ORIGINAL RESEARCH

Taxonomy of *Echinochloa* (L.) P. Beauv (barnyard grass) in the Asian-Pacific Region: An Update

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Editor's Note:

The article on barnyard grasses (*Echinochloa* P. Beauv. spp.) republished below was one of the first to be received and published by the APWSS Journal **WEEDS** (2019, Volume 1, Issue 1, pp. 30-42).

It is republished in honour of Peter Michael, for the benefit of new APWSS members and other weed scientists for their appreciation. I have added a few additional notes and photographs of *Echinochloa* specimens that Peter Michael named that were sent to me by the Kew Herbarium.

Our weed science community would be interested to learn that Peter Michael's interest in *Echinochloa* spp. began with the first APWSS Conference in 1967 as he has stated in the article..

Peter Michael's findings on *Echinochloa* species across the world have been well captured by the updated *Kew Plant List – Plants Of The World Online database* (**https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:17976-1**) and also by *The Atlas of Living Australia Online database* (**https://bie.ala.org.au/search?q=Echinochloa&fq=&dir=&sortField=&rows=&offset=20&max=10**).

The rhizomatous perennial, native to Papua New Guinea and North and North-East Australia, *Echinochloa praestans*, which P. W. Michael had described in *Telopea* 2:31 (1980) had earlier been relegated as a synonym of *E. polystachya*. However, *E. praestans* has now been accepted as a different species and the naming authority credited to Peter Michael (**https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:399726-1**).

Abstract

This paper provides a revised key to the identification of taxa of *Echinochloa* in the Asian-Pacific region, the result of many years' study of this important weedy genus, with an emphasis on the importance of association with the Asian-Pacific Weed Science Society. Descriptions of two new Indian species are included.

Key words: *Echinochloa*, barnyard grass, Asian-Pacific grasses, *E. mentiens, E. trullata*

Introduction

The inauguration of the Asian-Pacific Weed Science Society (APWSS) at the Asian-Pacific Weed Control Interchange in 1967 coincided with the beginning of my serious interest in the taxonomy of *Echinochloa*. After a year in Japan in 1965 on a technical scholarship at the National Institute of Agricultural Sciences in Tokyo, where I learnt much about one form of *Echinochloa* now known as *E. oryzicola* (*tainubie* in Japan), I was keen to find out whether it occurred in Australia. This led me into a field of surprises.

Contrary to the belief held by grass botanists in Australia that all of our barnyard grasses were exotic, Australia did have a number of native species, as Dr Joyce Vickery—distinguished grass taxonomist of the National Herbarium of New South Wales (NSW)—and I found in our detailed studies of

Australian and exotic collections. Only one of these had been noted as a weed in rice.

In my annual report for 1966, in dealing with my studies on *Echinochloa*, I drew attention to the confused state of the taxonomy of the genus, noting that I was "…*in the process of trying to elucidate (with the help of plants grown from seed) some of the problems involved*…," which I expected would "…*take some time in view of a number of difficulties, not the least being the relative inaccessibility of the relevant literature*…"

In those days I was working in the Ecology Section of the Division of Plant Industry at the Commonwealth and Scientific Research Organisation (CSIRO) in Canberra, ACT, where I was encouraged in my work by the staff of the Herbarium, now included in the Australian National Herbarium (CANB). On my moving to the Faculty of Agriculture at the University of Sydney in 1969, I was able to continue my work in closer association with Dr. Vickery.

My first association with the APWSS was at the Fourth Conference held in 1973 at Rotorua, New Zealand, where I presented a paper, my first on *Echinochloa* in the Asian-Pacific region, and again met Japanese delegates, who I had first been introduced to in 1965 in Japan. Since then I have received help and suggestions from various members of the Society and from others in the countries it represents. Attending APWSS conferences has enabled me to collect *Echinochloa* in New Zealand, Japan, the Philippines, and India.

Visits to herbaria in these countries as well as in St Petersburg (Leningrad), Europe and the United States have been of great benefit. Special collecting trips in the Philippines, Indonesia and Burma (Myanmar) have given me a good appreciation of the distribution and variation of the species. I must acknowledge, too, the great support I have had in Australia, especially in relation to travelling costs.

The main purpose of this paper is to describe two new annual species of *Echinochloa*, collected originally from India, and to also present a revised key to *Echinochloa* in the Asian-Pacific region.

My first key (Michael, 1983) was the first attempt to put the world members of the genus in proper focus; the second key (Michael, 1994) included only *Echinochloa* in China; and the third key (Michael, 2001), here revised, include species and varieties in the Asian-Pacific region. It is important for readers to absorb the contents of the notes in these three attempts as background to my new key. In this paper I have provided additional comments on only a few taxa. My recent publications on *Echinochloa* have included an account of the genus in North America north of Mexico (Michael, 2003) and in Australia (Simon et al. 2009).

A great inspiration has been the revised edition of studies on the natural history of *Echinochloa* (Yabuno and Yamaguchi, 2001). It would be good to have an English translation of this thoroughly satisfying book. Additional useful contributions to the taxonomy of *Echinochloa* are to be found in K-U Kim and Labrada (2003).

Two new annual species of *Echinochloa* from India

In the following two descriptions, I have used codes for the various herbaria mentioned. They are:

BM The Natural History Museum, London, UK

K Royal Botanic Gardens, Kew, UK

MO Missouri Botanic Gardens, St. Louis, Missouri, USA

NSW Royal Botanic Gardens & Domain Trust, Sydney, New South Wales, Australia

P Museum National d'Histoire Naturelle, Paris, France

US Smithsonian Institution, District of Columbia, Washington, USA

I am most grateful for the opportunities to visit these and other herbaria throughout the world. Without their help, my work on *Echinochloa* would have been impossible. The acronym KFP in the first description means the Karnataka Flora Project.

