THE IDENTIFICATION AND DISTRIBUTION OF RUSHES (**JUNCUS** SPP.) IN NEW ZEALAND

A. J. HEALY, Botany Division, D.S.I.R., Wellington.

THE rushes (*Juncus* spp.) belong to a cosmopolitan genus, represented in New Zealand by 15 indigenous and 14 alien species. Of this number some 10 species have economic significance as weeds of damp pastures, damp cultivated land, swampy waste places, drains, waterways, and brackish coastal areas, and this present consideration is concerned only with these significant species.

Botanically the rushes constitute a group difficult of determination, many species showing variation, and with the limits of the described species not always clearly defined. Though forms typical of many species can be identified with reasonable ease and accuracy, there occur atypical forms which prove difficult of specific identification.

In view of this variation you will almost certainly encounter plants which are difficult to identify to a species, but do not be disheartened, because some forms present difficulties to botanists as well as to laymen.

Though in some instances specific identification may be possible on the basis of a single character, e.g., nature of pith, it is often necessary to consider a combination of characters, e.g., nature of pith, colour of stems, type of head, etc., when making an identification.

Until recently there has been little necessity for farmers and others to go further than apply the collective vernacular term "rushes" to the species which have proved troublesome, especially in pastures, and the economically important species of *Juncus* have not been distinguished by individual common or vernacular names. It is not proposed to invent such common names for this consideration, and it is suggested that the botanical or technical names be used, a practice not without precedent in farming circles in New Zealand, as witness the wide usage of the names *Poa pratensis*, *Phalaris tuberosa*, *Lotus major*, *Danthonia pilosa*, etc.

The development of selective, hormone-type weedkillers and the discovery that some species of *Juncus* are susceptible and others resistant to the action of these preparations have emphasised the need for farmers, weed-spraying contractors, and agricultural instructors to have a rather more detailed knowledge of the economically important species, such that identification to a species, or at least to a group of several closely related species, is possible.

Considering the species of *Juncus* in the broad sense, they have a wide distribution through both Islands, with an altitudinal range from sea-level to over 4,000ft. They are characteristic plants of damp and swampy situations, but occur elsewhere under drier conditions, where the competition effect is low. The common pasture species are sometimes found in pastures on dry shallow soils, and both *J. bufonius* and *J. tenuis* are often well established on dry road verges and tracks.

The nature of a rush infestation will vary from district to district, from farm to farm, and even from paddock to paddock. It may consist of a single species, or of several species; if of several species, one may be more abundant than the others, or each species may be represented by significant numbers. As an example of the different types of infestation, one locality in the Hutt Valley shows all six important leafless species in a paddock within an area of about 2 square chains, and less than a mile away the infestation consists of a single species.

Coming now to consideration of the species that are troublesome weeds to farmers, drainage engineers, etc., we find that they fall into three distinct groups, based on (a) presence or absence of leaves and (b) if leafy, on presence or absence of internal leaf partitions (septa).

PRIMARY GROUPS:

- I **Leafless Species:** Leaves reduced to sheaths at bases of long cylindrical stems. Heads borne on sides of stems near tops, never on tips of stems.
The common pasture rushes all belong to this group.
- II **Apparently Leafless Species:** Leaves present, similar to stems, long, cylindrical, arising from sheaths at bases of stems. Heads borne on sides of stems near tops, never on tops of stems. Species of coastal sands and brackish-water marshes.
- III **Leafy Species:** These species have grass-like or bristle-like leaves, which are readily distinguished from the stems. The species form two distinct sub-groups, based on presence or absence of interior leaf partitions, apparent when leaves are split along their length with a knife.
 - (a) Species with leaves lacking distinct interior partitions.
 - (b) Species with leaves with distinct interior partitions.

GROUP I. LEAFLESS SPECIES

Group I, leafless species, is the group of greatest significance to farmers, comprising six perennial species which occur as major pasture weeds in districts throughout New Zealand.

The distribution and chief characters of these six species can be summarised as follows:—

Juncus vaginatus R. Br.: Occurs through North Island and north of South Island in damp pasture and swampy places, often locally abundant. Recognised by the absence of pith, presence of interior scales, stout habit, bluish- or greyish-green stems, and usually dense heads.

