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CYPERUS ROTUNDUS (NUT GRASS) AND ITS ALLIES IN AUSTRALIA.

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INTRODUCTION.

Cyperus rotundus L., the well-known "nut grass," is widely spread and abundant along the coastal districts of Eastern Australia as far south as Victoria and South Australia, and is a very serious pest of cultivated land. Hitherto no entirely satisfactory means of controlling the weed has been devised.

There are, however, allied species in Australia, some of which are of considerable economic value, and as they have been confused with *C. rotundus* it is important that they be recognised. It is with the object of providing a means to the discrimination of the species that this paper is presented. The following brief survey of the history of the nomenclature of the Australian forms gives some idea of the confusion that has arisen, and the difficulties encountered in studying the group.

HISTORICAL.

The first record of the occurrence of any species of the group in Australia is that given by R. Brown in his Prodromus Florae Novae Hollandiae, p. 216 (1810), where three species are distinguished, namely: *C. scariosus* R.Br., *C. litoralis* R.Br., and *C. rotundus* L.

Bentham, in Flora Australiensis vii., 279-280 (1878), gives a description of *C. rotundus* L., citing *C. litoralis* R.Br. as a. synonym, describes a var. *carinalis* Benth. and var. *pallidus* Benth., uniting under the latter *C. scariosus* R.Br. He adds another species, *C. stenostachyus* Benth., and on p. 281 describes another member of the group as *C. subulatus* var. *conferta* Benth.*

C. B. Clarke, in Journ. Linn. Soc. xxi. 171 (1884), describes *C. rotundus* var. *Amaliae* C. B. Clarke, based chiefly on *Dietrich* 712 from near Rockhampton, but included also specimens from Victoria collected by Mueller on the Murray River. On the same page he records for Australia *C. rotundus* var. *Salsola* C. B. Clarke and var. *centiflora* C. B. Clarke.* On p. 175 he describes *C. tenuiflorus* forma *australica* C. B. Clarke,* and on p. 180 he refers Wuth's specimens from Tambo, Queensland, which constitute the type of *C. rotundus* var. *pallidus* Benth., to *C. esculentus* L. Later, however, in Kew Bull. Add. Ser. viii. (1908), he makes Mueller's Victorian specimens the type of a new species, *C. victoriensis* C. B. Clarke (p. 13) and on p. 12 he describes Wuth's plants as *C. bifax* C. B. Clarke. On the same page he also describes two other species, *C. disruptus* C. B. Clarke based on some of the specimens he had previously described as *C. tenuiflorus* forma *australica,** and *C. Andrewsii* C. B. Clarke based on specimens collected by Andrews near Lake Eyre and cited by Bentham under his *C. subulatus* var. *conferta.**

* These are the original spellings, but the correct spellings should be *confertus, centiflorus,* and *australicus* respectively.

F. M. Bailey, in Queensland Flora vi. 1745 (1902), records with descriptions the occurrence of *C. tenuiflorus* Rottb. and *C. lucidulus* Klein. These records are based on correspondence with F. Mueller. Then on p. 1749 he records *C. esculentus* L., citing under it two aboriginal names "mangaru" and "makora."

Domin, in Journ. Linn. Soc. xli. 268 (1912), records the occurrence (based on a determination by C. B. Clarke in the Kew Herbarium) of *C. bulbosus* Vahl, and repeats this in Biblioth. Bot. xx. Heft 85, 434 (1915). On p. 433 of the latter work he records *C. tuberosus* Rottb. citing in the synonymy Bailey's reference to *C. lucidulus* Klein, and referring to it some of the specimens cited by Clarke under *C. tenuiflorus* forma *australica.**

Kükenthal, in his monograph of *Cyperus* in Pflanzenreich, Heft 101 (1935), records the following forms as occurring in Australia:—

C. rotundus L.

C. rotundus forma *comosus* (Sibth. et Sm.) K. Richter (= *C. rotundus* L. var. *centiflorus* C. B. Clarke).

C. rotundus var. *salsolus* C. B. Clarke. (This record is copied from Clarke.)

C. rotundus subsp. *tuberosus* (Rottb.) Kükenth.

C. rotundus subsp. *Retzii* (Nees) Kükenth.; under this as synonyms he cites *C. rotundus* var. *pallidus* Benth., *C. rotundus* var. *Amaliae* C. B. Clarke, *C. victoriensis* C. B. Clarke, and *C. bifax* C. B. Clarke.

C. rotundus subsp. *Retzii* var. *nubicus* (C. B. Clarke) Kükenth.

C. rotundus subsp. *Retzii* var. *disruptus* (C. B. Clarke) Kükenth.

C. stoloniferus Retz., with *C. litoralis* R.Br. as a synonym.

C. longus L. subsp. *tenuiflorus* (Rottb.) Kükenth. var. *stenostachyus* (Benth.) Kükenth., based on *C. stenostachyus* Benth.

C. corymbosus Rottb. var. *scariosus* (R.Br.) Kükenth., based on *C. scariosus* R.Br.

C. corymbosus Rottb. var. *longispiculatus* (O.K.) Kükenth.

C. bulbosus Vahl.

C. bulbosus var. *elatior* Kükenth.

The above species are distributed by Kükenthal among three sections. *C. bulbosus* is referred to the *Tunicatae, C. corymbosus* to the *Brevifoliatae,* and the remainder to the *Rotundi.* As a doubtful member of the last-mentioned section he refers *C. Clelandii* J. M. Black, but I have previously shown in Proc. Roy. Soc. Queensl. li. 43 (1940) that this is conspecific with *C. dactylotes* Benth. which is quite dissimilar from *C. rotundus.*

TAXONOMY.