1. *Echinochloa mentiens* P.W. Michael

Description:

Annual grass of rice-fields, mimicking rice. Culms close, erect to 1.3 m tall with lower portions up to 10 mm thick. Leaf blades erect, strongly scabrid. Ligules sparingly, finely pubescent. Panicles narrow, linear with branches (racemes) appressed to the primary axis, up to 2.5 mm long and 7 mm wide with the internodes scarcely longer. The nodes of the primary axis of the panicles and the whole length of the branch rhachises bear numerous bristles (setae).

Spikelets are in pairs, congested from the base of the branches, often appearing to be in regular rows, ovate, rigidly cuspidate, around 3.5 mm long. Lower glume reaches to be about half the length of the spikelet. Mature caryopses brownish, 2.0-2.3 mm long. An image of the holotype, from the Kew herbarium catalogue, is reproduced in **Figure 1**.

Diagnosis:

Similar to *E. colona* (L.) Link but with more robust habit, racemes of the panicles broader and with abundant bristles, spikelets bigger and the mature caryopses brownish, not whitish. The quite common form of *E. colona* in wetland rice (Michael, 2001) with spikelets around 2.5 mm long and whitish caryopses is much less robust than *E. mentiens*. *Echinochloa frumentacea* Link differs from *E. mentiens* in its panicles with spreading, curved racemes, often nodding at maturity. Spikelets are more swollen, and caryopses are whitish. **Figure 2** provides images that can be compared.

Holotype:

(see Figure 1). India, Karnataka, Hassan District, Maranahalli, 15 km from Sakleshpur, on main road from Hassan to Mangalore. In rice-field, standing above the level of mature paddy. C. J. Saldanha, P. W. Michael and S. R. Ramesh. KFP 14236, 30 Nov 1981 (K); Image ID – K000245284.

Isotypes:

St. Joseph's College Herbarium, Bangalore, India; NSW, Australia.

The specific epithet '*mentiens*' implies both imitation and deception and is considered appropriate to describe a plant that *mimics* rice so closely. Other rice mimics in the genus *Echinochloa* include *E. crus-galli* (L.) Beauv. var. *formosensis* Ohwi (syn. *E. glabrescens* Munro ex Hook f.) and the two, often misunderstood, taxa, *E. crus-galli* (L.) Beauv. var. *oryzoides* (Ard.) Lindm. [(syn. *E. oryzoides* (Ard.) Fritsch and *E. phyllopogon* (Stapf) Koss)] and *E. oryzicola* (Vasing.) Vasing.

Distribution and other Specimens:

Known only from India. North-West India ex Herb. Ind. Or. Hook.fil. & Thomson, originally labelled *Oplismenus frumentaceus*, collected by T. Thomson, without precise location or date (P) but quite likely to have been collected in 1842-1847 (Hooker and Thomson, 1855).

Central India, Madhya Pradesh, Gwalior, ex BM, C. Maries, 1 Oct. 1890 (NSW)

South India, Karnataka, near Mangalore. Plants were collected by J. F. Metz (1819-1886) in 1853, named as *Oplismenus colonus* Kunth var. *pseudocolonus* ejusd. by C. F. F. Hochstetter (1787-1860) and distributed by R. F. Hohenacker (1819-1886). The publication of this new name has been long delayed because of doubts about the name *Panicum pseudocolonus* Roth, which had been applied by Hochstetter under the derived name *Oplismenus colonus* Kunth var. *pseudocolonus* ejusd [1].

The type of Roth's species was based on a collection of Benjamin Heyne (1770-1819), now believed to be lost (unpublished note by J. F. Veldkamp, 2003). Roth's brief diagnosis is insufficient to separate it from the somewhat bristly forms of *E. colona* commonly occurring in the tropics. Nor did Roth (1821) refer to the large spikelets, thus pointing along with other distinguishing features to the new species, *E. mentiens*, described here.

Specimens have been seen in P (Herb. Steudel, Herb. E. Drake del Castillo and Herb. Mus. P.). These specimens prompted me to ask Fr. C. J. Saldanha of St. Joseph's College, Bangalore, for help in a search for the plants fitting those old specimens. It was due to his great kindness that we were able to rediscover the plants in 1981.

Hohenacker's distributed specimens have also been seen in K and BM, along with specimens of *E. colona* collected in the same region. Additional specimens from the location of the holotype – KFP 14237 - are to be found in St. Joseph's College Herbarium and NSW.

Echinochloa mentiens may have been introduced to Louisiana, USA. with rice. A photograph that appears to be of this plant, referred to as a variety of *E. crus-galli* and given the common name 'Baronet grass' was presented by Robert E. Williams in 1956, in '*The Rice Journal*' (see **Figure 3**). Unfortunately, I have not been able to locate the authentic specimens of the original plants discovered on the farm of Mr. Jules Baronet, in about 1920.

It is highly probable that *E. mentiens* has been derived at least in part from the very variable *E. colona* (L.) Link as a response to the hand-weeding of rice throughout its long period of cultivation in India. A form of *E. colona*, showing appressed panicle branches, with unusually setose rhachises, has been collected from Karnataka (Herbarium of St. Joseph's College, Bangalore, Hassan District, Arsikere – C. J. Saldanha 13746, 10 June 1969; Mysore District, Virajpet – S. R. Ramesh and P. Prakash, KFP 3119, 9 Oct 1978).

This form has also been collected as a rice-weed from Louisiana (south of Crowley, C. E. Chambliss July 1930 (US); Plants of Louisiana, St. Mary Parish, D. S & H. B. Corell 9432, 3 July 1938 (MO); Crowley

[1] **Editor's Note**: *Ejusdem generis* is a Latin phrase used also in scientific names of plants and animals to mean "**of the same kind**."

Research Station, B. Cox, 23 Aug 1984 (NSW) – see **Figure 3**).

