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Delimitation of taxa and cultivars of red fescue (Festuca rubra L. sensu lato)

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Summary

Red fescue (Festuca rubra L. s. l.) is a widely distributed cross-fertilizing species represented in nature by different ecotypes. It is also a cultivated species of which in the EEC more than 10 million kg of seed is produced each year. A cultivated species is not bound by natural borders so that the relation with the original distribution pattern gets lost.

Latin species names are internationally used in education, legislation, agricultural research and seed trade. This presupposes that normally developed

Abgrenzung von Taxa und Sorten von Rotschwingel (Festuca rubra L. sensu lato)

Zusammenfassung

Rotschwingel (Festuca rubra L. s. l.) ist eine weitverbreitete fremdbefruchtende Art, die in der natürlichen Vegetation durch unterschiedliche Ökotypen repräsentiert wird.

Zugleich ist es eine Kulturart, wovon in der EWG jährlich mehr als 10 Millionen kg Samen produziert werden.

Eine Kulturart ist nicht an natürliche Grenzen gebunden, so daß die Relation mit den ursprünglichen Standorten verschwindet.

Die lateinischen Artbezeichnungen werden überall benutzt beim Unterricht, bei der Gesetzgebung, der landwirtschaftlichen Forschung, dem Samenhandel, usw. Dies unterstellt, daß von jeder normal entwickelten Pflanze unter sehr verschiedenen Umständen einfach festgestellt werden kann, zu welcher Art sie gehört. Demzufolge ist insbesondere für Fremdbefruchter ein breiter morphologischer Artbegriff angebracht, wobei die Abgrenzung der Arten basiert auf einer deutlichen Diskontinuität in mindestens zwei morphologischen Merkmalen. Andererseits werden Subspezies verstanden als Taxa, die bestimmte ökologische / geographische

Délimitation des taxa et des cultivars de fétuque rouge (Festuca rubra L. sensu lato)

Résumé

Le fétuque rouge (Festuca rubra L .s. l.) est une espèce allogame très répandue qui est représentée dans la végétation naturelle par des écotypes différentes. En même temps c'est une espèce cultivée dont plus de dix millions de kg de semence sont produits dans le CEE chaque année.

Une espèce cultivée n'est pas liée aux frontières naturelles si bien que la relation avec la répartition originale se perdra.

Les noms d'espèce Latins sont utilisés partout dans l'éducation, la législation, la recherche agronomique, le commerce etc. Ceci présuppose que chaque plante normalement développée peut facilement être identifiable quant à son nom d'espèce sous des conditions très diverses. Par conséquence, en particulier pour les espèces allogames, une notion d'espèce assez large est requirée dans laquelle la délimitation entre deux espèces se base sur une discontinuité claire dans aux moins deux caractères morphologiques. De l'autre côté les

plants must be identifiable as to their species names under a broad scale of circumstances. Consequently, in particular in cross-fertilized species, a wide morphological species concept is required whereby the delimitation between the species is based on a clear discontinuity in two or more morphological characters. On the other hand subspecies are conceived as taxa with a certain ecological/geographical area showing some morphological intergradation.
One can observe an inflation in rank in literature when within Festuca rubra L. s. l. some micro species are distinguished e. g. Festuca nigrescens and F. diffusa. The morphological species concept has not been respected to a sufficient degree. A uniform and stable Latin nomenclature is pursued in practice with help of the ISTA List of Stabilized Plant Names.
A cultivar is a group of plants which is distinct, sufficiently uniform (defined in relation to its way of reproduction) and stable. Cultivars are distinguished on morphological and physiological characters, including chromosome number. For practical purposes the cultivars of red fescue are at present divided into three groups, viz.:

hexaploid non-creeping red fescue
hexaploid creeping red fescue
octoploid creeping red fescue

The borderline between non-creeping and creeping is not sharp since there is a continuum in the proportion of intravaginal and extravaginal shoots. With the exception of chromosome number all investigated characters show continous series and the borderlines between the cultivar groups do not coincide with a discontinuity in a morphological character. On the basis of the morphological characters the chromosome number of a creeping red fescue plant cannot be predicted.
Since apparently none of the cultivar groups coincides with a certain taxon no Latin name can be associated with a cultivar group.
On the basis of an ecological/geographical subspecies concept the following subspecies can be designated in the Dutch habitats.

Festuca rubra subsp. commutata Gaud.
Festuca rubra subsp. litoralis (G. F. W. Meyer) Auquier
Festuca rubra subsp. arenaria (Osbeck) Richter

Further research is necessary to elucidate the taxonomic position of e. g.

Festuca rubra subsp. planifolia (Hackel) Hayek.

The fact that several taxa show character combinations not yet represented in the cultivars offers perspectives for plant breeding.

Standorte einnehmen und einige morphologische Intergradation zeigen.
In der Literatur zeigt sich eine Ranginflation, wenn jetzt innerhalb Festuca rubra L. s. l. Kleinarten unterschieden werden, z. B. Festuca nigrescens und Festuca diffusa. Der morphologische Artbegriff wird nicht hinreichend respektiert. Eine uniforme und beständige lateinische Nomenklatur wird in der Praxis angestrebt mit Hilfe der ISTA-liste von stabilisierten Pflanzennamen.
Eine Sorte ist eine Gruppe von Pflanzen, die unterscheidbar, hinreichend homogen und beständig ist; die Homogenität wird in Verbindung mit der Vermehrungsweise der Sorte definiert. Sorten werden auf Grund von morphologischen und physiologischen Merkmalen, einschließlich Chromosomenzahl, voneinander unterschieden. Für praktische Zwecke werden die Rotschwingelsorten zur Zeit in drei Gruppen eingeteilt:

hexaploid nicht-kriechender Rotschwingel
hexaploid kriechender Rotschwingel
octoploid kriechender Rotschwingel

