BLUMEA 47 (2002) 545–580

REVISION OF CHIONACHNINAE (GRAMINEAE: ANDROPOGONEAE)

T.A. JANNINK & J.F. VELDKAMP[1]

Nationaal Herbarium Nederland, Universiteit Leiden branch,
P.O. Box 9514, 2300 RA Leiden, The Netherlands

SUMMARY

A revision is presented of the four genera of the SE Asian Chionachninae Clayton (Gramineae: Andropogoneae). Twelve species are recognised: nine (with two new combinations) in *Chionachne* R.Br. (incl. *Sclerachne* R.Br.) with an emended circumscription, one in the reinstated *Cyathorhachis* Nees ex Steud., one in *Polytoca* R.Br., and one in *Trilobachne* M. Schenck ex Henrard.

Key words: Andropogoneae, *Chionachne*, *Cyathorhachis*, Gramineae, *Polytoca*, *Trilobachne*, Australia, SE Asia.

INTRODUCTION

The Chionachninae Clayton (1981) are a SE Asian and Australian subtribe of the Andropogoneae Dumort. with four genera. Its twelve species are fairly rare and hence have been treated in some depth by only a few authors, e.g. Bennett & Brown in Brown (1838), Henrard (1931, with additional taxa added in 1938 and 1939), and by Nirodi (1955).

The most widespread species of the alliance is *Polytoca digitata* (L.f.) Druce, and not surprisingly it was the first to be described. Linné f. (1782) regarded it as a member of *Apluda* L., and called it *A. digitata*.

The next one, *Coix gigantea*, was described by König (1788) in a rare publication with a very vague description and the name was not entered into the Index Kewensis. The combination was again used for *Coix* L. taxa by Jacquin (1820), Roxburgh (1814, 1832) and Stapf (1896). The latter attributed it to König, but did not cite the 1788 publication, and so he made a later heterotypic homonym. Roxburgh's application has been accepted for a form of or a species related to *Coix lacryma-jobi* L. (Stapf (1896: 100) as a variety, reduced to var. *ma-yuen* (Rom.Caill.) Stapf (1897: 421)). Bor (1960: 264) regarded it as a somewhat doubtful species, which, when accepted, has to be called *C. lingulata* Hack. It may be a tetraploid form (Nirodi, 1955: 120). Isotypes in BM, K, and UPS show that König's name actually refers to what generally is known as *Chionachne koenigii* (Spreng.) Thwaites, here therefore renamed to *Ch. gigantea* (J. König) Veldk.

Willdenow (1805–1806) described *Coix arundinacea* Willd., a later homonym of *Co. arundinacea* Lam. (1791), and it was therefore renamed to *Co. koenigii* by Sprengel (1824), and supposedly to *Ch. barbata* by Bennett (1838).

1) Corresponding author, e-mail: veldkamp@nhn.leidenuniv.nl

Contrary to later authors (see the caustic remark by Gould, 1994: 111), Bennett did not make the combination. He stated "it may perhaps be advisable to substitute for (*Coix arundinacea* Willd.) ... *barbata*", and not following his own advice did not include it in his Index (see also Articles 34.1(a, b)). It was first made by Aitchison (1869) and again by Bentham (1878) and Duthie (1883).

Unaware of the existence of these earlier names, Roxburgh described *Apluda digitata* L.f. again as *Coix heteroclita* Roxb. and *Co. gigantea* as *Co. barbata* Roxb. (1814, names only, validly published in 1832).

In 1838 Brown distinguished the genera *Chionachne* R.Br., *Polytoca* R.Br., and *Sclerachne* R.Br., while in the same chapter Bennett, apparently based on Brown's notes, gave extensive comments. They regarded these genera as "a passage between *Coix* and *Tripsacum* ... too evident to be mistaken", immediately pointing out, however, the entirely different origins of the involucre of the two. They also noted the curious prophyll in the *Coix* inflorescence and remarked "no analogous organ occurs in any of the related genera" (i.e. *Chionachne, Polytoca, Sclerachne*), which is exactly another reason why they are not closely related to *Coix*. *Zea* L., they wrote, is "manifestly allied to *Polytoca*; and one whose Paniceous character is so obvious that it is surprising that it should not long ago have assumed its proper position in that tribe".

