Barley Grass Taxonomy, Distribution and Identification

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In Volume 5 of the Flora of New Zealand (Edgar and Connor, 2000), which dealt with grasses, the botanical name of the barley grasses were changed from species of *Hordeum* to *species of Critesion.* Cultivated barley retains its old botanical name of ***Hordeum vulgare***, *Critesion* includes a number of small seeded species, some of which are important components of grassland in certain parts of the world. In New Zealand six of these smaller seeded species are found (Allen 1973; Popay 1976).

The characteristic inflorescence of the genus ***Critesion*** is a spike on which spikelets are arranged in groups of three, alternating on opposite sides of the main axis. Each group of three spikelets, (known as a triad) consists of a central, hermaphrodite spikelet and two lateral male or sterile spikelets.

When the seed is ripe, the main axis of the spike breaks just below the triad. This is dispersed as a unit. The triad plus a portion of the spike axis is commonly referred to as the seed.

The different species of barley grass are easy to distinguish from other grasses when in flower or fruit. In the vegetative stage, they are less distinctive. The species ***Critesion glaucum*** and ***C. murinum*** (with 2 subspecies) are relatively easy to recognise by:

- The large auricles (ears) at the junction of leaf and sheath.
- Rolled young leaves.
- Non-shiny leaves.
- Scattered white hairs on leaf and sheath.

The two species ***Critesion marinum*** and ***C. hystrix*** are more difficult to recognise:

- They do not have auricles.
- Their leaves are usually bluish-green.
- Leaves are covered with small, scattered hairs.
- Leaves have short, untoothed ligules.

Confusion with soft brome, ***Bromus hordeaceus,*** is common. ***Critesion secalinum*** also presents problems but can best be recognised by its tufted, perennial habit, the dull, hairy lower leaf surface and the small auricles. ***Critesion jubatum*** is also difficult to recognise in the vegetative state, being similar in appearance to creeping bent, ***Agrostis stolonifera.***

It is not possible to distinguish between the species within a group in the vegetative state.

A key for identifying the six New Zealand species (and two subspecies) of barley grass on the basis of flower or seed structure, is given in Table 1. Further information on the identification and distribution of each species is given below.

Critesion jubatum
Squirrel tail grass, *C. jubatum* (L.) Nevski $2n^1$ =28 (Chin 1941; Morrison 1959).

This species has a very distinctive appearance when flowering, with its large, attractive, rather fluffy inflorescences. The spikelets have long, soft, reddish-tinged awns.

The species is a perennial, restricted in New Zealand to the low rainfall zone of Central Otago, and is usually found in situations which do not dry out rapidly in summer. Its tolerance of saline conditions, recorded overseas (Wilson 1967; Ungar 1974), may also be partly responsible for its limited distribution.

Its presence in Otago, apparent absence from Australia and its North American origin suggest possible introduction direct from America in gold rush days. Allen (1973) considered the species to have limited weed potential but thought that it could be eradicated. Allan (1933) also suggested that it be eradicated.

Squirrel tail grass is native to and widespread in North America. Here, it is found on wet, moderately saline soils and as a weed of roadsides and pastures (Wilson 1967; Ungar 1974). It has been introduced elsewhere as a decorative garden plant and has been reported as escaping from cultivation (Hubbard 1954).

Critesion secalinum
Meadow barley grass, *C. secalinum* (Schreb.) Á.Löve, Schreb. $2n^1 = 28$ (Hubbard 1954).

From a distance the flower spike looks rather like that of crested dogstail, *Cynosurus cristatus*, but closer examination shows that it has the typical *Critesion* structure. The inflorescence is smaller and finer than that of common barley grass and its awns are more upright and not as bristly as those of Mediterranean or salt barley grass.

The species is apparently restricted to wetter grasslands near Porangahau in southern Hawke's Bay. It could possibly spread to other similar coastal areas. Eradication of the present infestation would be costly and difficult.

Meadow barley grass is a perennial, probably native to Europe, Asia and North Africa and introduced to North and South America, South Africa, Australia and New Zealand (Clapham *et al.* 1962; Smith 1972; Popay 1976). It usually occurs near the coast or in saline areas (Smith 1972).