Die Abgrenzung zwischen nicht-kriechend und kriechend ist nicht scharf, weil es ein Kontinuum gibt in dem zahlenmäßigen Verhältnis von intravaginalen und extravaginalen Sprossen.
Mit Ausnahme der Chromosomenzahl zeigen alle untersuchten Merkmale kontinuierliche Reihen und die Grenzen zwischen den Sortengruppen fallen nirgendwo zusammen mit einer Diskontinuität in einem morphologischen Merkmal.
Auf Grund der morphologischen Merkmale kann man die Chromosomenzahl einer kriechenden Rotschwingelpflanze nicht vorhersagen.
Weil offensichtlich keine der Sortengruppen mit einem bestimmten Taxon zusammenfällt, kann auch keine der lateinischen Namen mit einer Sortengruppe verbunden werden.
Auf der Grundlage eines standort-spezifischen Subspeziesbegriffes können in dem niederländischen Raum folgende Subspezies angegeben werden:

Festuca rubra subsp. commutata Gaud.
Festuca rubra subsp. litoralis (G. F. W. Meyer) Auquier
Festuca rubra subsp. arenaria (Osbeck) Richter

Weitere Untersuchungen sind notwendig zur Aufklärung der taxonomischen Stellung von:

Festuca rubra subsp. planifolia (Hackel) Hayek

Die Tatsache, daß verschiedene Taxa Merkmalskombinationen zeigen, welche noch nicht in den Sorten vorhanden sind, bietet Perspektiven für die Pflanzenzüchtung.

sousespèces sont conçues comme taxa avec un certain territoire écologique/géographique et montant quelque intergradation morphologique.
On peut observer une inflation de rang dans la litérature quand on distingue quelques micro-espèces dans Festuca rubra L. s. l. p. e. Festuca nigrescens et Festuca diffusa. La notion d'espèce morphologique n'a pas été respectée suffisamment.
Une nomenclature uniforme et stable est poursuite par la constitution des listes de noms de plantes stabilisées par l'ISTA.
Une cultivar est un groupe de plantes qui est distinct, suffisamment homogène et stable; l'homogénéité est définie en relation avec la manière de réproduction de la cultivar.
Les cultivars sont distinguées par des caractères morphologiques et physiologiques, y compris le nombre de chromosomes.
Pour les buts pratiques les cultivars de fétuque rouge sont actuellement classées en trois groupes, à savoir:

fétuque rouge hexaploide non-traçant
fétuque rouge hexaploide traçant
fétuque rouge octoploide traçant

La démarcation entre non-traçant et traçant n'est pas nette car il existe une continuité dans la proportion des innovations intravaginales et extravaginales d'une plante.
A l'exception du nombre de chromosomes tous les caractères étudiés montrent une continuité et les limites des trois groupes de cultivars ne coincident pas avec une discontinuité dans un caractère morphologique. Sur la base des caractères morphologiques on ne peut pas pronostiquer le nombre de chromosomes d'une plante de fétuque rouge traçant.
Puisqu'apparemment aucun des groupes de cultivars coincide avec un taxon, il est impossible d'associer un nom Latin avec un groupe de cultivars.
Sur la base d'une conception de sous-espèce écologique/géographique les sousespèces suivantes peuvent être désignées dans les habitats Néerlandais:

Festuca rubra subsp. commutata Gaud.
Festuca rubra subsp. litoralis (G. F. W. Meyer) Auquier
Festuca rubra subsp. arenaria (Osbeck) Richter

Continuation de la recherche sera nécessaire pour élucider la position taxonomique de

Festuca rubra subsp. planifolia (Hackel) Hayek.

Le fait que plusieurs taxa montrent des combinaisons de caractères qui ne sont pas encore représentées parmi les cultivars offre des perspectives pour l'amélioration des plantes.

1. Introduction

Red fescue (Festuca rubra L. s. l.) is a polymorphic species that is very common and widely distributed in Western Europe. It occurs in diverging habitats; in some areas with very specific ecological conditions the natural vegetation consists of distinct ecotypes, e. g. non creeping red fescue of the dry sandy soils, salt marsh fescue and dune fescue. These ecotypes are often separated from one another by spatial isolation and/or genetic crossing barriers, so that in nature hardly any hybridization occurs between the different ecotypes. Red fescue, however, has also become a cultivated species and within this species plant breeding is going on on a large scale. From different ecotypes plants are collected that meet each other at the breeding stations. From these ecotypes through narrowed populations cultivars *) are made but also new combinations may arise through hybridization. By the activities of the plant breeders already many cultivars have been deve-

loped that suit specific purposes. In the OECD List of Cultivars Eligible for Certification 1980 114 cultivars of red fescue from thirteen countries in Europe and North America are listed. In the nine countries of the European Economic Community on average a total of more than 10 million kg of seed of these red fescue cultivars is produced each year.
As a consequence of the regular sowing of this seed in different areas, the original ecological/geographical distribution pattern is disturbed and intermingling will take place between the cultivars and the ecotypes in their natural habitats.

2. Prolegomena

– In human society species names are used in many instances, e.g. in education, legislation, agricultural research and seed trade.
– Optimal communication is pursued by the use of Latin names following the International Code of Botanical Nomenclature. Article 28.1 prescribes that plants brought from the wild into cultivation retain the names that are applied to the same taxa in nature.
– The species must be defined in such a way that every normally developed individual plant can be identified ("keyed out") as to its species name, irrespective of the place where the plant is growing.
– The identification should at the same time be certain and simple; only characters that can be assessed with the naked eye or a hand lens are practicable for identification in every day life.
– National laws and international agreements are only revised incidently and not in all countries at the same time. For practical usage Latin names should be changed only when this is absolutely unavoidable.
– The ISTA-List of Stabilized Plant Names (ISTA, 1966) has served as a buffer between the research on the front lines of our knowledge and the practical needs of human society and will hopefully continue to do so.
– The results of monographic work and revisions published in scientific periodicals and books should be absorbed in the Stabilized List only after they have been accepted by a broad international forum.