Bennett thought there was no pedicelled spikelet to the female one in *Co. barbata*, but there is a very reduced one with its stipe completely adnate to the joint. He also said that the male spikelets would be solitary; we have always seen them paired, one sessile, one pedicelled. For *Polytoca* Bennett remarked that *Rottboellia*, i.e. *R. cochinchinensis* (Lour.) Clayton, is very similar, and that "from *Tripsacum* to *Rottboellia* the transition is easy". Phylogenetically it seems to be the other way around.

In the following years several new taxa were added and transferred from one genus to another, while two new genera were added: *Cyathorhachis* Steud. (1854) and *Trilobachne* M. Schenck ex Henrard (1931). Henrard (1931), partly based on the "notes and sketches" made around 1912 by "Professor Dr. M. Schenck at Siegen", summarised the work done on the so-called 'Maydeae' Dumort. during the 93 years since Brown's paper. This probably is Martin Schenck, a physician in Siegen, "with an interest in grasses" (see Schenck, 1907; Möbius, 1927), father of J.H.R. Schenck (see Stafleu & Cowan, 1985: 130–133). Henrard added *Chionachne hubbardiana* (1938) and *Polytoca javanica* (1939). Since then no new taxa of the Chionachninae have been discovered and the discussion at present is how they should be classified.

TAXONOMIC POSITION

In most accounts the genera are included in the 'Maydeae', a tribe regarded as standing next to the 'true' Andropogoneae for which reason it was not treated by Hackel (1889). Even in recent accounts this position is still maintained (Kellogg & Watson, 1993).

Actually, the 'Maydeae' is a nomenclatural and taxonomic monstrosity. Nomenclaturally, because '*Mays*' Miller is not a legitimate name, and there seems to be no correct name for a tribe including *Zea mays* L. Taxonomically, because it is an artificial assemblage of some genera of the Andropogoneae with monoecious plants, with unawned, unisexual spikelets in different parts of the inflorescence or plant, with the

fruits inside an indurated cover of various origin. In the Chionachninae and *Tripsacum* L. the cover is formed by the indurated lower glume, in *Zea* by a number of bracts (the 'husks'), in *Coix* by an indurated spatheole.

Nirodi (1955) made an extensive cytological analysis of the Asian 'Maydeae' mainly centred on various taxa of *Coix*, but she also included *Ch. gigantea* (as *Ch. koenigii*) and *Ch. macrophylla* (Benth.) Clayton (as *P. macrophylla* Benth.). She concluded that *Chionachne* and *Polytoca* bear a closer affinity to each other than to either *Coix* and the New World 'Maydeae'.

The 'tribe' was definitively broken up by Clayton who distinguished at first two (1973), later three (1981) apparently more 'natural' lines:

- Coicinae Rchb. for the originally Asian genus *Coix*, which he regarded as derived from the tropical Asian *Apluda* L. of the Ischaeminae J. Presl, where the female inflorescences are hidden in a strongly indurated utricle, derived from a spatheole, i.e. the transformed sheath of the uppermost leaf.
- Tripsacinae Dumort., restricted to the American genera *Tripsacum* and *Zea*, where the female spikelets are solitary at the base of the inflorescence and more or less embedded into the inflorescence rhachis, and the male spikelets are terminal in pairs of a sessile and a pedicelled one (*Tripsacum*), or where the female inflorescences are axillary, the female spikelets are solitary or paired (*Z. mays* L.) and the male one at the top of the plant (*Zea*). The subtribe is clearly derived from the Rottboelliinae (J. Presl) Clayton (Clayton, 1973, 1981, and Clayton & Renvoize, 1986: "barely distinct").
- Chionachninae with Asian and Australian taxa, where the sessile female spikelets more or less clasp the inflorescence rhachis (except in *Chionachne javanica* (Henrard) Clayton) and are accompanied by a more or less reduced, at most male spikelet. The male spikelets would be distal to the female spikelets, but *Cyathorhachis* and *Polytoca* have male spikes at the base of the terminal female spike, which may end in either sterile spikelets (*Cyathorhachis*) or male ones (*Polytoca*).