J. luxurians Col.: Occurs in both Islands, more common in North Island, apparently absent from some districts, common to locally abundant in damp pastures and swampy places elsewhere.

Recognised by the interrupted, loose pith, the densely tufted strictly erect (especially when young) habit, bluish- or greyish-green stems to 7ft. or more tall, and slender branched, small-fruited, closely packed heads from 1 to 5in. long, lying upwards along the stem.

J. polyanthemus Buchen.: Common to locally abundant in damp pastures and swampy places throughout New Zealand, and the most widely distributed and abundant species of this group. A very variable species, pith either continuous or interrupted, more dense in consistency than in *J. luxurians*; stems 2 to 7ft. or more tall, bright-green to brownish-green, wiry; heads variable, from few-flowered and spreading to many-flowered and dense and resembling some forms of *J. vaginatus*. Some forms of this species are difficult to distinguish from *J. pauciflorus* in the absence of seed capsules.

J. pauciflorus R. Br.: Occurs in damp pasture and wet places in both Islands, uncommon in or absent from some districts, locally abundant in some South Island districts.

Recognised by the interrupted pith, the short, slender habit, the thin wiry reddish-brown stems, relatively few-flowered heads, and large shining seed capsules.

J. effusus L.: Occurs through both Islands in damp pastures and wet places generally, often locally abundant, especially on roadsides cut up by mechanical equipment.

Recognised by the continuous, watery-white pith, the usually short, relatively stout habit, the soft, **not** wiry stems; stems bright-green to mottled yellowish-green, oval when immature and often spirally twisted; heads globe-shaped in outline, loose or dense, branches curved, the lower branches curved downwards.

J. pallidus R. Br.: Occasional to locally common in wet pastures and swampy places in both Islands. Recognised by the continuous pith, the robust habits, stems stout, to 7ft. or so tall, oval in cross-section when immature and often spirally twisted, bright-green to greyish-green; heads many-flowered, dense, seed capsules relatively large.

Despite the earlier-mentioned variability of some species, and the often close superficial resemblance, identification with reasonable ease and accuracy can be achieved by a layman. That difficulties will probably be experienced is admitted, but I feel certain that with a little effort and experience you will be able to make identifications adequate for all practical purposes.

The preliminary step in identifying plants which fall in Group I is to take a sharp pocket-knife and slit along the length of several of the long cylindrical stems, exposing the interior central pith cavity.

In familiarising yourself with this technique take mature stems, i.e., stems with either flower head or seed head present, since young or immature stems are not always typical, and may give a false initial impression of a particular species. Care should also be taken to avoid using stems which have suffered grub attack, since the pith is modified, and in extreme instances, a stem which normally possesses continuous pith may appear to be lacking pith completely.

The interior pith cavity exposed, its character can be checked against the characters in the following tabulation, which contrasts the nature of the pith in the six species of the group, representative stems being shown in Fig. 1.

Species	Nature of Pith
J. vaginatus	Pith absent. Interior longitudinal ridges and furrows clearly visible. Cavity more or less completely hollow with small, scale-like projections around interior walls, or with thin, scale-like cross-partitions across cavity. In more mature stems knife makes a distinct clicking sound as it passes through these scale-like projections.
J. luxurians	Pith present, interrupted, loose in texture, somewhat cobwebby. Pith partitions narrower or wider than cavities, predominantly narrower. Pith becoming harsh in mature stems, knife sometimes making clicking sound as it passes along stem.
J. polyanthemos	Pith present, interrupted or continuous, whitish, more dense than in J. luxurians , not cobwebby. Pith partitions wider or narrower than cavities between, predominantly wider. A single stem may occasionally show both interrupted and continuous pith, as shown in Fig. 1.
J. pauciflorus	Pith present, interrupted, occasionally continuous. Pith consistency similar to that in J. polyanthemos . Pith partitions usually wider than cavities between; cavities often very small, sometimes difficult to distinguish. Pith cavity of stem very narrow.