3. Cultivar description and classification

3.1 Concepts and criteria

A taxon is a botanical unit with a Latin name. The nomenclature is governed by the International Code for Botanical Nomenclature (ICBN, Stafleu et al. 1978). According to this code the application of names of taxa is determined by means of nomenclatural types; a nomenclatural type is that element to which the name of the taxon is permanently attached. The nomenclatural type is not necessarily the most typical or representative element of the taxon. The frequency distribution of different forms within a taxon is not defined. Since every individual is treated as belonging to a number of taxa of consecutively subordinate ranks, in each rank all taxa together cover the total variation.
A cultivar (variety) is a unit for agricultural use (agriculture in the broad sense). The nomenclature is governed by the International Code of Nomenclature for cultivated plants (Brickell et al, 1980), under auspices of the same organization as the ICBN. Cultivars are given a fancy name, that is a name of a non-Latin form. As far as genetic variation is present within a cultivar its frequency distribution is known and stable after repeated reproduction. Cultivars are man-made groups. Only a limited number of plants is selected, maintained and given a name as a cultivar. So the cultivars do not cover the total variation.
Therefore we consider a cultivar not to be a taxon.
In the national legislation of many countries and also in international organizations like EEC and UPOV requirements have been formulated which candidate cultivars must satisfy in order to be accepted. The cultivar concepts vary with the way of reproduction, e.g. apomictic, vegetatively reproduced, self fertilized, random mating, F1 hybrid. In red fescue only random mating varieties are known.
Candidate cultivars are judged on three criteria: distinctness, uniformity (= homogeneity), and stability.
A cultivar is considered to be distinct if it is clearly distinguishable by one or more important characters from any other variety whose existence is known at the time of examination. Preferably, characters are used that are capable of precise description and recognition and are not much influenced by the environment, so that the sequence of the cultivars remains the same irrespective of the conditions.
A random mating cultivar is considered to be sufficiently uniform if for each continuous linear measurable character it shows a normal distribution with a standard deviation that does not exceed that of the already accepted varieties. A normal distribution is characterizid by two parameters: the mean and the standard deviation. On the basis of the mean values of the characters the variesties are classified and described. For the sake of completeness it is mentioned that a random mating cultivar of red fescue must be uniform for discontinuous characters, e.g. number of chromosomes.
A cultivar is considered to be stable if it remains true to type after isolated reproduction.

3.2 Methods of cultivar research

Every year at the RIVRO trial farm "De Hoge Born" at Wageningen a new registration trial of about 1.5 ha is grown that remains for one and a half year. Such a trial always consists of two parts, viz. a part with single plants and a part with rows.
For the single plant trial 60 plants of every variety are raised in the greenhouse and planted in the field in three replications of 20 plants each. The row trial has

Single plant trial with cultivars of different grass species at RIVRO, Wageningen

*) To avoid misunderstanding with the word variety in the taxonomic sense, we use the word cultivar, although variety in the agronomic sense is commonly used in agriculture, also for red fescue.

two replications of two rows, each 2.50 m. In red fescue the rhizome formation, the growth habit of the plant and the size, colour and degree of folding of the vegetative leaf are observed in the summer and autumn of the sowing year.

In the spring of the year following, the time of panicle emergence of each plant is observed by going through the trial three times a week and recording for each plant the date on which in three tillers the panicle is just visible. About the time of panicle emergence the length and the width of the flag leaf of one culm per plant are measured.

After anthesis, when the culms have reached their maximum length, the plant height and the length of the panicle are measured.

In this way 60 observations per cultivar are obtained for each character. On the basis of these data the mean and the variation per cultivar, the variation of the total assortment and the accuracy of the measurements can be calculated.

Furthermore the ploidy level of a cultivar is assessed by counting the number of chromosomes in squash preparates of root tips of germinating seeds. In view of the entry in the "Dutch Variety Register" new applications are studied during three subsequent years in field trials in comparison with the largest possible reference collection.

In 1980 in 59 red fescue cultivars other characters have been observed in four plants per cultivar chosen at random, viz.:

the number of ribs, the hairiness of the lower and upper surface of the vegetative leaf blade and the hairiness of the leaf sheath at about a month before panicle emergence,

the number of nerves in a cross section of blades of the flag leaves,

the number of spikelets per panicle, the length and the hairiness of the length of the lower panicle internode,

In 1978 a special trial was executed to assess the salt tolerance. Before the results of the investigations are summarized it may be useful to spend a few words on the shoots and the rhizomes which were studied in much detail by Keyzer (1975).

In his Monographia Festucarum Europaearum (1882), Hackel distinguishes between extravaginal and intravaginal shoots. An extravaginal shoot breaks through the base of the leaf sheath with a wide angle, often even perpendicular to the main stem. The prophyl is elliptic and the leaves on the first nodes are undifferentiated. An intravaginal shoot grows practically parallel to the main stem inside the leaf sheath. The prophyl is rather long and from the very first node onwards all leaves are differentiated, so that the junction between the leaf sheath and the leaf blade is clearly visible.

Both the extravaginal and the intravaginal shoots show internode elongation. Elongated extravaginal shoots always grow below the soil surface and are called rhizomes. Under certain conditions the lower internodes of an intravaginal shoot can elongate; the growing point of the tiller with some leaves will rise, thus forming an aerial tiller. An intravaginal shoot may have several elongated internodes; when such a shoot lies on the ground it is sometimes called a stolon, when covered with soil it is sometimes — erronously — called a rhizome.