Especially the terminal inflorescence of *Polytoca* has great resemblance to that found in *Rottboellia cochinchinensis* and a derivation of the Chionachninae from the Rottboelliinae, the so-called 'awnless Andropogoneae', seems probable (Clayton (1973); Clayton & Renvoize (1986); see also Bennett, as early as 1838!). Note, however, that in *Rottboellia* the lower floret of the sessile spikelet is male.

Clayton (1981) noted that *Ch. javanica* would have "a somewhat tenuous link to *Heteropholis*" C.E. Hubb., now reduced to *Mnesithea* Kunth (see Veldkamp et al., 1986), a rottboellioid genus, in which the lower floret ranges from being epaleate to paleate, but sterile.

The species first described were often associated with *Coix* of which the original concept had become rather muddled. The bead-like appearance of the female spikelets is not a shared character: in *Coix* it is a transformed spatheole, in the Chionachninae it is the indurated lower glume of the female spikelet. The female spikelet of *Coix* is solitary and the male inflorescences emerge from the involucre. Their relative position is difficult to see, as structures are easily damaged when attempting to crack the bead. They are on independent rhaches, the male ones situated below the female spikelet,

an arrangement found in *Cyathorhachis* and *Polytoca*, too. In *Coix*, however, these branches are separated by a prophyll, a rather unexpected presence which suggests an originally lateral vegetative branching system within the utricle. Within the Rottboelliinae prophylls may occur in the inflorescence, but then they are associated with the penultimate, not the ultimate node, see for instance *Hemarthria altissima* (Poir.) Stapf & C.E. Hubb. as depicted by Vegetti (1993).

Cyathorhachis Steud. (1854) was created for a very strange species, *Cy. wallichiana* Steud. from Bhutan, Sikkim, Bangladesh (Chittagong, Sylhet), Burma, and N and SW Thailand for which areas there are few agrostological accounts: Stapf (Burma: 1896), Craib (Thailand: 1912), Bor (Burma: 1940, 1960), Shukla (Mizoram: 1996), Moulik (India: 1997) and Noltie (Bhutan: 2000). Also, it has only been rarely collected, which factors may account for the fact that, although it has some features that excludes it from the definition of the Chionachninae as given by e.g. Clayton & Renvoize (1986), it has been regarded as a species of *Polytoca*. Of all species here studied, it is, indeed, most similar to *P. digitata*, but significantly different, as can be seen from the key. Of note are the following features:

- Racemes digitate or paniculate, with the male spikelets on lateral branches, the terminal branch 'mixed', i.e. at base female, distally with neuter, not well-developed pairs of spikelets. In *P. digitata* they are male. Note that Clayton (1981: 813; in Clayton & Renvoize (1986); or. comm. to Esen & Hilu, 1993) described the tribe as having a "raceme female at base, male above with paired spikelets" which is not the case here.
- Female spikelet without a second floret, as was also observed by Bor (1940). This feature is most exceptional for the *Panicoideae* A.Br. as a whole. The usual series in reduction within the essentially biflorous spikelet is from the base upward: in principle the lower floret is bisexual (as in *Isachne* R.Br. sect. *Isachne*, and exceptionally the case in the rest of the subfamily), but is usually reduced to paleate and male, then paleate and sterile (often), to epaleate and so virtually absent (e.g. in *Digitaria* Haller). The position and nature of the single floret then remaining can be deduced from that of the glumes, lemma, and palea: the upper lemma is on the same side as the upper glume and its palea on the side of the lower glume.
- Male spikelets with the apex of the lower glumes long-attenuated, more or less awned, which is unique in the alliance (but see some species of Vossiastrae Stapf (or Vossiinae Pilg.) further mentioned below).

These unique features, especially the division of the sexes over the panicle, are suggesting that a distinct genus, if not a subtribe, is involved.

Polytoca digitata has the same type of inflorescence, but the female spikelet has the 'normal' complement of florets: the lower sterile and epaleate, the upper female, and the pedicelled spikelet of the male pair has an acute to somewhat attenuate lower glume. If a distinct subtribe is considered for *Cyathorhachis, Polytoca* should be included in it. Otherwise, however, it appears to be intermediate with the other Chionachninae and therefore we have refrained from recognising one.