FIG. 1

J. effusus	Pith present, continuous , watery-white to almost colourless, spongy, sometimes almost honey-combed under lens, often rolling and compressing ahead of knife edge, especially if knife is at all blunt.
J. pallidus	Pith present, continuous , often more cobwebby than in J. effusus , and showing arrangement of fibres across the interior cavity. Pith colour tends more dense white than in J. effusus .

From this preliminary analysis, it will be seen that if the specimen lacks pith it is **J. vaginatus**, if pith is continuous it could be **J. effusus**, **J. pallidus**, or **J. polyanthemus** (rarely **J. pauciflorus**), and if pith is interrupted it could be **J. luxurians**, **J. polyanthemus**, or **J. pauciflorus**.

When one becomes familiar with these plants, it is often possible to identify a specimen on pith character and habit, but initially, at least, you will find it necessary (and advisable) to work with one or more of the complementary characters given below. Even with familiarity, it is often necessary with a typical specimen to make use of a number of characters to secure an accurate identification.

The following tabulations treat several complementary characters, those of the different species being contrasted in each table.

GROWTH HABIT

Species	Growth Habit
J. vaginatus	Either (a) stout stemmed, medium height clump, usually broad-based, stems loosely packed at base, centre of clump often thin, basal diameter to 1ft. or so, or (b) stems few, sparse, not clump-forming, in sparse colonies several feet in diameter.
J. luxurians	Medium to tall, to 7ft., clump narrow-based in contrast to J. vaginatus and J. effusus , stems tightly packed at base, strictly erect, in tall clumps, stems drooping from above, not spreading from base. One form in pasture resembles the form of J. vaginatus with few stems, sparsely arranged, not clump-forming, in sparse colonies from a few inches to several feet in diameter.
J. polyanthemus	Medium to tall, clump broad or narrow-based, usually tightly packed at base, especially in the narrow-based clumps; stems strictly erect in narrow-based clumps, spreading from some distance above base in larger clumps.
J. pauciflorus	Short, clumps small, stems tightly packed, strictly erect or spreading above.
J. effusus	Short to medium, clumps broad-based, stems loosely packed, spreading outwards from base.
J. pallidus	Medium to tall, coarse, usually broad-based clumps, stems loosely packed at base, erect or inclined outwards from near base.

STEM SIZE AND SHEATH CHARACTER

Species	Stem Size and Sheath Character
J. vaginatus	Relatively stout, 2 to 3ft. long x 1/8 to 1/5in. diam., sheath loose.
J. luxurians	Slender to medium stout, 2 to 7ft. long x 1/16 to 1/6in. diam., sheath pressed close to stem.
J. polyanthemus	Slender to medium stout, 2 to 7ft. x 1/16 to 1/6in. diam., sheath usually pressed close to stem.

J. pauciflorus	Short, slender, 0.5 to 2ft. long x 1/20 to 1/10in. diam., sheath pressed close to stem.
J. effusus	Slender to medium stout, 1 to 4ft. x 1/10 to 1/6in. diam. sheath.
J. pallidus	Stout, 2 to 7ft. long x 1/8 to 1/4in. or more diam., sheath loose.

COLOUR AND TEXTURE OF STEMS

Species	Colour and Texture of Stems
J. vaginatus	Bluish- to greyish-green. Hard, splitting when tied around bundle of stems, usually not breaking.
J. luxurians	Bluish-green, particularly when immature, tending greyish-green when mature. Hard, sometimes wiry, tending to split when tied round bundle of stems.
J. polyanthemos	Bright, shining- to brownish-green. Smooth, wiry, not splitting when tied round bundle of stems.
J. pauciflorus	Usually reddish-brown. Wiry, not splitting when tied round bundle of stems.
J. effusus	Bright- to yellowish-green, when the latter usually mottled with dark specks. Soft, not wiry, usually breaking readily when tied round bundle of stems.
J. pallidus	Usually bright- to dark-green, occasionally greyish-green. Soft, usually less so than in J. effusus , not wiry, splitting or breaking when tied round bundle of stems.