3.3 Results

In cultivar research and in the seed trade it is international practice to classify the cultivars into three groups

Figure 1. Shoots of red fescue

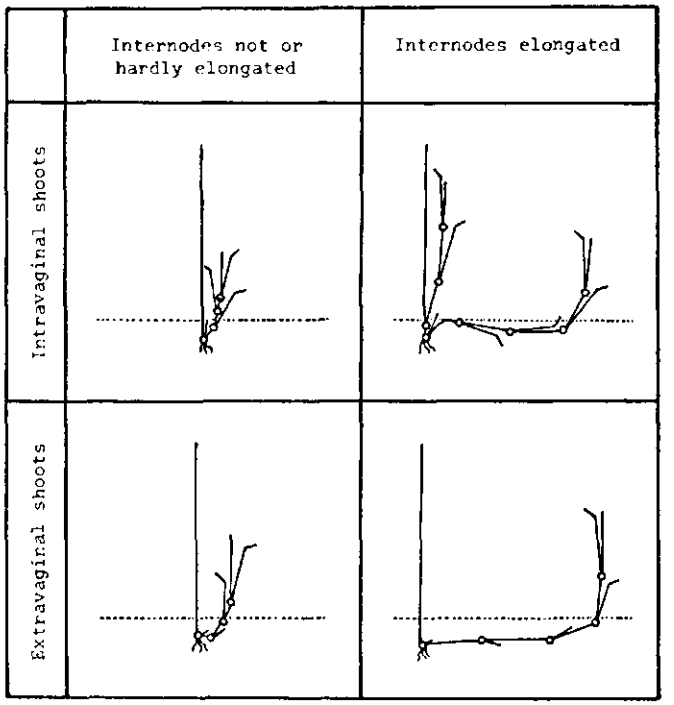

Table 1. Variation in some characters of individual plants belonging to three cultivar groups of red fescue, Wageningen 1980

group / character	hexaploid non-creeping	hexaploid creeping	octoploid creeping
chromosome number 2n =	42	42	56
intravaginal shoots	abundant	frequent	rare-frequent
extravaginal shoots			
presence	absent-rare	more or less frequent	abundant
length	if present very short	short-medium	medium-long
vegetative leaf blade:			
shape	open-folded	open-folded	open-folded
number of ribs	5–9	5–9	5–11
hairiness			
upper side	glabrous-hairy	glabrous-hairy	glabrous-hairy
hairiness	glabrous-	glabrous-	glabrous-
lower side	sparsely hairy at the base	sparsely hairy at the base	sparsely hairy at the base
vegetative leaf sheath:			
hairiness	glabrous-hairy	glabrous-hairy	glabrous-hairy
ear emergence days after 31 March	10–50	20–50	25–50
flag leaf blade:			
shape	open	open	open
length	4–20 cm	4–16 cm	4–20 cm
width	1.0–4.0 mm	1.5–4.0 mm	1.5–4.0 mm
number of veins	7–14	7–15	8–15
plant height	55–110 cm	30–90 cm	60–100 cm
panicle:			
length	5–18 cm	5–13 cm	9–18 cm
length lower internode	2.5–5 cm	2–4 cm	3–6 cm
number of spikelets	14–60	10–40	16–54
lemma length	4–7 mm	4–7 mm	5–7 cm
awn length	0.6–2.8 mm	0.4–2.4 mm	0.6–2.0 mm
lemma hairiness	glabrous-hairy	glabrous	glabrous-hairy
salt tolerance	more or less susceptible	tolerant – susceptible	more or less susceptible

on account of the number of chromosomes and the degree of rhizome formation. Two chromosome numbers have been found, viz. 2n = 42 and 2n = 56.

Within a red fescue plant we generally observe a combination of several shoot types described in section 3.2. The relative proportion of each of the types determines the size and density of the plant; it is our experience that it is not always easy to decide whether a given shoot is extravaginal or intravaginal, especially in older plants.

Table 1 gives a survey of the range of variation of the characters in individual plants in each of the three groups. The fluctuations occuring from location to, location or from year to year have not been included in the range, so that the figures give an indication of the genetic variation only.

In hexaploid non-creeping red fescue, the longest awns are found but the variation between plants is great. On average, hexaploid creeping red fescue plants have a shorter culm and smaller flag leaves. Cultivars selected from sea marsh fescue are more extreme in these characters than cultivars from inland origin. Haired lemmas were not found in our hexaploid creeping cultivars. The octoploid creeping red fescues have on average the widest flag leaves and the longest rhizomes.

In a small number of plants the shape of the fibrous tissue was studied in microscopic cross sections of flag leaves. The sklerenchymstrands were small and restricted to the lower leaf surface in the plants of hexaploid non-creeping red fescue. In the hexaploid creeping group the sklerenchyma was somewhat stronger developed and present in both the upper and the lower surface of the flagleaf. The sklerenchyma was still more developed in the plants of octoploid creeping cultivars where the strands sometimes touch the vascular bundels. In 1978 a large number of cultivars was tested for salt tolerance: For this purpose plants were sown in boxes on 29 March 1978. These were placed outside and received normal rainfall. The plants were sprayed with different NaCl solutions on 24 April 1978 and from then on once every 14 days till September.

Each of the three cultivar groups showed a range in susceptibility to high salt concentrations. Within the hexaploid creeping group there were both cultivars originating from the sea coast with the highest salt tolerance and cultivars originating from the south-eastern part of the Netherlands with a fairly low salt tolerance, comparable to the most tolerant cultivars in the other groups.

Table 2. Variation in salt tolerance of cultivars belonging to three cultivar groups of red fescue after two months salt treatment
Scale: 9 = no visible dammage; 1 = dead.

NaCl concentration	hexaploid non-creeping	hexaploid creeping	octoploid creeping
3 %	6–1	9–6	6–2
5 %	1–1	9–1	2–1

Concluding we can state that for each character with the exception of the chromosome number the variation proved to be continuous. When we compare the three groups with one another we see that the ranges overlap. The usual splitting in these three clusters is artificial, its purpose being to classify cultivars.