Nearly all species have at one time or the other been included in *Polytoca*. We regard the genus as monotypic, and distinct especially because of the structure of the panicle.

Trilobachne cookei (Stapf) M. Schenck ex Henrard is the most peculiar of all and only remotely similar to *P. digitata*. It has some unique features, e.g. the female spikelet with a 3-lobed lower glume, a coriaceous upper glume, large fruits (4–5.5 mm long) with a hollow base, and a dorsal hilum.

Sclerachne punctata R.Br., on the other hand, has no characters of sufficient importance to distinguish it generically from *Chionachne*. The differences suggested by the program INTKEY using the DELTA file are based on erroneous observations or of specific worth, e.g. sculpture of the lower glume of the female spikelet, shapes, sizes, and nervature of the various parts, etc. Most similar, not necessarily most related, seem *Ch. hubbardiana* from Java, Sumbawa, and Australia, and *Ch. massiei* Balansa from N and C Thailand, Laos, N Vietnam, and ? S China (Hainan). *Sclerachne punctata* is therefore here included in *Chionachne*. The generic names are equally old, but as the latter genus is relatively better known, is the type of the subtribe, and has most species, it is to be preferred.

MORPHOLOGY

The abbreviation 'bbb', for bulbous based bristles, is used for those hairs that have a multi-cellular base, visible as small pusticules when the usually setose hairs have dropped off.

There is quite a considerable range in culm length. *Chionachne* has the smallest plants, many not reaching above the one metre mark. In *Ch. massiei* there seem to be two types of plants, one being tall and slender, the other small and stocky. The cause of this is not clear and may be due to seasonal variation.

Chionachne macrophylla is easy to distinguish from the other species by its exceptionally broad leaves (as its name implies). It is also the only species in which only some of the spikes are enveloped by a spatheole.

Only *Ch. macrophylla* and *Ch. javanica* have glabrous leaves.

The margins at the summit of the sheath next to the ligule (and usually adnate to it) may form elongated appendages, the auricles. These are found in *Ch. javanica, Ch. macrophylla, Cy. wallichiana*, and *P. digitata*, and sometimes in *Ch. gigantea* and *Ch. massiei*.

The inflorescence of *Chionachne* is either a simple spike or a compound umbel of several spikes. At the base of each spike a number of joints have sessile, female spikelets, accompanied by a much reduced pedicelled one, distally there are a number of joints with paired male spikelets. This arrangement of a spike with both 'male' and 'female' joints is referred to in the key as a 'mixed spike'. This term has also been used by Nirodi (1955: 108, key); from her drawing (t. 4) we think that she meant that the terminal inflorescence was male and the lower ones mixed. We have not observed such an instance, but it may not be ruled out.

Assuming derivation of this type of inflorescence from what is present in *Rottboellia cochinchinensis* is tempting: there the simple spike when well developed has a number of bisexual sessile spikelets in the lower part, then several that are male (!), while the upper ones are much reduced and sterile, as was already observed by Bennett (1838!). All pedicelled spikelets are sterile. At first glance when one does not expect a *Chionachne* species a specimen may easily be mistaken for a *Rottboellia*.

Trilobachne cookei has a number of mixed spikes in a compound umbel. Each has 1–3 female spikelets at base with 3–7 pairs of male spikelets above.

These two genera show the inflorescence structure reported for the Chionachninae by Clayton (1981), Clayton & Renvoize (1986), and Connor (1987), but *Cyathorhachis* and *Polytoca* are different: here there are both mixed and entirely male spikes. In *Cyathorhachis* the basal spikes have male spikelets, the terminal one has female spikelets at base with neuter spikelets above. In *Polytoca* the lateral racemes also are male (literature suggests that they may have basal female spikelets as well, but we have not observed them), the central one may have pairs of male spikelets below a number of female ones, above these the pairs of spikelets are male, the most distal pairs of course may be badly developed and neuter.

It is possible to assume that in some genera the inflorescence with a single spike is derived from a compound one, and that the lower branches have been lost. However, such compound inflorescences are absent in the Rottboelliastrae Stapf (Jacques-Félix, 1962) or Rottboelliinae (Pilger, 1954), and a panicle would seem an autapomorphy.