HEAD CHARACTERS

Species	Head Characters (See Fig. 2.)
J. vaginatus	Three clearly marked types: (a) many-flowered, densely packed in single globe-shaped cluster, (b) many flowered, a single globe-shaped cluster against stem, with one or more stalked clusters arising from, and standing above large basal cluster, and (c) many-flowered, head open, branching, with loose clusters towards ends of branches.
J. luxurians	Head usually narrow-oblong in outline, many-flowered, much branched, branches slender, lying close together, the whole head pressed against stem above point of attachment. Portion of stem above point of attachment of head up to a foot long, longer than in any other species.
J. polyanthemos	Heads variable: (a) many-flowered, in dense seated cluster as in J. vaginatus , but flowers and seed capsules smaller, (b) many-flowered, branches few to many, spreading, forming open head, with few-flowered clusters at ends of branches, which are noted for much of their length, or (c) few-flowered, in small compact or loose cluster seated or short-stalked, or with small basal cluster and one to several short-stalked clusters. The head in some forms closely resembles that of J. pauciflorus , but the capsules are distinctly smaller.
J. pauciflorus	Heads usually few-flowered, seated against stem, or short-stalked, dense or open.
J. effusus	Many-flowered, globe-shaped in outline, loose or compact, branches many, upper curved upwards or downwards, lower always downwardly curved.
J. pallidus	Many-flowered, in single, dense, seated, globe-shaped cluster, or with single basal cluster and several stalked clusters. Similar to some forms of J. vaginatus , but seed capsules larger.

FIG. 2

SEED CAPSULE CHARACTERS

Species	Seed Capsule Characters
J. vaginatus	Length about 1/10in. Capsule as long or longer than surrounding perianth segments.
J. luxurians	Length about 1/16in. Capsule shorter to about as long as surrounding perianth segments.
J. polyanthemus	Length 1/16 to 3/32in. Capsule shorter to just longer than surrounding perianth segments.
J. pauciflorus	Length about 1/8in. Distinctly longer than surrounding perianth segments.
J. effusus	Length about 1/16in. Capsule shorter to about as long as surrounding perianth segments.
J. pallidus	Length about 1/8in. Capsule longer than surrounding perianth segments.

Two further species belonging to this group have a restricted distribution, and have not, as far as is known, any great importance as yet. For completeness their main characters are given below:—

J. inflexus L. (Syn. **J. glaucus** Ehr.): Pith present, interrupted. Stems strictly erect, bluish- or greyish-green, with 12 to 18 prominent external longitudinal ridges (species treated previously lack distinct external ridges). Seed capsules dark-brown to almost black, sharply pointed at top.

J. conglomeratus L.: Pith present, continuous. Similar to **J. effusus**. Stems with 40 or more distinct ridges just below heads; opening in stem from which head arises widely expanded (opening narrow or closed in species treated previously). Head similar to **J. effusus**, dense.

GROUP II. APPARENTLY LEAFLESS SPECIES

Group II, apparently leafless species, is represented in New Zealand by two species, one of wide distribution, and the other restricted to a single locality as far as is known.

J. maritimus Lam. var. **australiensis** Buchen. Occurs on coastal sands and in brackish-water marshes in North Island, and to Okarito and Banks Peninsula in South Island. It is sometimes of consequence in reclamation of coastal waste land.

Clumps densely or loosely tufted. Stems rigid, wiry, 1 to 4ft. tall, yellowish to dark-brown, sheaths at bases of stems as in Group I, but upper sheaths with distinct, round, cylindrical, sharp-pointed leaves similar to stems. Heads compact or branched, on sides of stems as in species of Group I. Seed capsules about 1/8in. long, dark-brown, pointed at top, slightly longer than surrounding perianth segments.

J. acutus L. Apparently restricted to but thoroughly established in salt meadows at the mouth of the Manawatu River, North Island.

Similar to, but more robust than, **J. maritimus**, this species is distinguished by the much larger seed capsule (about 3/16in. long), shining, light-brown, and at least twice as long as the surrounding perianth segments.