In the following attempt to elucidate the Australian forms, the conclusions reached have been based chiefly upon the extensive collections already in the Brisbane, Sydney, Melbourne, Perth, Tate (University of Adelaide),

* *See* Note on previous page.

Cleland (University of Adelaide) and Black (Adelaide) Herbaria, a considerable series of exotic specimens in my own herbarium, many of which are duplicates of collections cited by Kükenthal, and extensive collections and field observations made by myself in recent years over the greater part of Queensland. I wish to thank the officers in charge of these herbaria for the loan of the specimens under their charge so that I was enabled to complete a careful examination of them in Brisbane. In the Melbourne Herbarium are representatives of the type collections of Bentham's species and varieties, Clarke's species and varieties (except *C. Andrewsii, C. rotundus* var. *Amaliae* and possibly *C. disruptus*), and most of the collections cited by Bentham, Clarke, Domin and Kükenthal; in the Sydney Herbarium are to be found duplicates of most other collections cited by Kükenthal, while Bailey's specimens are in the Brisbane Herbarium. To Dr. Kükenthal I am indebted for a piece of *C. Retzii* from a specimen collected in the Concan, India, which he assures me matches the type specimen of this species, and for notes on some of my specimens.

1. *C. scariosus* R.Br. is quite distinct from *C. rotundus,* and to my mind also distinct from *C. corymbosus* to which Kükenthal refers it as a variety. From the former and its allies it differs in the shorter leaves and bracts, the scanty inflorescence, and the narrowly elliptic acute nut*; and from the latter it differs in the more slender rhizome, the presence of tubers, the more rigid slender stems, the better-developed leaves, and the form of the nut. The specimen cited by Kükenthal from Western Australia (Gascoyne River) is *C. victoriensis,* and the specimen from Wilcannia, which I have not seen, is very probably the same. So far as I have seen it *C. scariosus* is always found close to the coast.

2. *C. litoralis* R.Br. is synonymous with the earlier-described *C. stoloniferus* Retz., and was first reduced to this species by Clarke in Journ. Linn. Soc. xxi. 173 (1884). It is sharply distinguished by the broad flattened nut.*

3. *C. rotundus* var. *carinalis* Benth. is *C. Zollingeri* Steud. as was indicated by Clarke in Hooker, Fl. Brit. Ind. vi. 613 (1893). Though superficially resembling members of this group, this species does not belong to it as it has a short horizontal rhizome without tubers, thicker spikelets with more distant glumes, and a rather different nut. Bentham's varietal epithet was written as "*carinatus*" by Bailey, as for example in Queensl. Fl. vi. 1745.

4. *C. rotundus* var. *pallidus* Benth. is a mixture of *C. Retzii* Nees and *C. scariosus* R.Br.

5. *C. stenostachyus* Benth. appears to be identical with the South African *C. tenuiflorus* Rottb. and on grounds of priority has to be known by the latter name.

6. *C. subulatus* var. *confertus* Benth. Bentham cites two collections, Lake Eyre, *Andrews,* and Alice Springs, *Giles.* I have seen the latter and it is certainly *C. bulbosus* Vahl; the former is the type of *C. Andrewsii* C. B. Clarke which I have not seen, but from the description (so far as it goes) and locality it seems fairly certain to be also *C. bulbosus.* Since Clarke does not describe the base nor nut, it would appear that the specimen is imperfect and in flower only. Domin follows Clarke, and Kükenthal follows Bentham in regard to

* "Nut" as used throughout this paper is the technical description of the fruit of the family (popularly called the "seed"), and is quite distinct from the tubers, which are popularly called "nuts," this being the origin of the name "nut-grass."

Andrews' plant. *C. subulatus* R.Br. has not been found in South Australia and seems to be strictly a coastal plant. Though superficially resembling *C. rotundus* and its allies in the thickened base of the stem and the colour and arrangement of the spikelets, it differs from the group in its tufted habit, short thick knotty rhizome, mostly narrower spikelets, and differently shaped nuts. In foliage it approaches *C. bulbosus* and some states with the inflorescence reduced to a few clustered spikelets might easily be confused with some states of that species if the characteristic bulbils are absent from the specimen.

7. *C. rotundus* var. *Amaliae* C. B. Clarke as originally described consisted of a mixture, some specimens of which later served as the type of *C. victoriensis*. The type collection is not represented in Australian herbaria, but to judge from the description and locality it seems identical with *C. scariosus*. Domin in Biblioth. Bot. xx. Heft 85, 433 (1915) cites a number of specimens under var. *Amaliae*; of those I have seen, some are to be referred to *C. scariosus*, others to *C. victoriensis*. The glumes in both species may be of various shades of brown, usually bright, or they may be pallid, apparently as the result of local climatic or weather conditions.

8. *C. rotundus* var. *Salsola* C. B. Clarke. I have seen no Australian specimens of this variety.

9. *C. rotundus* var. *centiflorus* C. B. Clarke. Kükenthal reduces this to a synonym of *C. rotundus* forma *comosus* (see no. 17 below), but does not cite the Australian specimens referred to by Clarke. The latter states merely that it is a frequent plant in Australia.

10. *C. tenuiflorus* forma *australicus* C. B. Clarke. Five collections are cited by the author, of which one was described later as *C. disruptus*. Four are cited by Domin (op. cit. 1915, p. 433) under *C. tuberosus* Rottb., three by Kükenthal (p. 114) under *C. rotundus* subsp. *Retzii*. Mueller's collection may be represented by a specimen in herb. Melbourne labelled "North Australia," since there is no specimen of the group labelled "Arnhem Land" as quoted by the authors mentioned. This specimen is matched by my no. 12299 from 35 miles south of Bedourie in the far west of Queensland, and represents a tall very stout plant with long broad leaves, very different in aspect from other Australian members of the group. The material is, however, unsatisfactory; it may be an unusually robust state of *C. Retzii*.