Branched panicles are present in some 'Vossiastrae' (or Vossiinae), in some accounts implied to be the sister group of the Rottboelliastrae (but see Kellogg & Birchler, 1993: f. 5). However, the panicles of *Phacelurus* Griseb. (sensu Clayton & Renvoize, 1986) and *Vossia* Wall. & Griff. have a different structure. Curious to note is the presence of caudate glumes in some of these species.

It is then difficult to derive one structure from another, but fairly easy to see them as having two different origins in rottboellioid progenitors. They would thus represent two different lines originating in Asia parallelled by the origin of the Tripsacinae in the Americas and hence representing a distinct subtribe.

However, if we disregard the inflorescence branching the overall similarities suggest that we are dealing with a natural, monophyletic group.

A good question, which at present we are not prepared to answer, is of course, whether we should become so exited about unisexual spikelets at all, and reduce the Chionachninae to the Rottboelliinae altogether. Watson & Dallwitz (DELTA grass file, version 3.14, 1998) are a bit ambivalent about this. On the one hand they recognise the 'Maydeae' as a tribe next to the Andropogoneae, but at the same time they split up the Andropogoneae into the awned Andropogoninae J. Presl and the unawned Rottboelliinae which includes the 'Maydeae' species again.

Reduction of sexuality is rampant in the Andropogoneae, both within a spikelet, as well as between spikelets of one pair. The pedicelled spikelets range from bisexual to male to sterile to absent, rarely female (as in *Germainia* Balansa & Poitr., where the sessile spikelets are male). So a separation of the sexes in an inflorescence is not surprising, culminating in a separation of sexes on the plant as in *Zea*. Monoecism has been reported for 62 grass genera, 25 of which are in the Panicoideae (Connor, 1987) and has a polytopic origin. It may have been polytopic for the Chionachninae as well.

The structure of the rhachis is the same in all of the genera and like that found in the Rottboelliinae. Apparently the male part falls off as a whole when distal, or is long-persistent when present below the female part. The axis of the female part disarticulates into fragments consisting of a single internode ('joint') to which the female spikelet and the pedicelled spikelet remain attached, as is the usual case in the Rottboel-

liinae also. A joint occasionally may have three spikelets, a feature found in *Mnesithea* Kunth, formerly considered to be unique for *Mnesithea laevis* (Retz.) Kunth and indeed usual in well-developed spikes of its var. *laevis*. In var. *cochinchinensis* (Lour.) de Koning & Sosef and other species of *Mnesithea*, however, it is of a rare occurrence, e.g. in the former *Ratzeburgia pulcherrima* Kunth (Veldkamp et al., 1986: 289–290). Triads of spikelets are also found in *Lasiurus* Boiss., and in the more remotely related *Polytrias* Hack.

At maturity the base of each joint has a curious protrusion. It fits nicely into a cavity at the top of the joint beneath it and is said to contain oil that attracts ants which then carry off the diaspore. This structure has been called an 'elaiosome'. We have not been able to detect any oil in the dried, usually very old specimens, however. This elaiosome is derived from the vascular bundles running through the rhachis. Beumée (1927) reported myrmecochory in Java for *Ch. macrophylla* (there cultivated as *P. macrophylla*), *Ch. punctata* (as *S. punctata*, also noted on *Monod de Froideville 1458*), and *P. digitata* (as *P. bracteata* R.Br.), and the rottboellioid taxa *Mnesithea glandulosa* (Trin.) de Koning & Sosef (as *Rottboellia glandulosa*), *M. laevis* (Retz.) Kunth, *M. mollicoma* (Hance) A. Camus (as *M. pubescens* Ridl.), *Ophiuros exaltatus* (L.) Kuntze, and *R. cochinchinensis* (as *R. exaltata* L.f.). Davidse (1984) because of the presence of an oily elaiosome suspected myrmecochory for *Rhytachne gonzalezii* Davidse.

The joint is rather inflated, and another dispersal mechanism may be by floating in the sheets of water that occur after tropical showers (Van der Pijl, oral comm.).

A typical feature is the structure of the female spikelets: The lower glume of course envelops the other floral parts but also often part or all of the joint as well. Thus there is the superficial resemblance to the 'bead' of *Coix* as mentioned above. The apex varies from truncate to three-lobed. The body assumes clearly distinct shapes which are difficult to describe in words.