GROUP III. LEAFY SPECIES

(a) Species with leaves lacking distinct interior partitions

J. bufonius L. (toad rush). Occurs abundantly through both Islands, tolerant of a wide range of soil conditions. Found in damp lowland pastures, in hill-country pastures, in modified tussock

grassland, on coastal sands; often troublesome in cultivated land in wet seasons, particularly in cereals when cut with a binder, a nuisance in gardens and in newly sown lawns and greens; occurs along ditch-banks, about swamps, along road verges, and in paths. Altitudinal range from sea-level to over 4000ft.

Annual in habit, extremely variable in size. Light-green in colour, tufted or spreading, from 1 to 18in. tall, stem slender, branched or unbranched. Leaves normally bristle-like, in luxuriant specimens grass-like. Flowers and seed capsules dispersed along branches, forming a loose head occupying the greater part of the plant.

Roots fibrous, plant easily pulled from ground by contrast with the next species, *J. tenuis*, which is difficult to pull.

***J. tenuis* Willd.** Occasional to locally abundant through both Islands, from sea-level to over 3000ft. A persistent weed of damp pasture, swamp margins, and damp waste places, and tolerant of trampling on paths, tracks, and roadways; in some localities it forms distinct colonies along shingle shoulders of bitumen road, and in country districts along crown and shoulders of metalled roads.

Perennial, forming distinct leafy tufts or small clumps. Leaves grass-like, flat, or channelled, 3 to 9in. long, very narrow, rarely more than 1/8in. wide, light to yellowish-green, sometimes reddish tinged. Flowering stems one to many, leafless, erect. Flowers and seed capsules arranged along spreading branches or tops of flowering stems, forming a distinct head, which occupies only a small proportion of the height of the plant by comparison with *J. bufonius*; head usually with one or more leaf-like bracts from base of head, and shorter or longer than it. Seed capsule globe-shaped approx. 1/8in. long, straw-coloured, shorter than the surrounding perianth segments which spread or stand out from it star fashion.

This plant has a dense mass of spreading fibrous roots, is difficult to pull from the ground, generally bringing a large clump of soil with it.

***J. planifolius* R. Br.** A common plant of wet places, in some districts significant as a weed of ditch banks and along road drainage channels, especially at foot of banks or cuttings.

Leaves many, in dense spreading tufts, 1/8 to 1/2in. or more wide, flat, grass-like, often reddish tinged.

Flowering stems one to many, much longer than leaves, to 2ft. tall. Flowers brown, in small, dense clusters at ends of branches radiating from top of flowering stem like ribs of an umbrella.

Distinguished from both *J. bufonius* and *J. tenuis* by the much broader leaves, and flowers and seed capsules arranged in small dense clusters at ends of branches of head.

***Luzula* spp. (wood-rush).** Occasional to locally common in pastures, mostly on hill country or in damp unimproved pastures on flats.

Perennial in habit, variable in size, tufted, grass-like, usually with short, above-ground runners. Leaves flat, grass-like, usually dark-green and reddish on margins, tip narrow and thickened, with long conspicuous hairs along margins. Flowering stems longer than leaves, head either compact and

pyramidal in outline, or open with branches spreading like ribs of an umbrella. Seeds much larger than in *Juncus* spp., and with conspicuous whitish base.

Distinguished from all species of *Juncus* treated in this paper by the conspicuous long hairs along the leaf margins.

(b) **Species with leaves with distinct interior partitions.**

The species of this sub-group are characterised by the hollow leaves with interior partitions, either cross or longitudinal, often visible internally on mature leaves, and detected in young green leaves by slitting along the leaves with a sharp pocket-knife.

J. articulatus L. (syn. *J. campocarpus* Ehrh.) Common to locally abundant along rivers and creeks and in swampy places in both Islands. Has significance as a weed impeding water-flow in creeks, waterways, and drains generally, and commonly present in swampy areas on farms.

Perennial, growing in water or on land, tufted or spreading to prostrate. Stems 6 to 30in. long or more. Leaves 3 to 8in. long, oval or round, basal ones in fan-like arrangement; hollow, with distinct, widely separated cross partitions; stems leafy, leaves shorter than flower heads. Flowers brownish, in 2-to-8-flowered cluster at ends of head branches, and in junctions of branches; head branches spreading from top of stem, forming usually an open branching head. Seed capsules approx. 1/8in. long, dark-brown to black, sharp at top, longer than surrounding perianth segments.