4. The classification of taxa according to Hackel compared with cultivar classification

In Table 3 the assortment of cultivars has been classified by the number of chromosomes, the degree of rhizome formation, the degree of folding of the radical leaf and the flag leaf, the hairiness of the lemma and the time of panicle emergence and panicle length.
Table 4 gives a survey of the Western European taxa according to Hackel (1882). The taxa have been classified by the degree of rhizome formation, the degree of folding of the radical leaf and the flag leaf and the hairiness of the lemma. The survey of the taxa according to Hackel is restricted to the taxa with a glabrous ovary, while taxa exclusively occurring in other areas than Western Europe have been omitted. This does not mean, however, that we exclude them from Festuca rubra L. s. l., but we have insufficient data about these taxa to include them in our considerations.
A problem with these classifications is the exact definition when a plant has folded or flat leaves: there are plants with conspicuously flat leaves and plants with tightly folded leaves, but there are also many transitional habits, together forming a continuum. Within the cultivars with predominantly open leaves most plants have flat leaves, but some plants may have folded leaves. Furthermore a plant's older, wider leaves are more open than its younger leaves. It is also quite possible that the borderline between open and closed leaves has not been drawn in exactly the same way by us as by Hackel (1882).
Another difficulty stems from the fact that the classification of the cultivars is also based on lemma hairiness. However, not only between the cultivars but also between the individuals within a cultivar one can find large differences in lemma hairiness. The set of characters in which cultivars have to be homogeneous according to the actual internationally agreed requirements may well differ from the characters used for delimitation of taxa.
Comparison of Table 3 with Table 4 shows that within the three cultivar groups several taxa can be distinguished, so that none of these commonly used groups coincides with any taxon.

5. Species and subspecies concepts

There is no universally accepted, precise definition of what a species is. If we look at the discontinuities for deliminating species we find that they are of different degrees and natures; there can be morphological discontinuities or discontinuities in breeding pattern.
Two main classes of species definitions can be distinguished: taxonomic species and biological species.
Since Linnaeus, the plant kingdom has been classified in a hierarchic system in which the species in the taxonomic sense is the essential unit. Linnaeus also was the first person to indicate plant species with a binomial. The original Linnean species or Linneont is a relatively large abstract unit.
Modern taxonomists, however, tend to give more weight to the biological nature of the species. In biological species two aspects are important: interbreeding between the species members and reproductive isolation from other populations. According to the biosystematist the intercrossing populations (natural units) are the true species. The trend to use either geographical or ecological data in taxonomy is widespread.
Certain Linneonts consist of microspecies which are isolated from one another by barriers that prevent intercrossing e. g. distance, chromosome numbers or incompatability genes.

Table 3 Classification of red fescue cultivars

ploidy	hexaploid				hexaploid		octoploid	
shoot	non-creeping				creeping		creeping	
radical leaf	open		folded		open	folded	open	
panicle length	medium	long	medium	long	medium	short	medium	long
panicle emergence: flag leaf / lemma: glabrous / early				Koket		Starlight		
glabrous / medium	Jamestown		Bingo[1], Lobi	Cirrus	Dawson, Oase	Golfrood		Engina, Ensylva, Envira, Novorubra, Rapid
glabrous / late			Agram, Frida, Gavotte, Parita[1]		Sonnet, Merlin	Manoir	Simone	Bargena, Moncorde, NFG, Ruby
more or less haired / early	Luster[1]	Veni	Encota[1], Highlight[1], Rapton[1]					
more or less haired / medium			Adonis	Diamond, Extase, Fidelimo, Mars, Menuet, Scarlet				Accent, Enzet, Gracia
more or less haired / late			Atlanta	Barfalla, Bolero, Waldorf, Jade				Agio

1) Leaf sheath anthocyanin coloration practically absent.

Table 4 Festuca rubra L. s. l. with glabrous ovary in Western Europe, according to Hackel (1882)

shoot	non-creeping (2n = 42)		more or less creeping (2n = 42)		more or less creeping (2n=56)	widely creeping
radical leaf / lemma / flag leaf	open	folded	open	folded	open	folded
open / glabrous	Frr Bartherei	Frr fallax sv grandiflora	Frr planifolia	Frr genuina -sv vulgaris -sv grandiflora f litoralis[1] -sv pruinosa[2][3] Frr trichophylla	Frr planifolia	Frr genuina sv juncea
open / more or less haired		Frr fallax sv barbata	Frr planifolia sv villiflora	Frr genuina -sv glaucescens -sv barbata	Frr planifolia sv villiflora	Frr genuina sv arenaria[4]
folded / glabrous		Frr oelandica		Frr trichophylla		
folded / more or less haired						Fr dumetorum[4]

xxxxx The cultivar survey of table 3 falls within this borderline.

Frr = Festuca rubra subsp. rubra (eu-rubra) var. ...
Fr = Festuca rubra subsp. ...
sv = subvar. f = forma.
1) Fr litoralis (G. F. W. Meyer) Auquier, although different, would occupy the same place in this table. 2) Hackel (1885). 3) According to Auquier (1971 a) also hairy specimens. 4) According to Auquier (1971 b) also glabrous specimens.

Many taxonomists still advocate adherence to the principles on which the Linneont is based. Van Steenis (1957) gives some examples of the tendency to raise for the sake of convenience taxa of cultivated plants to specific rank, although they do not deserve the rank of botanical species. This entails a devaluation of the higher ranks, which militates against the principles of scientific classification. He quotes Vavilov, one of the prominent plant breeders and geneticists of this century, who after intensive studies of cultivated plants and their relatives also decided to adhere to the large Linnean species. In the conclusion of their book, Davis and Heywood (1973) summarize (p. 487): "Species and other taxonomic groups in the Angiosperms are traditionally defined in such a way that they can be morphologically recognized. Species are groups of individuals sharing characters in common and separable from each other by highly correlated discontinuities in two or more features excluding geographical distribution." They also state (p. 99) "The subspecies has been widely accepted as a considerable segment of a species with a distinct area and more less distinct morphology, often showing some intergradation . . ."
These species and subspecies concepts appear to us an excellent starting point for our further considerations, since they are in line with our prolegomena.

6. The taxonomy of red fescue

In Table 5 a summary is given of the nomenclature of the Western European taxa of red fescue. The summary is restricted to the taxa with a glabrous ovary for which the Flora Europaea (Markgraf Dannenberg, 1980) indicates occurence in Western Europe. The taxa have been arranged according to the degree of rhizome formation as given by Hackel (1882), while the nomenclature of Hackel and some recent national floras are given as well.
It appears that Hackel's monography still serves as a basis for the delimitation, but many of his infraspecific taxa have been raised to a higher rank.
In our taxonomic analysis use is made of the fact that the bred cultivars originate from natural populations. They do not, however, represent an unbiassed sample of these populations: some agriculturally interesting ecotypes are overrepresented and the gap between creeping and non-creeping has probably been widened by the breeders who tend to discard the transitional types.
We apply the species and subspecies concepts as formulated by Davis and Heywood (1973). In view of the absence of two discontinuous characters the taxa in Table 5 cannot be considered as species. On account of their distinct ecological/geographical distribution, the occurence of two chromosome numbers and/or of some characters with a different mean but with some intergradation we consider some taxa in the Netherlands as subspecies of Festuca rubra L.