The fruit of the Chionachninae, once carefully pried out from between the floral parts, is dorso-laterally flattened and concave-convex. In *Trilobachne cookei* the base is hollow, in the other genera it is truncate to retuse. The character Henrard considered to be the most valuable in distinguishing between genera, namely the shape and position of the hilum, only partly shows the variation he described. Nearly all taxa have a basal, circular (to oval) hilum, only *T. cookei* differs by its lateral, (oval to) linear one.

There have been only a few anatomical studies which have incorporated species of this subtribe. Of note are the summaries given by Watson & Dallwitz (1992: 220 (*Chionachne*), 736 (*Polytoca*, incl. *Cyathorhachis*), 819 (*Sclerachne*)).

A few chromosome counts have been reported: Nirodi (1955) was already mentioned above. The basic number is 10, a common number for the tribe. *Chionachne punctata, Ch. semiteres* (Benth. ex Stapf) Henrard, *P. digitata*, and *T. cookei* are diploids, *Ch. gigantea* (as *Ch. koenigii*) may be both diploid and tetraploid, while *Ch. macrophylla* is tetraploid.

The chromosomes are exceptionally large for the family, a character that is shared with the Rottboelliinae and Tripsacinae (see also Christopher, 1986).

Members of the subtribe are occasionally included in numerical studies where they then may turn up in the most remarkable places, putting doubt to the methods employed, when we persist to maintain that it belongs to the Andropogoneae.

Hilu & Wright (1982) performed a numerical study on 215 genera based on 85 morphological and microscopical data in which *Chionachne* clustered with *Muhlenbergia* Schreb. in the Eragrostoideae Pilg.

Esen & Hilu (1993) studied the distribution of prolamin size variation and immunological relationships in the Panicoideae. These supported the monophyletic origin of the subfamily and its tribes. They included a single collection of *Ch. gigantea* (as *Ch. koenigii*), but none of the genera we think are close, as *Rottboellia* or *Zea*. Remarkably they found it quite distant from panicoid genera and instead associated with *Danthonia* DC., *Digitaria*, *Eragrostis* Wolf, and *Hordeum* L. One suggestion offered was that this would reflect the primitive status of the subtribe and that of the Digitariinae Butzin. This is obviously unacceptable, as both genera are very derived in their own lines, and at least morphologically have very little in common. Another suggestion was that this result would reflect the distance of *Chionachne* from the core panicoid genera. The error then is due to the sample being too small and anecdotal to detect the actual relationships in a subfamily as large and diverse as this. Not being familiar with the subject and methodology employed here, we disagree with the results, but cannot offer an alternative solution.

A phylogenetic study on a much grander scale was made by Kellogg & Birchler (1993), more extensively explained, but more or less repeated by Kellogg & Watson (1993). For its morphological and anatomical analyses use was made of the vast DELTA data base with a matrix of 220 morphological characters for 94 genera of Andropogoneae. This supported the classical idea of the 'Maydeae' being a single unit and showed it to be distinctly associated with and nesting within the Rottboelliinae clade. If recognised as a distinct taxon, the Rottboelliinae become paraphyletic (Kellogg & Watson, 1993: 299). Curious to note is that in the first analysis *Chionachne* teamed up with *Coix* and that *Polytoca* appeared to be closer to *Tripsacum* than the latter is to *Zea*. This seems due to the fact that the Rottboelliinae clade is largely unresolved, which may cause errors in higher branching.

It may also be pointed out that the DELTA data by necessity often had to be based on an interpretation of existing literature, e.g. that of Clayton & Renvoize (1986), and inevitably contains errors, as e.g. with the interpretation of the inflorescences of the Chionachninae as noted above. Kellogg & Birchler (p. 422) and Kellogg & Watson refined the analysis but in the first publication noted that comparisons lack data on *Chionachne*, *Polytoca*, and other members of the Rottboelliinae.