11. *C. victoriensis* C. B. Clarke is a very widely spread species very distinct from *C. rotundus*, differing particularly in the tall cylindrical stems triquetrous only near the top, the very slender rays of the inflorescence, the fewer spikelets to each ray, the longer spikelets, the acute glumes with straight backs, and in the narrowly obovate nut. The specimen of the type collection in herb. Melbourne is in flower only and lacks its rhizome, but there seems to be no doubt possible as to its identity with the rest of the material I have referred to the species. In spikelet structure it seems to be more closely allied to *C. corymbosus* Rottb. than to *C. rotundus*. We have seen above (under no. 1) that it has been confused with *C. scariosus* which has been referred to *C. corymbosus*, and to judge from the locality, the Winton specimen referred by Kükenthal to *C. corymbosus* var. *longispiculosus* (O.K.) Kükenth. is also *C. victoriensis*. That author has also cited specimens of this species under *C. Retzii*. (*C. corymbosus* differs from the species dealt with in this paper by the absence of tubers, the rather stouter rhizome, the leaves reduced to loose sheaths, or with only very short blades, the softer stems which are somewhat septate, the large inflorescence and oblong-elliptic nut.)

12. *C. bifax* C. B. Clarke. This is certainly identical with *C. Retzii* Nees (1834), to judge from the Indian material received from Dr. Kükenthal. But *C. Retzii* differs from *C. rotundus* in its stouter habit, brighter coloured spikelets, the glumes acute in profile with straight keels and each side nerved for $\frac{1}{2}$–$\frac{2}{3}$ its breadth. It fruits freely, while I have never seen mature fruit in Australian specimens of *C. rotundus*. The type collection of *C. bifax* is in flower only, with pale-coloured spikelets rather similar to those of *C. esculentus* L., but in general the colour of the glumes varies from yellowish through chestnut to reddish, and occasionally darker brown.

13. *C. disruptus* C. B. Clarke. This seems to be a form of *C. Retzii*. Of the specimens cited by Clarke I have seen only Dallachy's, which are young and unsatisfactory, at least as to the material in the Melbourne herbarium. However, my 11555 from Hughenden, which is fruiting, seems to be the same form, and although it has the spikelets somewhat shorter, darker coloured, and with tighter glumes than is usual in *C. Retzii*, it seems impracticable to distinguish it from this species. The dark-coloured and hardened wings of the rhachilla stressed by Clarke in his rather full description of the species are to be found in *C. Retzii*, and many variations can be observed in one and the same inflorescence of the latter.

14. *C. Andrewsii* C. B. Clarke. Probably identical with *C. bulbosus* Vahl; see above under no. 6, *C. subulatus* var. *confertus* Benth., upon specimens of which Clarke based his species.

15. *C. tenuiflorus* and *lucidulus* of the Queensland Flora refer to *C. Retzii* Nees. *C. esculentus* of the same work, at least as to the description and the remark "The nut grass often met with on downs country, not so troublesome as *C. rotundus*," is also the same species. The aboriginal name "mangaru," however, belongs to the very different *C. bulbosus* Vahl. True *C. esculentus* is known in Australia only from two specimens in herb. Brisbane from North Queensland, namely Nelson, *Girault*, and Springmount Station, *Flecker* 7337.

16. *C. bulbosus* Vahl is a distinctive species, readily distinguished by the numerous threadlike rhizomes bearing acuminate tubers with shining separable coats, the numerous long narrow leaves, and (for *Cyperus*) the very peculiar inflorescence. In this the branches (rays) and their bracts are not close together at the top of the stem as is usual in the genus, but distinctly separated. Var. *elatior* Kükenth. is only a large state, and there seems no good reason for giving the form a distinctive name.

17. Kükenthal's comprehensive treatment complicates the position by reason of the author's recognition of the categories of subspecies and formae. To me there is little doubt that *C. rotundus* L., *C. tuberosus* Rottb., *C. Retzii* Nees, and *C. victoriensis* C. B. Clarke are distinct though closely allied species. Of the specimens cited under *C. rotundus* forma *comosus*, Camfield 81* is a form assumed by plants growing on railway tracks and is apparently of no taxonomic importance, while the other, *Officer* 56,* is *C. victoriensis*. I have not seen the specimens referred to *C. rotundus* subsp. *tuberosus*, but *C. tuberosus* does occur in Queensland, though very sparingly. *C. rotundus* subsp. *Retzii* (*C. Retzii*) and the species and varieties referred to it are discussed above (nos.

* These are not collector's numbers, but were reference numbers in herb. Sydney for duplicates sent to Dr. Kükenthal.

10-13), particularly under *C. bifax,* with the exception of var. *nubicus* (C. B. Clarke) Kükenth. The Australian record of this is based on *Bidwill* 137 p.p., the other part of the number being referred to *C. Retzii* itself. Clarke refers one part of the number to *C. rotundus* var. *centiflorus* and the other to *C. tenuiflorus* forma *australicus.* Domin apparently refers the whole number to *C. tuberosus,* giving Wide Bay as the locality. I have not seen the specimens, and it is difficult to guess at them, but it certainly seems most likely that they are of some form or forms of *C. Retzii.* This species, *C. rotundus,* and *C. scariosus* are the only species of the group at present known to occur anywhere near Wide Bay, even allowing for the very loose application of locality names in the early days of settlement.