A commentary on the taxa of Table 5 is given.
– Festuca rubra subsp. commutata Gaud., 2n = 42, is rather common in the Netherlands on diluvial, poor, dry, sandy soils. The plants have no or very short rhizomes, the radical leaves are folded and rather fine. The plants can easily be confused (commutated!) with sheep's fescue or hard fescue (F. ovina L.s.l.); Hegi (1965) mentions the German name "trügerischer (= deceptive) Rotschwingel". Often a good look at the tubular shape of the leaf sheath is necessary to be sure it is red fescue.

Within this subspecies plants with the longest awns can be found, but there are also plants with a short awn (< ½ lemma); awn length is, therefore not decisive for this subspecies. Since furthermore neither in rhizome length nor in any other character a clear demarcation towards the following taxa can be found there is no ground to indicate this taxon on species level as Festuca nigrescens.

F. rubra subsp. commutata is often indicated as Chewings fescue; according to Hubbard (1974) the name is from Mr. Chewings, who first sold its seed in New Zealand. This is an example of a cultivar or provenance name becoming commonly used for a taxon, but also for a group of cultivars (viz. the hexaploid non-creeping red fescue cultivars).

– Festuca rubra subsp. litoralis (G. F. W. Meyer) Auquier, 2n = 42, grows in salt marshes on places that are

Table 5 Nomenclature of red fescue in Western Europe

	Monographia Festucarum europaearum Hackel 1882	Great Britain Hubbard 1968	France Kerguélen 1975	Belgium Langhe et al. 1978	Germany Oberdorfer 1979	Netherlands V.d. Meijden et al. 1980	Flora Europaea Markgraf-D. 1980
non-creeping	Frr fallax	Fr commutata	F nigrescens	F nigrescens	Fr commutata	F nigrescens	F nigrescens
more or less creeping	Frr gen.grandiflora litoralis[1]	Fr litoralis[3]	Fr litoralis	Fr litoralis	Fr litoralis	Fr litoralis	Fr litoralis
	Frr gen.pruinosa[2]	Frr pruinosa	Fr pruinosa	Fr pruinosa			Fr pruinosa
	Frr trichophylla		Fr trichoph.		Fr trichoph.		F trichoph.
	Frr gen.vulgaris	Frr vulgaris	(Fr rubra)[5]	Fr rubra	Fr rubra	Fr rubra	Fr rubra
	Frr planifolia	Fr multiflora[4]	Fr multiflora	Fr planifolia	Fr multiflora	(F diffusa?)	F diffusa
widely creeping	Frr gen. juncea		(Fr juncea)[6]	Fr juncea	Fr juncea	Fr juncea	Fr juncea
	Frr gen. arenaria	Frr arenaria	Fr arenaria	Fr arenaria	Fr arenaria	F arenaria	Fr arenaria
	Fr dumetorum	F juncifolia	F juncifolia	F juncifolia			F juncifolia

Frr gen. = Festuca rubra subsp. rubra (eu-rubra) var. genuina.
1) According to Auquier (1968) the holotype of Hackel differs clearly from the type specimen of G. F. W. Meyer, 1836. 2) Hackel (1885). 3) In Shildrick (1970). 4) In Farragher (1969). 5) Nomenclatural and taxonomic problems not resolved. 6) Taxonomic problems not resolved.

washed by the sea a few times a year. The plants are not very tall and have rather short rhizomes, small panicles, glabrous lemmas and usually glabrous shoots with tightly folded radical leaves.
Acccording to Auquier (1968) the holotype of F. r. r. genuina grandiflora f. litoralis of Hackel (1882) differs clearly from the type specimen G. F. W. Meyer established in 1836.
The French cultivar Manoir is classified by INRA (1979) as F. r. pruinosa (Hackel) Piper, a taxon which according to Auquier ist native on the coastal rocks of Normandy and Bretagne. Like the cultivars originating from the salt marshes Manoir has glabrous lemmas, but Auquier (1971 a) indicates that F. r. subsp. pruinosa sometimes has haired lemma's.
—Festuca rubra subsp. trichophylla Gaud. according to Hackel (1882) has short rhizomes, while both the radical leaves and the flag leaves are folded, although open flag leaves can be found too. In an earlier publication Duyvendak and Vos (1974) have associated this Latin name with the group of the hexaploid creeping cultivars since it is the oldest name (Gaudin 1828) for an infraspecific taxon characterized by short rhizomes. The introduction of new cultivars has, however, revealed that both the morphological variation and the area of the natural distribution of the hexaploid creeping red fescues were larger than was at first thought and that it was not correct to identify this cultivar group with one infraspecific taxon.

— Of old Festuca rubra L. subsp. rubra is the name for all creeping red fescues in the seed trade.
Hackel's description of F. r. r. var. genuina subvar. vulgaris refers to Gaudin's F. r. vulgaris. Both are described as having glabrous lemma's. Howarth (1924) noted that the holotype of Festuca rubra of Linnaeus from Lapland has strongly haired lemma's and he designated it as F. r. genuina arenaria, although he was aware that var. arenaria is confined to maritime sands whereas Linnaeus' Festuca rubra is "everywhere in Sweden" and "in Europe in dry waste ground". Kerguélen (1975) writes that it is not impossible that the type specimen corresponds with F. r. r. var. planifolia subvar. villiflora Hackel, precisely described from Lapland; cultures from this taxon were shown to have 2n = 42 chromosomes. The character combination hexaploid/creeping/haired lemma's is not (yet) found among the cultivars.

