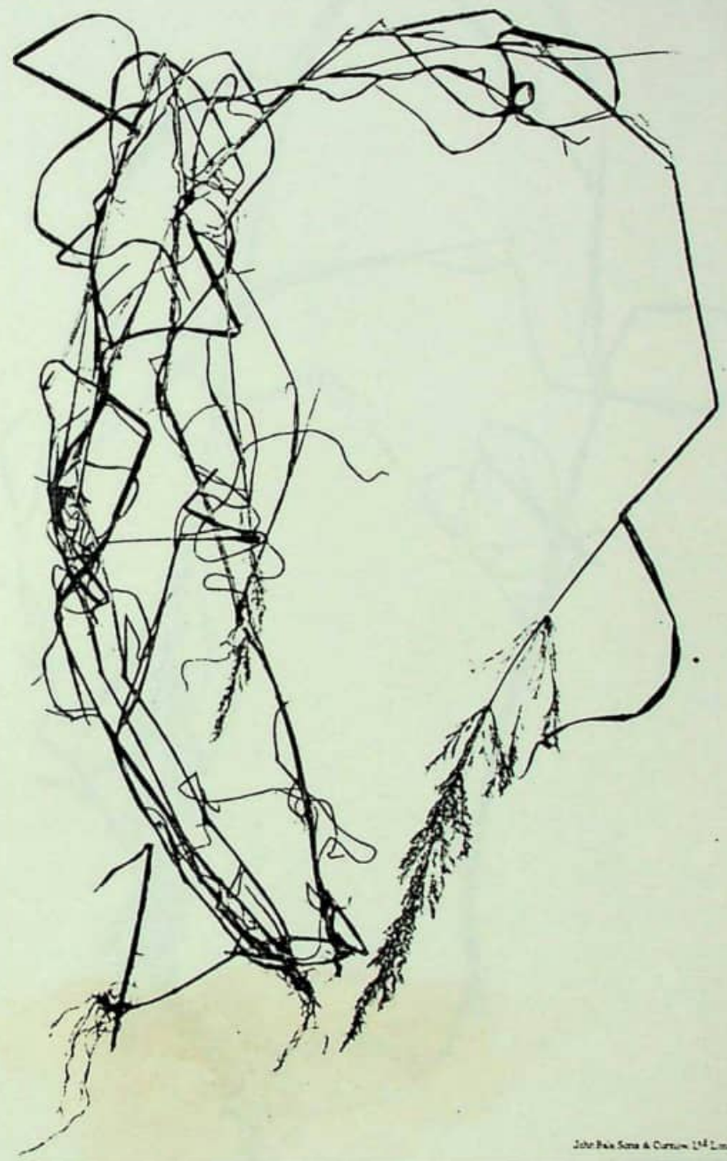

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EXPLANATION OF THE PLATES.

PLATE 4.—*A. setacea* Curtis. Inset: above, ligule; below, spikelet, lemma, ovary with palea and lodicule.

PLATE 5.—*A. canina* var. *fascicularis* (Curtis) Sinclair.

PLATE 6.—*A. canina* var. *arida* Schlect. Inset: left, ligule; right, spikelet, lemma, ovary with palea and lodicule.

PLATE 7.—*A. tenuis* var. *hispida* (Willd.) Philipson. Inset: left, spikelet, lemma, palea, lodicules (above); right, ligule.

PLATE 8.—*A. tenuis* var. *humilis* (Aschers. & Graebn.) Druce.

PLATE 9.—*A. gigantea* var. *ramosa* (S. F. Gray) Philipson.

PLATE 10.—*A. gigantea* var. *dispar* (Michx.) Philipson. Inset: above, ligule; below, spikelet, lemma, palea, lodicules (above).

PLATE 11.—*A. stolonifera* var. *stolonifera* ecas *stolonifera* (Linn.) Philipson. Inset: spikelet, lemma, palea, lodicules (above), ligule.

PLATE 12.—*A. stolonifera* var. *stolonifera* ecas *calcicola* Philipson. Type specimen.

PLATE 13.—*A. stolonifera* var. *palustris* (Huds.) Farw.

PLATE 14.—*A. canina* var. *fascicularis* Sinclair. Collected in a marsh in shade, at Sweethope Lough, Northumberland.

PLATE 15.—*A. canina* var. *fascicularis* Sinclair. From the same plant as Plate 14, after cultivation at Kew.

PLATE 16.—*A. tenuis* Sibth. Collected on dry soil in shade at Box Hill, Surrey.

PLATE 17.—*A. tenuis* Sibth. From the same plant as Plate 16, after cultivation at Kew.

PLATE 18.—*A. stolonifera* var. *palustris* (Huds.) Farw. Box Hill, Surrey, growing with the plant in Plate 19.

PLATE 19.—*A. gigantea* var. *ramosa* (Gray) Philipson. Box Hill, Surrey, growing with the plant in Plate 18.

PLATE 20.—*A. stolonifera* var. *stolonifera* (Linn.) Koch. Borth, Cardigan, growing with the plant in Plate 21.

PLATE 21.—*A. tenuis* Sibth. Borth, Cardigan, growing with the plant in Plate 20.