18. The species here recognised and their synonymy are as follows:—

Cyperus rotundus *L.* Sp. Pl. i. 45 (1753).

C. rotundus L. var. *centiflorus* C. B. Clarke in Journ. Linn. Soc. xxi., 171 (1884) (as *100-flora*).

C. rotundus L. forma *comosus* (Sibth. & Sm.) K. Richter, Pl. Europ. i. 135 (1890).

Cyperus tuberosus *Rottb.* Descr. et Icon. 28, t. vii., fig. 1 (1773).

C. tenuiflorus Rottb. sensu C. B. Clarke var. *australicus* C. B. Clarke op. cit. 175 (1884) partim ?

C. rotundus L. subsp. *tuberosus* (Rottb.) Kükenth. in Pflanzenr. Heft 101, 113 (1935).

Cyperus Retzii *Nees* in Wight, Contrib. Bot. Ind. 82 (1834).

C. rotundus L. var. *pallidus* Benth. Fl. Austral. vii. 280 (1878) pro parte max.

C. rotundus L. sensu Benth., etc., partim, non L.

C. rotundus L. subsp. *Retzii* (Nees) Kükenth. op. cit. 114, partim.

C. rotundus L. subsp. *Retzii* (Nees) Kükenth. var. *disruptus* (C. B. Clarke) Kükenth. op. cit. 115, et (?) var. *nubicus* (C. B. Clarke) Kükenth. loc. cit. partim.

C. disruptus C. B. Clarke in Kew Bull. Add. Ser. viii. 12 (1908).

C. bifax C. B. Clarke in Kew Bull. Add. Ser. viii. 13 (1908).

C. tenuiflorus Rottb. sensu F. M. Bail. Queensl. Fl. vi. 1745 (1902) non Rottb.

C. lucidulus Klein sensu F. M. Bail. loc. cit. non Klein.

C. esculentus L. sensu F. M. Bail. op. cit 1749, partim, non L.

Cyperus victoriensis *C. B. Clarke* in Kew Bull. Add. Ser. viii. 12 (1908).

C. rotundus L. sensu Benth., etc., non L.

C. rotundus L. var. *Amaliae* C. B. Clarke in Journ. Linn. Soc. xxi. 171 (1884), partim.

C. rotundus L. subsp. *Retzii* (Nees) Kükenth. loc. cit. partim, non *C. Retzii* Nees.

C. corymbosus Rottb. var. *scariosus* (R.Br.) Kükenth. op. cit. 83, partim, non *C. scariosus* R.Br.

C. corymbosus Rottb. var. *longispiculatus* (O.K.) Kükenth. op. cit. 82, partim, non *C. enodis* var. *longispiculatus* O.K.

Cyperus stoloniferus *Retz.* Observ. iv. 10 (1786).

C. litoralis R.Br. Prodr. 216 (1810).

C. rotundus L. sensu Benth. loc. cit. partim, non L.

Cyperus tenuiflorus *Rottb.* Descr. et Icon. 30, t. xiv., fig. 1 (1773).

C. stenostachyus Benth. Fl. Austral. vii. 280 (1878).

C. longus L. subsp. *tenuiflorus* (Rottb.) Kükenth. var. *stenostachyus* (Benth.) Kükenth. op. cit. 103.

Cyperus bulbosus *Vahl* Enum. Pl. ii. 342 (1806).

C. rotundus L. sensu Benth. loc. cit., partim, non L.

C. subulatus R.Br. var. *confertus* Benth. op. cit. 281 (as *conferta*).

C. Andrewsii C. B. Clarke in Kew Bull. Add. Ser. viii. 12 (1908).

C. esculentus L. sensu F. M. Bail. op. cit. 1749, partim, non L.

C. bulbosus Vahl var. *elatior* Kükenth. op. cit. 126.

Cyperus scariosus *R.Br.* Prodr. 216 (1810).

C. rotundus L. var. *pallidus* Benth. loc. cit. 280, partim.

C. rotundus L. var. *Amaliae* C. B. Clarke in Journ. Linn. Soc. xxi. 171 (1884), pro parte max.

C. rotundus L. subsp. *Retzii* (Nees) Kükenth. loc. cit. partim, non *C. Retzii* Nees.

C. corymbosus Rottb. var. *scariosus* (R.Br.) Kükenth. op. cit. 83, pro parte max.

Cyperus esculentus *L.* Sp. Pl. i. 45 (1753), nec sensu F. M. Bail.

ECOLOGY AND ECONOMICS.

Only two of the above species are serious weeds, and of these the most important and by far the most widely spread is *C. rotundus.* It is to this species that the name "nut grass" should be restricted. It is widely spread in the warmer parts of the world, and seems to be undoubtedly indigenous to Australia, at least in the north-east, but following settlement it has extended its range considerably. It seems not to have been collected by Banks and Solander in 1770, but it was collected by R. Brown in the neighbourhood of Sydney not later than 1805. At present it is found chiefly along the eastern coast of the continent, extending west of the Great Dividing Range in a few places. It has been found in South Australia, but there is no authentic record for its occurrence in Western Australia. It is a very serious pest of cultivated land, and occurs also on alluvial flats. Fruit rarely if ever matures under these conditions, and reproduction is entirely by means of the tubers.

In Western Australia the pest species is *C. tenuiflorus,* a South African species introduced apparently with other South African species to the south-west corner of the State. From the specimens seen it appears that the young parts of the rhizome do not bear tubers, but pass directly into the stem, the base of which later becomes thickened before a new rhizome is produced. I have not seen this species in the field, but Mr. C. A. Gardner, Government Botanist of Western Australia, has kindly informed me that it is only found in or near cultivated ground.