Evidently it is difficult to establish which plants should be designated as Festuca rubra L. subsp. rubra.

— Festuca rubra subsp. planifolia (Hackel) Hayek, 2n = 42 and 56. According to Lambinon and Duvigneaud (1980) this name has priority above F. r. subsp. multiflora (Hoffm.) Jirásek ex Dostál. Most octoploid creeping red fescue cultivars have unmistakebly flat leaf blades, but there are also octoploid plants with closed leaf blades and hexaploid plants with flat leaf blades. In England and Ireland Willis and King (1968) and Farragher (1969) have found hexaploid creeping plants with conspicuously flat leaf blades showing "some superficial resemblance to Festuca pratensis Huds."

In the Netherlands both hexaploid and octoploid creeping red fescue with flat leaf blades are found in the river valleys. Octoploid creeping red fescue with flat leaf blades also occurs behind the dunes, here one can find also transitions with F. r. subsp. arenaria with folded leaf blades. In view of the presence of transitional plants with other taxa the raising of this taxon to specific rank, i. e. as Festuca diffusa appears to us not justified.
— Festuca rubra juncea (Hackel) Soó was described originally by Hackel as widely creeping. In the Flora Europaea (Markgraf-Dannenberg 1980, p. 140), however, one reaches this subspecies via the choice "stolons short". Kerguélen (1975) writes that its taxonomy has not yet been solved.
— Festuca rubra subsp. arenaria (Osbeck) Richter, 2n = 56, is found in the Netherlands in the coastal dunes. The plants have long rhizomes and rushlike inrolled radical leaf blades, the flag leaf blades are flat to somewhat folded. Freysen and Heeres (1972) came to the conclusion that in the Dutch dunes only Festuca rubra subsp. arenaria occurs and that no clear separation with Festuca juncifolia exists. Auquier (1971 b) is of opinion that there are two taxa: Festuca juncifolia would be native in the dunes from southern Netherlands to northern Spain whereas Festuca rubra arenaria would occur along the North Western European coasts. We did not find any indication in the literature, e. g. Auquier (1971 b) or Markgraf-Dannenberg (1952), that both dune fescues differ in a discontinuous way in two or more morphological characters from the other taxa mentioned above or from each other, so that they cannot be given specific rank and can only be considered as subspecies of Festuca rubra L.

7. Discussion

The fact that a plant species is cultivated can bring it in a totally different position as compared with the situation that it only occurs in the wild. Red fescue is an example of this phenomenon.
For cultivation, red fescue is taken out of its natural environment and collected in breeding programmes of cultivars that are distributed all over the world; in this cross-fertilized species hybrid populations can arise more easily and more frequently than before. In such hybrid populations a free exchange of genes can take place with the effect that the individuals show continuous transitions in all characters. The species delimitation must, therefore, be taken sufficiently wide.
A cultivated species receives large national and international social interest, e. g. in various publications, regulations and laws. Here the species occupies a central place as the smallest botanical unit with relatively sharp borderlines. For optimal communication and in order to avoid misidentifications a broad species concept is desired. Geographical and ecological indications that can support identification of plants in the wild flora loose their value in cultivated plants, so that one is bound to use only morphological characters.
Dependent on the purposes or starting points there are widely different conceptions with respect to the species. In view of the aforementioned considerations the species definition of Davis and Heywood (1973) is to be preferred, viz.: „Species are groups of individuals sharing characters in common and separable from each other by highly correlated discontinuities in two or more features, excluding geographical distribution". The authors rightly accentuate the morphological identifiability.
In cultivar nomenclature the general principle holds that a once established name that is linked with an accurately described cultivar cannot be changed anymore.
The Botanical Code (Stafleu et al. 1978) provides for the conservation of names of genera and higher taxa (nomina conservanda), but not (yet) of species names. The Latin names of species and lower taxa are rather liable to changes, either for taxonomic or priority reasons. Davis and Heywood (1973) formulate their objections against the instability of Latin names as fol-

lows: „By all means let changes be made cautiously, and not before the evidence is strong" and "we cannot help feeling that name changes for anything except good taxonomic reasons are a disservice to biology". When a name has been used for a long time (many decennia) in the international society the weighing of priorities can better be omitted. A change of a species name creates confusion in the very wide circle of users of such names. "As plant's name is the key to its literature" (Van Steenis, 1957). The practical users of species names have a strong desire for uniformity and stability of the Latin nomenclature. In order to avoid problems as much as possible ISTA issues a recommended list of "stabilized" species names which is only adapted periodically, after broad consultations.

Table 5 shows an inflation of rank in the course of time as several species are distinguished within Festuca rubra. L. s. l. nowadays. In our opinion the morphological species concept has not been respected to a sufficient degree, e. g. in the case of Festuca nigrescens and Festuca diffusa.

Neither our investigations on cultivars nor the available literature data have revealed that the taxa mentioned in Table 5 are distinct in two or more morphological characters in a discontinuous way. There are, indeed, two chromosome numbers, but a grouping according to these chromosome numbers does not coincide with a discontinuity in one or other morphological character. Within one taxon individuals may even be found that have different chromosome numbers.

Dutch ecotypes, with a distinct ecological/geographical distribution, typical chromosome number and a set of characters that, without being discontinuous, define the majority of the individuals, are considered as subspecies of Festuca rubra. These ecotypes are:

Festuca rubra subs. commutata Gaud. (2n = 42)

Festuca rubra subsp. litoralis (G. F. W. Meyer) Auquier (2n = 42)

Festuca rubra subsp. arenaria (Osbeck) Richter (2n = 56)

No cultivars of the last subspecies are available. Most octoploid creeping red fescue cultivars have flat leaf blades and could be named F. r. subsp. planifolia (Hakkel) Hayek. There are, however, also octoploid creeping plants with closed leaves and hexaploid creeping plants with flat leaves. Red fescue with flat leaf blades is not growing in a well defined ecological or geographical area; further research is necessary to elucidate the taxonomic situaion of F. r. subsp. planifolia especially with respect to its delimitation with F. r. subsp. arenaria and F. r. subsp. rubra.