These plants are called 'Baronet grass' (*pers. comm*. J. B. Baker, 1989), suggesting that both *E. mentiens* and its supposed progenitors may have been introduced together to rice fields in Louisiana. Further investigations are needed to find the current distribution of *E. mentiens* in India and, perhaps, to locate specimens, old or new, from Louisiana.

2. *Echinochloa trullata* P.W. Michael

Description:

Robust, tufted, annual to 150 mm tall, geniculate or horizontal at the base and rooting from lower nodes, becoming erect. Leaf sheaths glabrous, ligular area smooth, occasionally with tubercle-based bristles at the margins of blade or sheath. Leaf blades up to 45 cm long and 1.0 cm wide.

Panicles stiffly erect at length, exserted, 8.5 to 17 cm long, rarely longer, no greater in width than one quarter to one fifth of their length and narrower than the length of the longest raceme; the greatest width is at the tips of the lower one to four racemes, gradually narrowing upwards becoming ovate-triangular in outline (trullate or trowel-shaped).

Racemes densely crowded with elliptical-ovate to ovate spikelets 2.5 to 3.5 mm long and 1.5 to 2.0 mm wide, often borne at right angles to racemes when mature. Glumes evenly rounded or truncate above the 1 to 2 mm long stipe-like base. Lower glume acute, one third to one half the length of the spikelet. Spikelets awnless (or rarely short-awned), falling very readily at maturity.

Caryopses ovate to broadly ovate, 1.5 to 2.0 mm long and 1.2 to 1.5 mm wide, pale golden brown. Embryo two thirds the length of the caryopses. An image of the holotype, from the Kew herbarium catalogue, is reproduced in **Figure 4**.

Diagnosis:

Similar to *E. crus-galli* (L.) Beauv. var. *crus-galli*, but the panicle, rarely exceeding 17 cm, always stiffly erect, ovate-triangular, no greater in width than one quarter or one fifth of its length and narrower than the length of the longest raceme, with greatest width at the tips of the lower one to four racemes. Spikelets mostly awnless, 2.5 to 3.5 mm long, falling very readily at maturity. Lower glume one third to one half length of the spikelet.

Holotype:

India, Manipur State, Tetland Bay, Imphal. A. A. Bullock 748, 27 Oct. 1945. Scrub Typhus Research Herbarium, Sheet 1 of 2 (K); Damp grassland. Not very common. Tufted grass, culm at first horizontal, becoming erect. An image is available at K of the isotype (sheet 2 of 2) (ID K – 000245285).

Distribution and other Specimens:

India, Assam, ex Herb. Hort. Bot. Calcuttensis W. Griffiths (1810-1845), no precise locality or date (P).

India, Manipur State, Dehra Dun, N. L. Bor 17188, 2 Nov 1942. A grass in the political agent's (PA's) garden, alt. 610 m (K).

India, Manipur State, Kanglatongbi, A. A. Bullock 657, 7 Oct 1945, alt. 910 m. Common in oak scrub (K).

Pakistan, Rawalpindi, A. Rahman 24852, May 1950. By stream alt. 510 m.

Fiji, Koronivia Research Station, Naitasiri D. Kooriveibau L18247, 8 June 1971. In rice field, common in wet land (NSW).

Australia, New South Wales, Camden glasshouse, grown from seed from Fiji, P. W. Michael, 6 Feb 1973 (NSW).

Indonesia, Sumatra, Lampung Utara, Sumberjaya, P. W. Michael 6681, 5 April 1981. Coffee plantation in water (NSW).

Myanmar, Maymyo, P. W. Michael 25, 28 Oct 1982. Annual in upland rice field, alt. 1050 m (NSW).

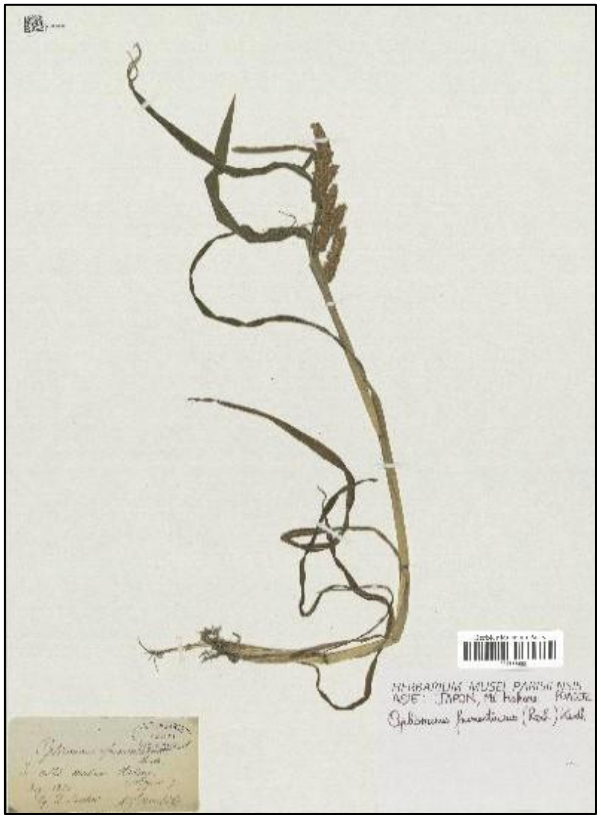
This species is poorly known and requires further investigation. It is clear, however, that its home is the Indian sub-continent and it would be surprising if it were not found to be widespread. The occurrences in Sumatra and Fiji are most likely explained by the migration of Indian peoples.

Dr. Joyce Vickery and I recognized this plant as an unusual *Echinochloa* among specimens from Kew, which we called the "Assam form". During the APWSS Conference at Hyderabad in 2015, Dr. Iswar Barua, from the Assam Agricultural University, India, showed me specimens that reminded me of the "Assam form".