C. Retzii and *C. victoriensis* are widely spread in the interior of the continent, *C. Retzii* approaching the coast in some places in the north and north-east, where its range overlaps that of *C. rotundus*. It is a larger and more brightly coloured plant than *C. rotundus* and fruits freely. It occasionally behaves as a weed of cultivation, but is never a pest. On the heavy clay soils in districts away from the coast it is often abundant over large areas on lower ground or on alluvial flats and is considered to be an excellent fodder plant. It is not destroyed by heavy grazing, and its system of rhizomes forms a useful soil-binding agent. *C. victoriensis* occurs chiefly on stream banks or in rather wet depressions, in rather damper situations than does *C. Retzii*. It is much taller and less leafy than this species and much less value as a fodder plant, but is of very real value in preventing erosion of the stream banks and the consequent silting of the channels. It is sometimes known as "balsam grass," and is restricted to Australia. The former species occurs in India and Northern Africa.

C. bulbosus occurs only in the more arid regions of the continent, chiefly on clay-pans and similar situations. The characteristic tubers are quite different from anything else and are eaten by the aborigines. The leaves are more numerous and narrower than those of other species treated here, and are eaten by stock. There is a specimen in herb. Melbourne labelled as from the Brisbane River, but this is surely a mistake. The species is widely spread in Africa and Southern Asia.

C. scariosus is a coastal species, almost restricted to brackish or near-brackish situations, from the neighbourhood of Brisbane north and west to the Kimberley District of Western Australia. It seems to be of no particular economic importance, and appears to extend to India.

C. stoloniferus is a plant of the coastal sands of the far north-east coast. It seems to be quite rare and except that it is one of the plants which assist in binding the sand, it is of no particular importance. Its range extends to India, Madagascar and Samoa.

C. tuberosus and *C. esculentus*, so far as is known, are far too rare to be of any importance, and nothing much can be said about their ecology. On the only occasion on which I have seen the former growing it was behaving as a weed. It is widely spread in Africa and southern Asia, while the latter occurs in all continents.

IDENTIFICATION.

As is implied by the involved synonymy of the group, the different species are not easy to identify from the hand-specimens usually received for identification or commonly seen in herbaria since they are most frequently gathered in the flowering stage, often without the basal parts. Also some species, notably *C. Retzii, C. scariosus,* and *C. victoriensis,* vary considerably in appearance according to the age of the inflorescence, to local weather conditions, and possibly to the mode of preparation of specimens; these variations are chiefly in the colour of the glumes, the degree to which the latter spread, and the extent to which their margins inroll if at all, but also in the degree of hardness or brittleness of the spikelets. Living plants and carefully collected and prepared specimens are usually identified without much trouble.

The following key has been drawn up in the hope that it may be of use in identifying the different species. The plates should be used in conjunction with the key; these are from photographs (prepared by the Department of

Agriculture and Stock, Brisbane) of carefully selected dried specimens, chosen to show the different types of rhizome and inflorescence, while the sketches show the shape of the glume as seen in profile and the nut. But it must be borne in mind that all the species vary to some extent, so that very many specimens will not match the plates exactly. The shape of the glume in profile is usually pretty reliable, but it is difficult to see in very young spikelets, and may be obscured if the margins are noticeably incurved or if the tips are damaged.

GENERAL CHARACTERS OF THE SPECIES.

Plants with slender to very slender wiry or delicate rhizomes producing tubers or tuberous swellings from which new stems arise, or rarely the rhizome passing into the new stem the base of which becomes thickened and tuberous later. Stems thus at intervals along the rhizome, or if clustered then arising from different rhizomes, more or less distinctly swollen at the base and there producing one or more fresh rhizomes, otherwise cylindrical with triangular tops or triangular throughout, not very stout. Leaves short or long, very narrow to relatively broad, mostly grass-like, sometimes some or nearly all reduced to loose sheaths. Bracts obvious, similar to the leaves, shorter or longer than the inflorescence. Inflorescence, except in *C. bulbosus*, umbel-like with few to several rays and a central spike of spikelets, the rays simple or with few short branches at and near the top. Spikelets in small spikes of usually 3–10 at the ends of the rays and their branches, rarely solitary on some branches, linear or lanceolate, acute or obtuse, distinctly flattened except in *C. stoloniferus*, more or less biconvex but never quadrangular, 1½–3 mm. wide, several- or many-flowered and sometimes very long, yellowish or reddish or of various shades of brown and sometimes brightly coloured, shining or dull, occasionally and then chiefly under very dry conditions, falling in their entirety from the rays; rhachilla winged. Glumes tight, or particularly in herbarium specimens somewhat spreading at maturity with more or less inrolled margins, usually not readily deciduous, when flattened out ovate or ovate-lanceolate or somewhat elliptic, obtuse or acute with rounded or triangular or nearly truncate sometimes hyaline tips, 7–15-nerved with the nerves more or less equally distributed or crowded close to the keel; when seen from the side of the spikelet (i.e. in profile) acute or obtuse, triangular or rounded at the tip, the keel straight from a short distance above the base or else curved and sometimes recurved, percurrent or disappearing below the then hyaline tip. Stamens 3; anthers linear, apiculate, yellow with reddish tips. Style long with 3 long stigmatic branches. Nut (fruit) from ⅓ to nearly ½ the length of the glume, narrowly obovate to broadly obovate or elliptical in outline, acute or obtuse and then shortly acuminate-apiculate, trigonous with obtuse angles and slightly convex sides or more rarely the angles rather acute and the sides flat or slightly concave, or in *C. stoloniferus* the nut is almost plano-convex with the dorsal angle inconspicuous, brown or grey-brown, more or less shining, smooth or punctulate or more or less distinctly reticulate, in some species rarely maturing.