During the last decennia a large number of cultivars have been developed. They are classified into three groups. Table 1 reveals that with the exception of chromosome number none of the investigated characters shows a discontinuity in expression, while the ranges of varation of the groups overlap.

A classification of the individual plants as creeping and non-creeping proves to be less definite than often has been supposed, not only because of the gradual transition in the proportion of intra- and extravaginal shoots, but also because of the occurence of prostrate, rooted, vegetative, elongated, intravaginal shoots, which complicates the determination of this character and with that the whole classification.

A classification on account of lemma hairiness fails for cultivars because some of them show a rather wide variation in this character, although others are reasonably uniform.

Comparison of a classification of the taxa with a similar classification of the cultivars shows that within one cultivar group more than one (infra specific) taxon can be found and that one and the same taxon can be met with in two cultivar groups.

Since the three cultivar groups do not coincide with a species, a subspecies or any other taxon, the names of the cultivar groups simply repeat the classificatory characters. Thus the three cultivar groups are designated:

hexaploid non-creeping red fescue,
hexaploid creeping red fescue,
octoploid creeping red fescue.

– From the viewpoint of plant breeding it is interesting to note a number of taxa in Table 4 with characters or character combinations that are not (yet) represented among the cultivars. For example there are no red fescue cultivars with folded flag leaves. Neither are there any hexaploid creeping red fescue cultivars with open flag leaves and haired lemma's which character combination is indicated as the one possessed by the nomenclatural type specimen of Festuca rubra L.

Literature

AUQUIER, P., 1968. Festuca rubra L. subsp. litoralis (G. F. W. Mey.) Auquier: morphologie, écologie, taxonomie. Bull. Jard. Bot. Nat. Belg. 38: 181–192.

AUQUIER, P., 1971 a. Festuca rubra L. subsp. pruinosa (Hack.) Piper: morphologie, écologie, taxonomie. Lejeunia nouv. série 56: 16 pp.

AUQUIER, P., 1971 b. Le problème de Festuca rubra L. subsp. arenaria (Osb.) Richt. et de ses relations avec Festuca juncifolia St-Amans. Lejeunia nouv. série 57: 24 pp.

BRICKELL, C. D. et al., 1980. International code of nomenclature for cultivated plants 1980. Regnum Vegetabile 104: 32 pp.

DAVIS, P. H. and HEYWOOD, V. H., 1973. Principles of Angiosperm Taxonomy. Krieger publishing Comp. New York. 558 pp.

DUYVENDAK, R. en VOS, H., 1974. Registration and evaluation of turfgrasses in the Netherlands. Proc. of the Second. Int. Turfgrass Res. Conf.: 62–73.

FARRAGHER, M. A., 1969. Festuca rubra L. var. multiflora (Hoffm.) Wallr. in Ireland. Irish Naturalist's J. (Belfast) 16: 32–34.

FREIJSEN, A. H. J. en HEERES, Els, 1972. Welke soort roodzwenkgras (Festuca rubra s. l.) komt voor in de jonge kustduinen van Voorne en die van overig Nederland. Gorteria 6 (4) aug.: 57–61.

HACKEL, E., 1882. Monographia Festucarum europaearum. 216 pp.

HACKEL, E., 1885. In Bennett, Bot. Exch. Cl. Brit. Isles. Rep. for 1884: 119.

HEGI, G., 1965. Illustrierte Flora von Mittel-Europa, Band I.

HOWARTH, W. O., 1924. On the occurrence and distribution of Festuca rubra Hack. in Great Britain. J. Linn. Soc. (Bot.) 46: 313–331.

HUBBARD, C. E., 1974. Grasses. A guide to their structure, identification, uses and distribution in the British Isles. Penguin books, Richard Cley Ltd., Bungay, Suffold. 463 pp.

INRA – 1979. Bulletin des variétés. Espèces et variétés de graminées à gazon. Editions S. E. I. INRA – Versailles. 214 pp.

ISTA – 1966. International seed testing association. ISTA-List of Stabilized Plant Names; with supplements.

KERGUELEN, M., 1975. Les gramineae (Poaceae) de la flore française. Essai de mise au point taxonomique et nomenclaturale. Lejeunia. nouv. série n. 75: 343 pp.

KEYZER, C. J., 1975, Intern rapport, RIVRO Wageningen.

LAMBINON, J. et DUVIGNEAUD, J., 1980. Remarques nomenclaturales à propos de la deuxième édition de la "Nouvelle Flore" de la Belgique et des régions voisines. Lejeunia nouv. série 101: p. 34.

LANGHE, J. E. de et al., 1978, Nouvelle flore de la Belgique, du G.-D. de Luxembourg, du Nord de la France et des régions voisines. 2e ed. Edition du Patrimoine du Jardin botanique national de Belgique.

MARKGRAF-DANNENBERG, I., 1952. Studien an irischen Festuca-Rassen. Veröff. des geobotanischen Inst. Rübel in Zürich. Heft 25: 114–142.

MARKGRAF-DANNENBERG, I., 1980. 4. Festuca L. Flora Europaea 5: 125–153. Cambridge Univ. Press.

MEIJDEN, R. van der en BRAND, A. M., 1980. Grassentabel, Rijksherbarium Leiden. 35 pp.

OBERDORFER, E., 1979. Pflanzensoziologische Exkursionsflora. Verlag Eugen Ulmer, Stuttgart 4. Aufl. 997 pp.

SHILDRICK, J. P., 1976. A provisional grouping of cultivars of Festuca rubra L. J. Sports Turf Res. Inst. 52: 9–13.
STAFLEU, F. A. et al., 1978. International Code of Botanical Nomenclature, Regnum Vegetabile 97: 457 pp.
STEENIS, C. G. G. J. van, 1957. Specific and infraspecific delimitation. Flora Malesiana ser. 1 vol. 5^3: 167–234.
WILLIS, A. J. and KING, Sylvia M., 1968. A broad leaved variety of Festuca rubra L. Proc. Bot. Br. Isl. Vol. 7 (2): 143–149.

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