Critesion marinum and ***C. hystrix***
Salt barley grass**,** *C. marinum* (Huds.) Á.Löve, $2n^1 = 14$, or occasionally 28 (Morrison 1959).
Mediterranean barley grass, *C. hystrix* (Roth) Á.Löve, $2n^1 = 14$ (Morrison 1959).

The inflorescences of both species are very similar in appearance, with the short, rigid, spreading awns giving the smallish inflorescence a "bottle brush" effect.

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[1] 2n represents the diploid number of chromosomes, which is the number of chromosomes in the nucleus of each vegetative cell.

Although the morphological difference between the species is small, their different geographical ranges in Europe (Clapham *et al.* 1962), America (Coves 1949) and New Zealand (see below) suggest ecological differences between the two.

In New Zealand, salt barley grass and Mediterranean barley grass were not referred to as separate species until Meeklah (1964) did so. Before that, both were called *Hordeum marinum,* which was first recorded in 1872 in Canterbury.

At the present time, salt barley grass is only found in low-lying saline coastal flats in Canterbury and Marlborough. Mediterranean barley grass also occurs on these sites but its range extends to similar localities in Hawke's Bay. It is also present in the low rainfall zone of Central Otago, a few places in North Canterbury and on one site on the Hauraki Plains.

Both species are annuals. Salt barley grass is native to west and south Europe and has been introduced to North America (Hubbard 1954), Australia and New Zealand. It is usually restricted to coastal areas and is not so widespread as Mediterranean barley grass. Mediterranean barley grass is of Mediterranean origin and is now widespread and locally abundant in North America, Australia and New Zealand (Smith 1972).

***Critesion glaucum* and *C. murinum* (with 2 subspecies)**
These are collectively referred to as 'barley grass'.

C. glaucum (Steud.) Á.Löve, $2n^1 = 14$ (Covas 1949; Morrison 1959; Allen 1973; Booth and Richards 1976; Cocks *et al.* 1976).

C. murinum subsp. *murinum* was formerly known as *Hordeum murinum*. It was first reported in Otago in 1864 (Hooker, in Allan 1940) but the presence of three species within this complex was not recognised until the late 1960s (Healy 1969). *C. murinum* subsp. *murinum* (Link) Á.Löve, 2n* = 28 (Morrison 1959; Allen 1973).

C. murinum subsp. *leporinum* (Link) Á.Löve, $2n^1 = 28$, or sometimes 42 (Rajhathy and Morrison 1962; Booth and Richards 1976; Cocks et al, 1976).

Species differentiation
Until the 1970s, all three taxa were separate species – *Hordeum glaucum*, H. *leporinum* and *H. murinum*. AlIen (1973) examined New Zealand material and found that *H. glaucum* could clearly be separated from *H. leporinum* on the basis of the characters described by Morrison (1958) (see Table 1). Although not mentioned by Allen, New Zealand *H. glaucum,* like that examined by Morrison and by Cocks *et al.* (1976), has its spikelets more densely packed in the spike than the other two species.

Allen (1973) also found that although typical plants of H. *murinum* and *H. leporinum* were readily distinguishable, many specimens fall between the two extreme forms. Ascribing a specific name on the basis of the several diagnostic features can sometimes be difficult or impossible. This recombination of characters is presumably due to hybridisation between the two species as was shown to be possible by Rajhathy and Morrison
(1962).

In 1976 Booth and Richards, using European and North American material, came to the conclusion that whilst *H, murinum* and *H. leporinum* could be satisfactorily distinguished by the use of a number of morphological characters, separation of *H. glaucum* from *H. leporinum* could only be certain on the basis of chromosome counts. Unfortunately they did not examine the anther size, rachilla size and shape, and spike density, which Morrison and Allen used for distinguishing *H. glaucum* from *H. leporinum.*

Cocks et al, (1976) described the identification and distribution of these three members of the *H. murinum* complex in Australia. They pointed out that earlier Australian authors may sometimes have been working with *H. leporinum* and sometimes with *H. g!aucum.* Cocks and Donald (1973) probably used seeds of both species, as did Smith (1968). Campbell et al (1972) were probably dealing with *H. glaucum.* This should be borne in mind when interpreting Australian results.