Only species agreeing with the above characters are treated here; some tufted species with the stems more or less distinctly bulbous at the base but with no wiry rhizomes or tubers and one creeping species but with no tubers have sometimes been confused with nut-grass; these are discussed at the end of this paper.

KEY TO THE SPECIES.

Tubers with shining removable scale-like coats, the rhizomes threadlike and soon disappearing; inflorescence not umbel-like, the rays relatively short or very short, not close together; bracts distant from one another, or the lowermost alone obvious; leaves numerous and narrow, relatively long; a plant of the arid regions; plate 8. .. *C. bulbosus*

Tubers when young covered by membranous scales, but these soon breaking up into fibres and at length disappearing; rhizomes wiry, producing tubers at their tips or in *C. tenuiflorus* passing into the new stem which becomes thickened and tuberous at the base sometime later; inflorescence umbel-like or dense, with the bracts and primary rays arising close together, the latter sometimes very short, and very rarely one lowermost a little lower down than the others; leaves grasslike, sometimes short, and sometimes (in *C. scariosus*) reduced to loose sheaths; plants of varied habit and habitat:

Spikelets 1½–2 mm. wide; glumes about 2½ mm. long; nut elliptic in outline, either with prominent rather acute angles or else the nut thin with the dorsal angle inconspicuous; plants of restricted distribution:

Young rhizomes with stout tubers; leaves scabrous on the margins in the lower part, as long as the stems; spikelets thick, often dirty white and then spotted or streaked with brown; nut nearly as wide as long, thin, nearly concavo-convex; strictly a plant of the coastal sands of the northern part of the continent; plate 7. .. *C. stoloniferus*

Young rhizomes passing into the stems; leaves not scabrous; spikelets distinctly flattened, usually of a rich dark brown; nut much longer than wide, subequally 3-angled with prominent angles; a weed of South-West Western Australia; plate 1 .. *C. tenuiflorus*

Spikelets 2 mm. wide or usually more; glumes 3–4½ mm. long; nut ellipsoid or obovoid with the angles usually obtuse; leaves smooth or nearly so throughout, often much shorter than the stem; distribution different from the previous two:

Stems cylindrical in the lower part, triangular only near the top, commonly 2–3 ft. high; leaves rarely half as long as the stem, sometimes very short, at least the sheaths rather prominently reticulate in the dry state; inflorescence sometimes thrown to one side with the lowermost bract more or less erect, the rays slender or short each with a very few spikelets and sometimes the whole inflorescence reduced to a cluster of very few spikelets; nut 2–3 times as long as wide:

A coastal plant with distinctly slender stems, often very short or no leaf-blades, small inflorescence with straight rays sometimes very short and rarely 3 cm. long, or the whole inflorescence reduced to a single cluster; nut elliptic, rather acute, rarely seen; spikelets rarely so long as 2 cm.; plate 2 .. .. .. *C. scariosus*

Chiefly an inland plant with stouter stems than the preceding, better developed leaves and larger inflorescence, the rays of the latter very slender and frequently curved by the weight of the spikelets; spikelets commonly 2 cm. long and often longer, usually at least 17 mm., freely fruiting; nut narrowly obovate or oblanceolate, obtuse and shortly acuminate-apiculate; plate 3 .. .. .. *C. victoriensis*

Stems triangular throughout, commonly less than 2 ft. though sometimes more; leaves mostly ½–⅔ as long as the stem, grasslike, usually well developed; sheaths not or but slightly reticulate when dry; inflorescence symmetrical, not thrown to one side, the rays often several, stouter and usually more numerous than in *C. scariosus* and *C. victoriensis*, sometimes branched in the upper part; spikelets more numerous, nut (if maturing) obovate or elliptic-obovate, about 1½ times as long as wide, obtuse at the apex and shortly acuminate-apiculate:

Tubers globular to ovoid, the old ones covered with a grey tomentum; rhizomes and their scales more or less yellowish brown; spikelets obtuse; glumes yellowish or reddish, very obtuse, with about 7 prominent nerves on each side equally distributed; some bracts longer than the inflorescence .. .. *C. esculentus*

Tubers more or less ellipsoid, without grey tomentum; rhizomes and their scales purplish brown or dark brown; glumes variously coloured but rarely yellowish, obtuse or acute, their lateral veins becoming less distinct away from the keel, up to 5 on each side; sometimes all bracts shorter than the inflorescence:

Spikelets 2–2½ mm. wide; glumes often very deep brown, never yellowish, the tip narrowly rounded in side view, the keel more or less curved and then slightly recurved, disappearing or minutely excurrent just below the hyaline tip, each side nerved for ⅓–½ its breadth; fruit very rarely maturing; scales of rhizome soon disintegrating and usually not evident on last year's growth; plate 4 *C. rotundus*

Spikelets 2½–3 mm. wide; glumes sometimes yellowish, rarely very deep brown, acute in side view with the keel straight from shortly above the base and percurrent or almost so; scales of rhizome sometimes persisting through the second year in *C. Retzii*:

Spikelets not thick, not prominently narrowed upwards, often rather obtuse; glumes often soon spreading and then often inrolling, when flattened out broadest near the middle and not much narrowed below and the upper part triangular or somewhat acuminate, usually richly coloured chiefly in shades of brown, striate for ½–⅔ the way from keel to margin, the outside nerves short and close to the base; freely fruiting; plate 5 .. .. *C. Retzii*

Spikelets rather thick, gradually narrowed to a prominently acute tip; glumes tightly appressed, when flattened out broadest well below the middle, distinctly narrowed below and gently rounded towards the rather acute tip, rather pale-coloured in various tints from yellowish brown to rusty brown, striate for up to half-way between keel and margins with no short nerves near the base; plate 6 .. .. *C. tuberosus*

APPENDIX.