J. holoschoenus R. Br. Uncommon in swampy places in North Island, often found with *J. articulatus*. Distinguished from *J. articulatus* by leaves longer than the stems, leaf-like bract from base of head longer than head, flowers greenish and 10 to 20in. each cluster; head contracted, not spreading.

J. prismatocarpus R. Br. Not uncommon in swampy places in North Island, local in north of South Island, often growing with *J. articulatus*.

Distinguished from both the above species by the longitudinal internal partitions of the leaves, the cross partitions often indistinct and poorly developed.

J. bulbosus L. (syn. *J. supinus* Moench.). Abundantly established in wet situations and over pakihi land on west coast, South Island, and in swampy places in drainage area of Hutt River, North Island.

Small perennial, tufted or prostrate and rooting along stems; leaves bristle-like, partitions indistinct, some forms with a superficial resemblance to *J. bufonius*. Readily recognised by the small tufts of bristle-like leaves which occur along the prostrate rooting stems and about each flower cluster in the head.

In conclusion, though I appreciate fully the difficulties of such identification, and realise the shortcomings of such a treatment as this, I trust that you will at least have gained one or two basic ideas for field identification of these troublesome weeds.

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APPENDIX

Key to Species (By Groups)

GROUP I

1. Stems with continuous pith 2
Stems lacking pith or with interrupted pith 5
2. Lower branches of head always curved downwards **J. effusus**
Lower branches of head not curved downwards 3
3. Stems stout, to 1/4in. or more diam.; head dense; capsule approx.
1/8in. long, longer than perianth segments **J. pallidus**
Stems more slender, approx. 1/8in. diam., head dense or spreading;
capsule shorter, to as long as perianth segments 4
4. Opening in side of stem from which head arises widely expanded;
stem soft **J. conglomeratus**
Opening in side of stem from which head arises narrow or closed;
stems wiry **J. polyanthemus**
5. Stems lacking pith, internal scales present; stems bluish- or
greyish-green **J. vaginatus**
Stems with interrupted pith; stems variable in colour 6
6. Stem bluish or greyish green 7
Stem bright green or brownish green or reddish brown 8
7. Stems deeply longitudinally ridged, ridges 12 to 18 **J. inflexus**
Stems not deeply ridged **J. luxurians**
8. Stems reddish brown, slender; capsules 1-8in. long **J. polyanthemus**
Stems bright green to brownish green; capsules approx. 1/16in.
long.

GROUP II

1. Seed capsule dark brown, approx. 1/8in. long, slightly longer than
perianth segments **J. maritimus**
var. **australiensis**
Seed capsules light brown, approx. 3/16in. long, at least twice as
long as perianth segments **J. acutus**

GROUP IIIa

1. Leaves with conspicuous long hairs **Luzula** spp. 2
Leaves lacking hairs
2. Leaves broad, 1/4in. or more, flat; flowers in stalked clusters **J. planifolius**
Leaves narrow, to 1/8in. wide, flat or channelled, grass-like or
bristle-like 3
3. Plant pulled from ground easily; flowers along upper part of
branches, forming head occupying greater part of plant **J. tenuis**
Plant pulled from ground with difficulty; head distinct, branched,
at top of naked stem, occupying small part of plant **J. bufonius**

GROUP IIIb

1. Tufts of bristle-like leaves along prostrate stems and about each
flower or capsule cluster in head; plant slender **J. bulbosus**
Tufts of bristle-like leaves absent; plants more robust; leaves not
bristle-like 2
2. Leaves with longitudinal interior partitions **J. prismatocarpus**
Leaves lacking longitudinal partitions; cross partitions present .. 3
3. Leaves longer than stems; flowers greenish; in clusters of 10 to
20; head contracted **J. holoschoenus**
Leaves shorter than stems; flowers brownish, in clusters of 2 to 8;
head open, spreading **J. articulatus**