Species distribution

In New Zealand there seems to be no clear-cut difference between the geographical distributions of the two subspecies of *C. murinum,* although plants of subsp. *leporinum* have not been found in cool, wet South Otago and Southland nor in Taranaki. Elsewhere, both species, and sometimes intermediate forms, are found. Although the proportions of the two species in populations have not been measured, *C. murinum* subsp. *murinum* predominates in the dairy pastures of North Canterbury, the western border of the Canterbury Plains and the Kaikoura flats (Allen 1973) and subsp. *leporinum* predominates in parts of the Waikato and of Otago.

C. glaucum is present in the dry climate portions of the Clutha, Taieri and Waitaki river basins, areas which are contiguous, and in the Amuri basin some 300 km further north (Allen 1973). Allen suggested that its distribution is circumscribed partly by soil fertility levels and partly by climate conditions. It seems to be restricted to areas with an annual rainfall of 550 mm or less and where evapotranspiration exceeds rainfall for more than 6 months of the year. Its distribution suggests a slow spread from Central Otago, but the sharp boundaries indicate ecological limiting factors. Nonetheless, it is likely to become more widespread and an eradication programme around stock yards in areas at risk could delay or prevent extension of its area.

This species complex is native to Europe, western Asia and North Africa. Within that area, *C. murinum* subsp. murinum tends to be restricted to the cool north and west. Subsp. *leporinum* is found in more southerly and Mediterranean climates and C. *glaucum* grows in the hotter, drier areas in the east (Davison 1970; Booth and Richards 1976; Cocks eta11976). Within Europe all the species are confined to roadside verges and waste places. All three have been introduced to North America, Australia and New Zealand (Covas 1949; Smith 1972: Cocks *et al.* 1976) and in some places have become major pasture components.

Table 1: Key to the New Zealand species of barley grass (after Allen 1973).

1. Inflorescence feathery with long lax awn……..***C. jubatum***
Inflorescence strict with rigid awns……**2**

2. Large clasping auricles, spike usually more than 5 cm long, lemma awns of lateral spikelets much longer than glume awns, glumes of central spikelet fringed with hairs in lower part …… ….**3**
Auricles small or absent, spike commonly less than 5 cm long, lemma awns of lateral spikelets shorter than glume awns, glumes all hairless……..**5**

3. Central spikelet of triad stalked, paleas and lemma awns of lateral spikelets overtopping those of central spikelet, inflorescence with 4 awn ridges (square) at top …… ……..……..…**4**
Central spikelet sessile or with very short stalk, central spikelet lemma awn overtopping lateral spikelet lemma awns, paleas about equal, inflorescence with 2 awn ridges (flat) at top ……...***C. murinum* subsp. *murinum***

4. Rachilla extension of lateral spikelets about 1/3 length of palea, lower third stout then tapering to tip, orange coloured, stamens of central spikelet much smaller than those of lateral spikelets ……..…. ***C. glaucum***
Rachilla extension of lateral spikelets more than 1/3 length of palea, tapering uniformly from base to tip, colour variable from bleached straw to orange, stamens of all spikelets similar in size……..…***C. murinum* subsp. *leporinum***

5. Short, spreading auricles, awns of spikelets erect or slightly spreading: grassland……..……..……. ***C. secalinum***
No auricles, awns widely spreading…….……...**6**

6. Both glumes of lateral spikelets bristle-like, more or less equal in width…….….. ***H. hystrix***
Glumes of lateral spikelets dissimilar, one side of inner member of each pair with a prominent wing……...… …..***H. marinum***

NB: The rachilla of *C. murinum* subsp. *murinum* is usually about 1/2 length of palea, narrow, bristle-like and colourless.
The deep orange colour and swollen base of the rachilla of *C. glaucum* is diagnostic though close to the Australian form of *C. murinum* subsp. *leporinum* collected in North Canterbury.

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