In addition to the above, several unrelated species of *Cyperus* have frequently been mistaken for nut-grass because of some resemblance in the vegetative parts or in the inflorescence. The most important of these are *C. brevifolius* (Rottb.) Haask., *C. sesquiflorus* (Torr.) Mattf. & Kükenth., *C. flavus* (Vahl) Nees, *C. congestus* Vahl, *C. subulatus* R.Br., and *C. Zollingeri* Steud.

C. brevifolius (also known as *Kyllinga brevifolia* Rottb. and *Kyllinga intermedia* R.Br.) and *C. sesquiflorus* belong to the subgenus *Kyllinga* with small 1-flowered flat spikelets densely clustered in a head of 1–3 short spikes, bifid styles, and biconvex to flat nut. *C. brevifolius* has a slender rhizome but there are no tubers and the stems are not thickened at the base; the spikelets are green or yellowish. It occurs on most continents and is widely spread in Eastern Australia in damp or shady places and is a common lawn weed. It is quite harmless, but is disliked because of its distinctive pale green colour. It is sometimes known as "Kyllinga."

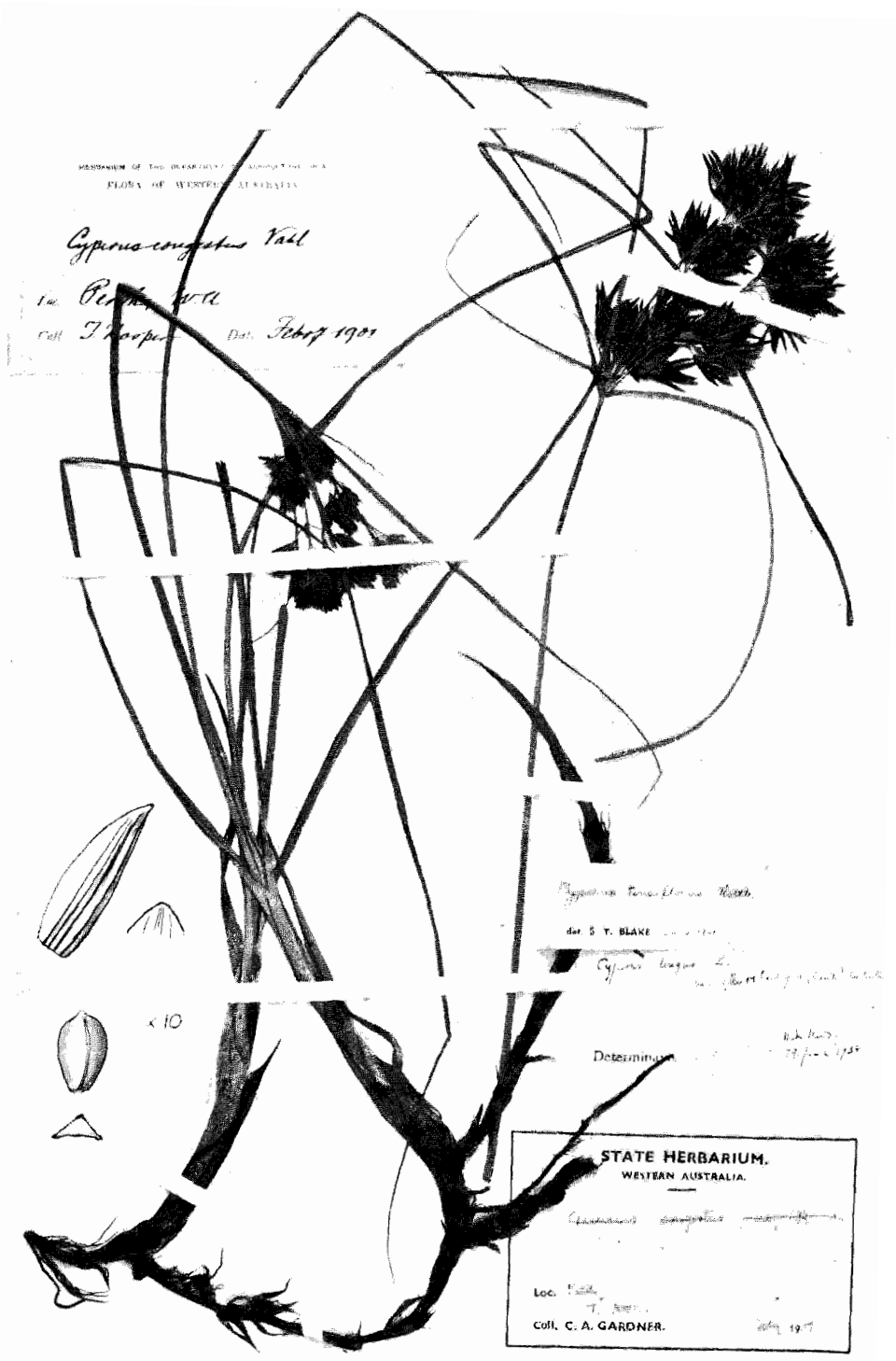
C. sesquiflorus, often known as "Mullumbimby Couch," has white spikelets, tufted usually short stems slightly bulbous at the base but not to the same extent as in *C. rotundus*, and very fragrant roots. Like the foregoing it is a common lawn weed but appears to be restricted to South-east Queensland and Eastern New South Wales as far south as Sydney. It also occurs in pastures and has been suspected of tainting milk. It is widely spread in America and Africa.