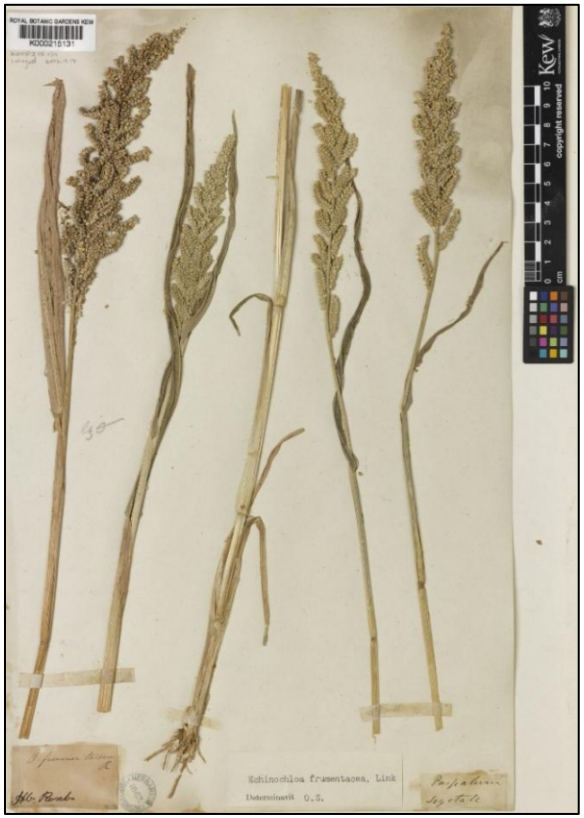
Dr. Hirohiko Morita (*pers. comm*., Morita, 2018), from Japan, has recently recognized it as a distinct form. These, in turn, have encourage me to describe it as a new species.

Figure 1 An image of the holotype *Echinochloa mentiens* P. W. Michael from the Herbarium catalogue at Kew (url: http://apps.kew.org/herbcat/getImage.do?imageBarcode=K000245284)

A fragment of *Echinochloa mentiens* P. W. Michael from the type collection



Oplismenus frumentaceus (Roxb.) Link *



Echinochloa frumentacea Link **

Figure 2 The new species - *Echinochloa mentiens* compared with old herbarium specimens of *E. frumentacea*

* Image from Muséum National d'Histoire Naturelle, Paris (France) (url: https://science.mnhn.fr/institution/mnhn/collection/p/item/p02722638)

** Image from the Herbarium catalogue at Kew (url: http://www.kew.org/herbcatimg/632497.jpg)

Figure 3 (Left) a scanned image of Baronet grass from Williams (1956); (Right) an image of a fragment of *E. colona* (L.) Link, called Baronet grass, collected by B. Cox at Crowley Research Station, Louisiana, 23 Aug 1984 (NSW)

List of Echinochloa taxa in the Asian-Pacific region

Given below is an updated list of the *Echinochloa* taxa in the Asian-Pacific region, based on my studies and reviews. A revised key to the species is also provided overleaf.

World Tropics

E. colona (L.) Link

Eurasia

E. crus-galli (L.) Beauv. var. *crus-galli*

Asia (South-East Asia, Indonesia, New Guinea and adjacent islands)

E. caudata Roshev.

E. crus-galli (L.) Beauv. var. *praticola* Ohwi.

E. crus-galli (L.) Beauv. var. *hispidula* (Retz.) Honda

E. crus-galli (L.) Beauv. var. *austro-japonensis* Ohwi

E .crus-galli (L.) Beauv. var. *formosensis* Ohwi

E. crus-galli (L.) Beauv. var. *persistens* Diao

E. crus-galli (L.) Beauv. var. *oryzoides* (Ard.) Lindm.

E. esculenta (A.Br.) Scholz

E. frumentacea Link

E. mentiens P.W. Michael [2]

E. oryzicola (Vasing.) Vasing

E. picta (Koen.) P.W. Michael

E. stagnina (Retz.) Beauv.

E. trullata P.W. Michael

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[2] **Editor's Note:** The taxonomic position of the two new species Peter Michael named in this article: *E. mentiens* and *E. trullata* are yet to be examined and resolved by *The Kew Plant List*. I have now registered these two species for consideration by the *International Plant Names Index* (IPNI: https://ipni.org/registration/). The species names will now appear in all other databases and resolved at a future date.

Figure 4 An image of the holotype *Echinochloa trullata* P. W. Michael specimen from the Herbarium catalogue at Kew (url: http://apps.kew.org/herbcat/getImage.do?imageBarcode=K000245285)