C. flavus has the fragrant roots and somewhat the aspect of the last-mentioned, but it is a stouter plant with 3–5 greenish or yellowish spikes. The spikelets are plump, 1-3-flowered, with 3-branched styles and acutely triquetrous nuts. The rhizome is short and knotty. It is apparently a very recent introduction from America that has established itself in South-east Queensland in the neighbourhood of Ipswich and Brisbane, and has been received as suspected nut grass.

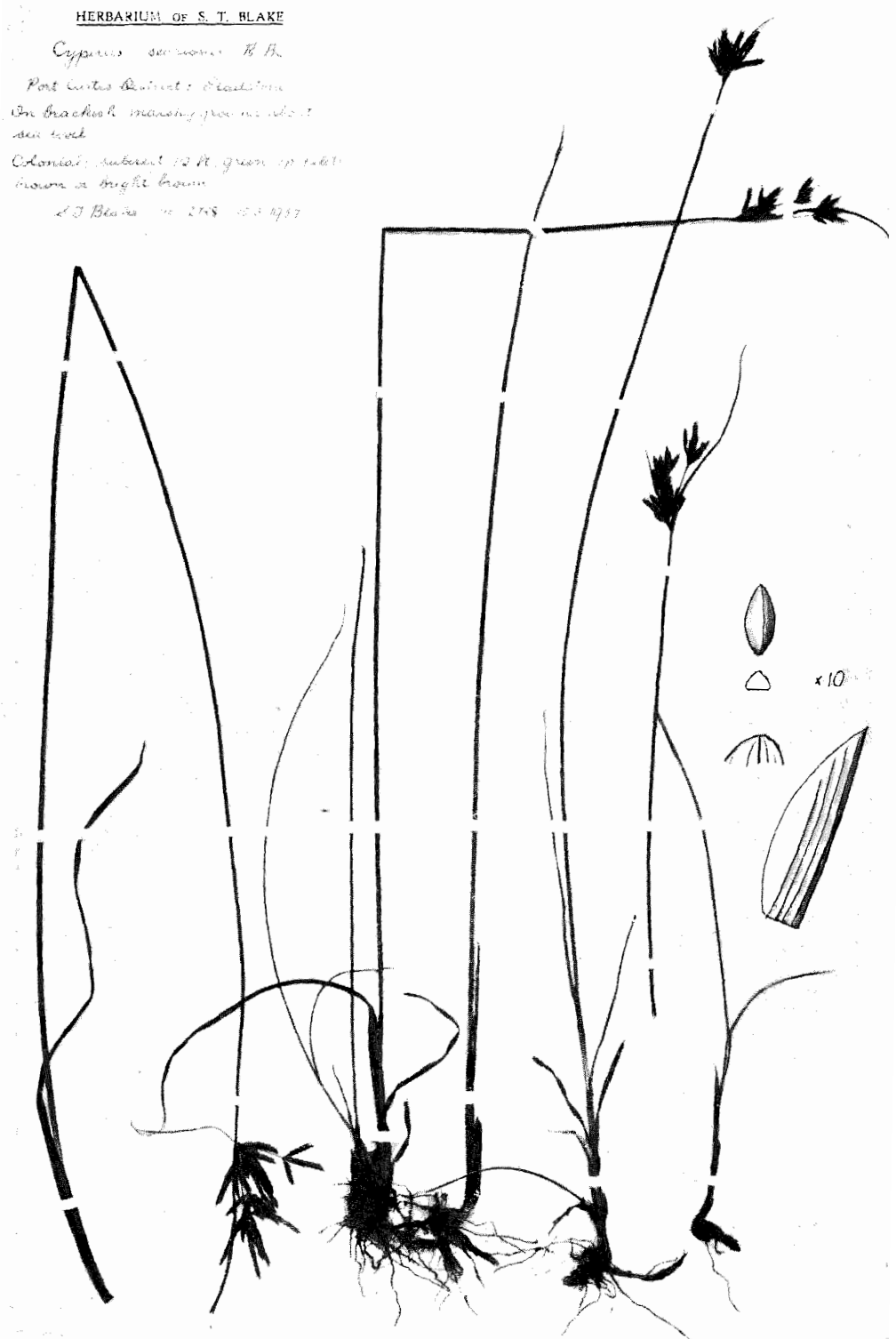
C. congestus has flowering stems very similar to those of *C. rotundus* and some of its allies, but there is no definite rhizome and the stems are only very slightly thickened at the base and usually tufted, while the spikelets are more numerous and very densely clustered on the rays or in a single head, quadrangular, with oblong-obovate nuts. It occurs chiefly in South-west Western Australia and in New South Wales in the neighbourhood of Sydney, and may be an introduction from Africa. It has also been introduced to Europe and has been cultivated under various names as an ornamental plant.

C. Zollingeri and *C. subulatus* have been discussed previously (see nos. 3 and 6, p. 5). The former, which ranges from South Queensland to tropical Asia and tropical Africa, is a plant of damp places which may occur as a weed in cane-fields. The latter is a coastal species from Victoria to about Mackay in Central Queensland.

A. H. TUCKER, Government Printer, Brisbane.



Cyperus tenuiflorus Rottb.; plant half natural size.



Cyperus scariosus R.Br.; plant half natural size.

Cyperus victoriensis C. B. Clarke; plant half natural size.

Cyperus rotundus L.; plant half natural size.

Cyperus Retzii Nees; plant half natural size.

Cyperus tuberosus Rottb.; plant half natural size.

Cyperus stoloniferus Retz.; plant half natural size.

Cyperus bulbosus Vahl; plant half natural size.