Australia

E. dietrichiana P.W. Michael

E. elliptica P.W. Michael et Vickery

E. inundata P.W. Michael et Vickery

E. macrandra P.W. Michael et Vickery

E. kimberleyensis P.W. Michael et Vickery

E. lacunaria (F. Muell.) P.W. Michael et Vickery

E. telmatophila P.W. Michael et Vickery

E. turneriana (Domin.) J.M. Black

Africa

E. pyramidalis (Lam.) Hitchc. et Chase

North America

E. muricata (Beauv.) Fernald var. *microstachya* Wiegand

South America

E. crus-pavonis (Kunth) Schult.

E. polystachya (Kunth) Hitchc.

Revised key to *Echinochloa* in the Asian-Pacific region

NB. Spikelet length measurements do not include awns

A. Annuals

1.	Spikelets 3-5 mm long.	2.
1.	Spikelets less than 3 mm or greater than 5 mm long.	18.
2.	Ligule a line of bristles or fine short cilia.	3.
2.	Ligule absent, or the ligular regions bearing a few cilia or fine pubescence.	4.
3.	Numerous long bristles at nodes of inflorescence. Panicle spindle-shaped, up to 15 cm long. Spikelets narrowly elliptical. Awns of lower lemma up to 30 mm long, of second glume up to 10 mm long.	*E. elliptica*
3.	No long bristles along main axis or branches of panicle. Panicle narrow, linear. Spikelets broadly ovate or ovate-elliptical.	*E. turneriana*
4.	Spikelets broadly ovate, crowded along the often incurved branches of the inflorescence. Fertile florets and caryopses markedly humped, so that the second glume often appears to be shorter than the spikelet. Mature fertile florets not easily deciduous.	5.
4.	Fertile floret and caryopses not markedly humped.	6.
5.	Spikelets brownish at maturity. Commonly awnless, sometimes awned. Caryopses brownish.	*E. esculenta*
5.	Spikelets pale green at maturity, awnless. Caryopses whitish.	*E. frumentacea*
6.	Essentially obligate weeds of rice or crop plants in rice fields. Close tufted erect habit. Greatly resemble rice before flowering.	7.
6.	Not obligate weeds of rice, but all growing in wet places and often occurring in rice. Plants more or less spreading at base.	11.
7.	Panicle narrowly linear with alternate branches up to 25 mm long pressed closely to the primary axis. Spikelets around 3.5 mm long, caryopses 2–2.3 mm long, brownish.	*E. mentiens*
7.	Panicles erect or nodding, branches not pressed closely to the primary axis.	8.
8.	Spikelets 3–4 mm long.	9.
8.	Spikelets 3.5–5 mm long.	10.
9.	Spikelets 3–3.5 mm long. Lower lemma convex, hard and shiny. Awnless or less often awned, occasionally found on banks and fallow land.	*E. crus-galli* var. *formosensis*
9.	Spikelets 3–4 mm long, persistent, lower glume 0.22 length of spikelet. Leaf sheaths glabrous.	*E. crus-galli* var. *persistens*

10.	Spikelets broadly ovate to ovate. Inflorescence hanging almost horizontal at maturity. Spikelets nearly always awned. Awns sometimes as long as 50 mm. Lower glume 0.33–0.5 the length of spikelet. Collar region of leaves rarely with tufts of hairs. Caryopses ovate, embryo 0.7–0.8 the length of the caryopsis.	*E. crus-galli* var. *oryzoides*
10.	Spikelets ovate-elliptical. Inflorescence more or less erect at maturity. Spikelets awned or awnless. Lower glume 0.5–0.66 length of spikelet. Lower lemma often convex, hard, and shiny. Collar of leaves often with tufts of hairs. Caryopses oblong, embryo often 0.9 or more the length of the caryopses.	*E. oryzicola*
11.	Lemma and palea of fertile floret acute or acuminate with stiff tip. Panicle spreading, erect. Caryopses yellowish. Spikelets 3–3.5 mm.	*E. muricata* var. *microstachya*
11.	Lemma of fertile floret with withering tip sharply differentiated from the body of the lemma.	12.
12.	Panicle erect, ovate-triangular. Spikelets 2.5–3.5 mm long, crowded, mostly awnless, falling very readily at maturity.	*E. trullata*
12.	Panicle erect or nodding. Spikelets short- or long-awned, sometimes apparently awnless but, if so, there are always a few awned at the ends of the racemes.	13.
13.	Inflorescence strongly drooping at maturity, sometimes bending over as much as 180 degrees. Spikelets crowded with short, curved awns, mostly 3–10 mm long, but can be up to 15 mm long.	*E. crus-pavonis*
13.	Inflorescence often nodding but not strongly drooping at maturity.	14.
14.	Spikelets narrowly elliptical, up to 4.2 mm long. Awns of lower lemma up to 40 mm long. Awn on the second glume up to 7 mm long or longer. Bristles on spikelets not spreading. Leaf sheaths glabrous.	*E. telmatophila*
14.	Spikelets broadly ovate to elliptical, never narrowly elliptical, almost awnless, short- or long-awned.	15.
15.	Spikelets ovate or ovate-elliptical up to 5 mm long. Panicle linear, anthers 1 mm or more long.	16.
15.	Spikelets broadly ovate, ovate, or ovate-elliptical, 3–4 mm long. Long bristles abundant along main axis and branches of panicle. Panicles various, often pyramidal. Anthers generally less than 1 mm long.	17.
16.	Spikelets ovate, uniformly 3 mm with strongly spreading bristles up to 1 mm long. Long bristles prominent at point of attachment of racemes and along main axis. Panicles not becoming purplish.	*E. dietrichiana*
16.	Spikelets 3.5–5 mm long, with few or no bristles on main axis and/or branches of panicle.	*E. inundata*
17.	Spikelets broadly ovate or ovate. Awnless except at the ends of branches, short-awned or long-awned. Lower lemma flat, occasionally convex and shiny. Caryopses ovate. Panicles of variable length, more or less erect, often pyramidal, sometimes nodding, branches never obviously whorled. Long panicles, often with secondary branches on lower primary ones.	*E. crus-galli* var. *crus-galli*
17.	Spikelets ovate-elliptical, short or long awns. Caryopses more or less oblong. Panicles rarely pyramidal, erect or nodding, branches often whorled, more or less erect except for the lowermost ones.	*E. crus-galli* var. *hispidula*
18.	Spikelets 5 mm long or longer.	19.
18.	Spikelets 3 mm long or shorter.	22.
19.	Spikelets with awns up to 90 mm long. Anthers more than 1.5 mm long. Ligule a line of bristles or cilia.	20.
19.	Spikelets awnless or awned. Ligule absent, rarely a line of short cilia.	21.
20.	Anthers 1.5–2 mm long. Palea of lower floret about half the length of the lemma, sometimes absent. Lower floret neuter.	*E. kimberleyensis*
20.	Anthers 2–2.8 mm long. Palea of lower floret about length of lemma. Lower floret staminate.	*E. macrandra*

21.	Spikelets awnless, ovate, very finely pubescent. Main axis and short branches of inflorescence without bristles.	*E. lacunaria*
21.	Spikelets awned, ovate. Panicles hanging more or less horizontally at maturity. Awns up to 50 mm long. Obligate weed of rice.	*E. crus-galli* var. *oryzoides*
22.	Palea of lower floret absent of poorly developed. Spikelets dense, 1 mm broad, with awns up to 45 mm long. Panicles up to 20 cm long.	*E. caudata*
22.	Palea of lower floret fully developed.	23.
23.	Spikelets broadly ovate to ovate, awnless with panicle not more than about 15 cm long.	24.
23.	Spikelets ovate-elliptical to elliptical, usually with short awns. Inflorescence close, short with more or less erect branches.	*E. crus-galli* var. *austro-japonensis*
24.	Spikelets regularly arranged in rows. First glume regularly half the length of the spikelet. Caryopses whitish. Long bristles mostly absent from main axis and branches of inflorescence, occasionally a few scattered along the branches and clustered at the nodes.	*E. colona*
24.	Spikelets irregularly arranged. First glume about 0.33 length of spikelet. Caryopses brownish. Long bristles along main axis and branches of inflorescence present or absent.	*E. crus-galli* var. *praticola*

B. Perennials

All species have spikelets 3 mm or more long. Ligular bristles are always present and obvious, especially in the lower leaves. The lower floret is often staminate. Plants may have long creeping rhizomes and/or stolons and spongy floating stems. Sometimes the rhizomes are much shortened and thickened.

1.	Spikelets awnless or with short awns or long cusps. Spikelets crowded, very finely pubescent or for the most part glabrous, with short bristles and short awns or long cusps. Inflorescence often more than 40 cm long. Secondary branches often closely appressed to primary branches of inflorescence. Plant often up to 4 m tall with stout culms.	*E. pyramidalis*
1.	Spikelets awned, awns often long.	2.
2.	Spikelets elliptical or lanceolate, up to 5 mm long with bristles up to 1 mm long and with long, narrow lower glumes. Floating, often with long culms.	*E. stagnina*
2.	Spikelets awned, 3–4 mm long.	3.
3.	Spikelets lanceolate, 3.5–4 mm long, finely pubescent. Awns up to 15 mm long. Racemes up to 90 mm long. Culms stout, up to 3.6 m tall. Leaves up to 20 mm or more broad. Nodes and leaf sheaths glabrous. Ligular bristles obvious on all leaves.	*E. polystachya*
3.	Spikelets broadly ovate, 3–4 mm long with bristles 0.5 mm long. Awns up to 18 mm long, whitish. Panicles sometimes one-sided. Racemes 20–50 mm long. Culms generally less than 1 m. Leave often with transverse purplish bands. Ligular bristles often not on upper leaves.	*E. picta*

Notes on selected taxa

E. crus-galli var. *formosensis*

Echinochloa crus-galli var. *formosensis* is often referred to as *E. glabrescens* Munro ex Hook. f.

E. crus-galli var. *hispidula*

I believe that this is the appropriate name to use for *E. crus-galli* with non-pyramidal panicles, ovate-elliptical spikelets, usually prominently awned, common in sub-tropical areas and extending to Japan and southern China. There has been disagreement about the nature of *Panicum hispidulum* Retz., on which the name *E. crus-galli* var. *hispidula* is based. Ohwi (1962), who showed a picture of the Retzius specimen collected in India, believed it did not fit features of *tainubie* (now known as *E. oryzicola*).

The density of its spikelets, short inflorescence branches and the long fine awns can be fitted easily to occasional specimens from wet places in Japan.

E. crus-galli var. *persistens*

This was originally described by Diao (1988) as *E. persistentia* and later as *E. crus-galli* var. *persistentia* Diao (1990). Its very short lower glume is unusual in *Echinochloa*.

E. picta

Yamaguchi (2007), in his treatment of a hidden variety of barnyard grass (*E. crus-galli* var. *riukiuensis* Ohwi), provided a photograph (see below, **Figure 5**) showing plants with distant racemes, whitish awns and one-sided panicles, which made me think immediately of *E. picta.* It would not surprise me to find *E. picta* in the far southern Ryukyu Islands. I have collected it in the far north of Luzon in the Philippines.

E. polystachya

My *E. praestans* has been relegated to a synonym of *E. polystachya* (Simon et al., 2009). I had previously followed South American treatments, which considered *E. polystachya* and *E. spectabilis* Nees both as varieties of *E. polystachya*. I now believe they are separate species. The much more open panicles of *E. polystachya* with its long racemes distinguishes it from the more crowded inflorescence of *E. spectabilis* with its shorter racemes.

Figure 5 ***E. crus-galli* var. *riukiuensis,* reproduced from Plate 2 of Yamaguchi (2007). Regenerating young shoots (left) and panicles (centre and right)**

Conclusions

It is to be hoped that readers will have the opportunity to test this key and to report any deficiencies. My hope is that some day more use will be made of the collections of *Echinochloa* in the National Herbarium of New South Wales, which now includes all of the species originally housed in the Faculty of Agriculture at the University of Sydney.

It would be good if this paper were followed by up-to-date treatments of *Echinochloa* in the Americas (New World) and in Africa, including especially Madagascar. It might then be possible, with the help of pertinent molecular studies, to prepare a world key to replace my first attempt in Michael (1983).

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URLs for important, old references now available online, is also appreciated.

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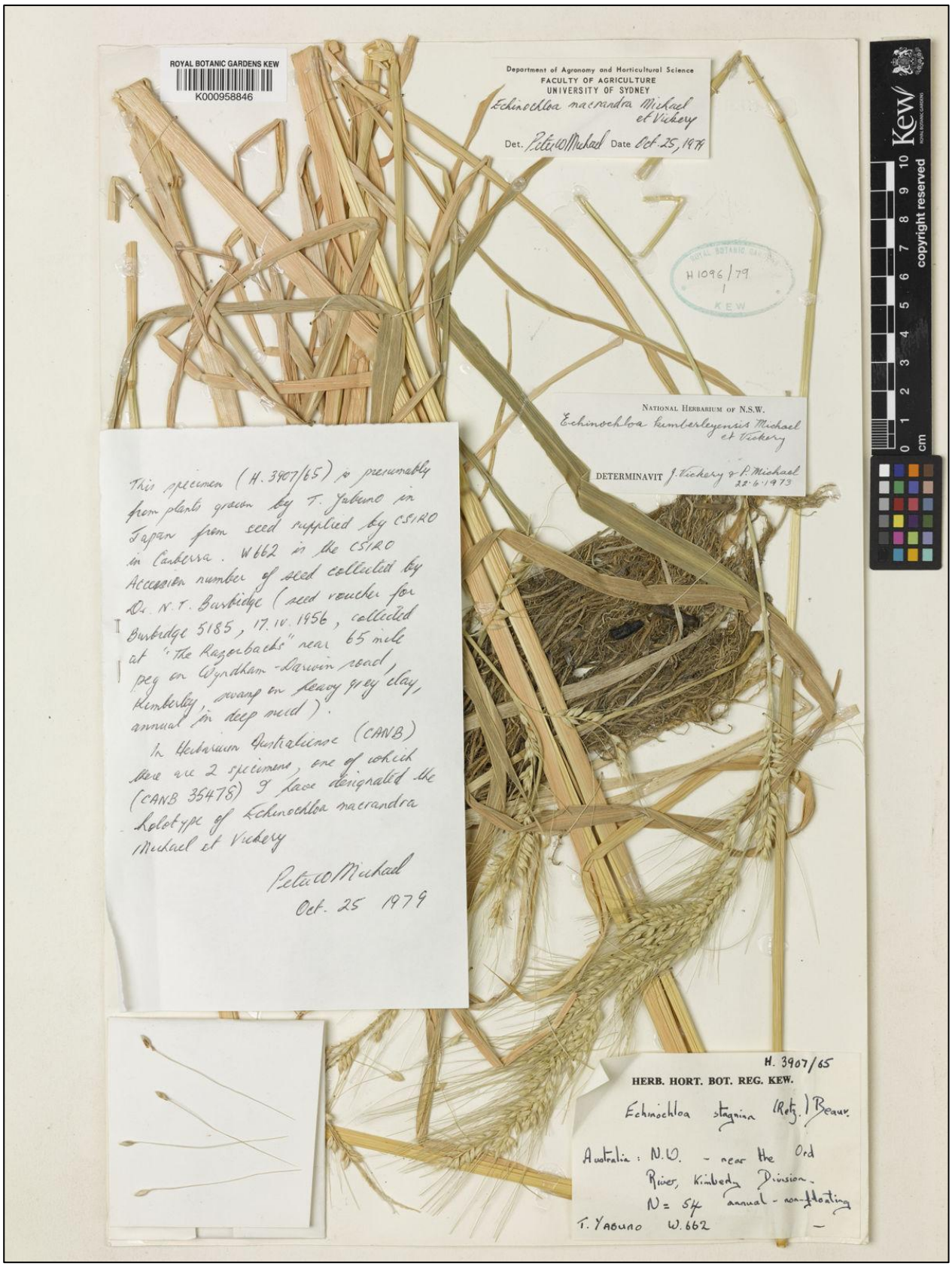

Figure 5 An image of the holotype *Echinochloa kimberleyensis* P. W. Michael et Vickery specimen from the Herbarium catalogue at Kew (Specimen Barcode: K000958846). Note the comments from Peter Michael as the determinant

Figure 6 An image of the holotype *Echinochloa elliptica* P. W. Michael et Vickery specimen from the Herbarium catalogue at Kew (Specimen Barcode: K000958847).

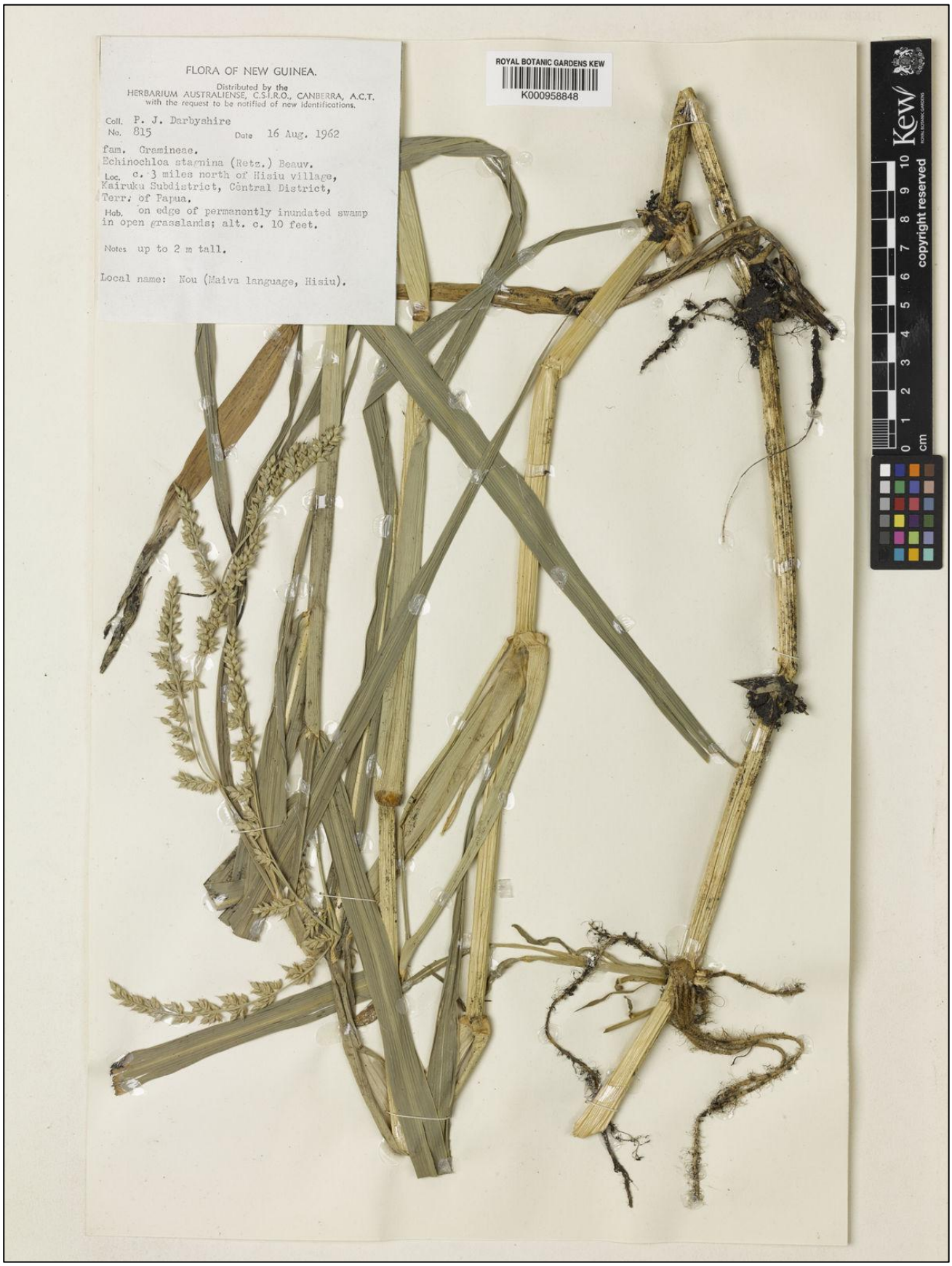

Figure 7 An image of the holotype *Echinochloa praestans* P. W. Michael from the Herbarium catalogue at Kew (Specimen Barcode: K000958848)

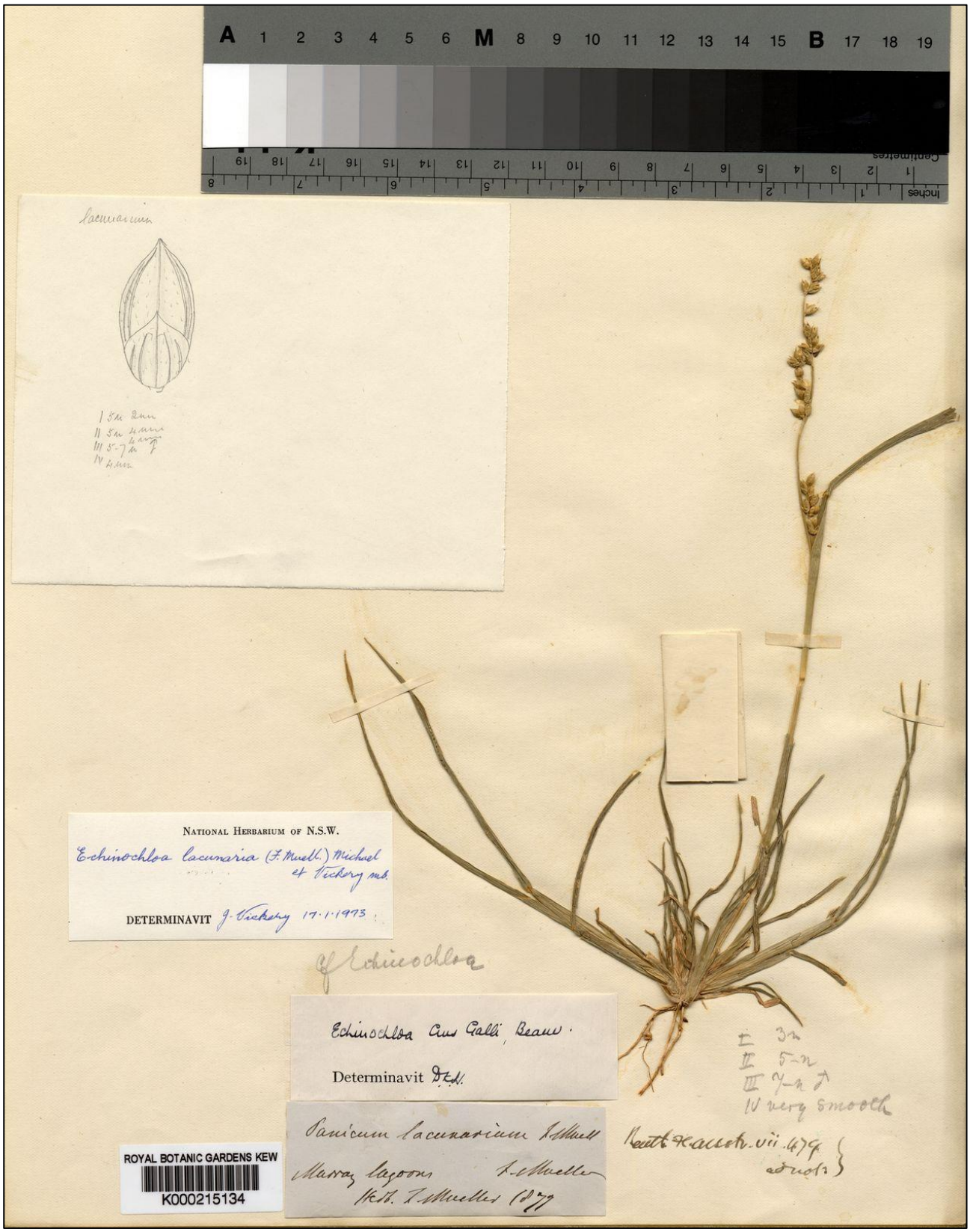

Figure 8 An image of the holotype *Echinochloa lacunaria* (F. Muell) Michael et Vickery from the Herbarium catalogue at Kew (Specimen Barcode: 000215134).