Their strict consensus tree (Kellogg & Birchler, f. 5) has a very low consistency index (CI = 0.25) possibly due to the large number of taxa, which affects the cladogram resolution and may explain some curious positions, e.g. *Polytrias* as the sister group of the Arundinelleae Stapf, while its clear position in the Andropogoneae close to if not identical with *Eulalia* Kunth is not evident at all. Also, *Garnotia* Brongn., generally considered as part of the Arundinelleae as a monotypic subtribe, rather unexpectedly finds itself in a quite heterogeneous clade with some Rottboelliinae, *Chrysopogon* Trin. and *Vetiveria* Bory, *Imperata* Cirillo (but not *Miscanthus* Andersson and others), etc.

GEOGRAPHY

The species of the Chionachninae range from Sri Lanka to N Pakistan, east to S China and south to N Australia. Although for some the range is wide, their occurrence seems to be scattered to disjunct and some are more or less local endemics (see below).

In view of the known distribution of other species it seems unlikely that under-collecting would be the main reason for the apparent fragmentary distribution. It is more likely due to changes in climatic conditions over time, e.g. the desiccation of C India, and the return of ever-wet rain forests in W Malesia whereby suitable habitats were obliterated. This would explain the absence of any representatives in Sumatra, Peninsular Malaysia, and Borneo, and the occurrence of one species of *Chionachne* in W Java and three in the dry eastern part. A survey:

Chionachne biaurita Hack.: endemic to Luzon.
Chionachne cyathopoda (F. Muell.) Benth.: restricted to N Australia.
Chionachne gigantea: Sri Lanka, N Pakistan, India to Upper Burma, and then again in N Vietnam (Ki-Luong).
Chionachne hubbardiana: N Australia, S Malesia (E Java and Sumbawa), which is typical for a drought species.
Chionachne javanica: a rare species of areas with a pronounced dry season: E Java (Besuki, Puger), Flores, Alor.
Chionachne macrophylla: Ternate (Moluccas), Kai Is., widespread in New Guinea, to the Solomon Islands.
Chionachne massiei: rare and local in N, C, and SW Thailand, Laos, N Vietnam (Sontay), perhaps introduced in S China (Hainan).
Chionachne punctata: a drought species of Java, Madura, the Kangean Is., and then in Luzon.
Chionachne semiteres: scattered in W and S India (Maharashtra: Osmanabad; Tamil Nadu: S Arcot, Coimbatore, Tirunelveli) and then again in Burma (Mandalay).
Cyathorhachis wallichiana: Bhutan, Sikkim, Bangladesh, Burma, and N and SW Thailand.
Polytoca digitata: Sikkim, NE India to S China, then in W to E Java, a few localities in the Philippines, Celebes, and once in Papua New Guinea (Northern Prov.).
Trilobachne cookei: W India.

CHIONACHNINEAE

Chionachninae Clayton (1981) 813. — Type: *Chionachne* R.Br.

Annual or perennial, monoecious. Auricles, when present, usually adnate to the short, scarious ligule. Inflorescences spatheate, consisting of solitary or digitate racemes. Spikelets unisexual. Racemes either female at base, distally male (mixed), or basal racemes male, the terminal female mixed, i.e. distally with male or neuter spikelets. Female spikelet sessile, clasping the slender joint. Lodicules usually absent (present in at least *Ch. gigantea*, *Ch. semiteres*, and *Cy. wallichiana*). Fruit dorso-laterally flattened, concave-convex, base truncate, retuse, or hollow. Hilum basal or dorsal,

circular to oval. Pedicelled spikelet sterile, reduced to almost absent. Male spikelets paired, with two male florets. x = 10.

Distribution — Old World tropics, 4 genera, 12 species.

KEY TO THE GENERA

1a. Spikes digitate, lateral branches male, terminal branch mixed, at base often with pairs of neuter spikelets, then with a zone of pairs of one female sessile and one neuter pedicelled spikelet, distally with pairs of neuter or male spikelets, then often ending with pairs of neuter spikelets. Female spikelets: lower glume not keeled. — Female spikelets: lower glume without lateral appendages; upper glume partly coriaceous. Fruit base truncate to retuse, hilum basal. Sessile male spikelets: first palea keeled 2

b. Spikelets arranged in solitary or paniculate mixed spikes. Spikes at base with pairs of one female sessile and one neuter pedicelled spikelet, distally with pairs of male spikelets. Female spikelets: lower glume keeled. — Female spikelets: first floret epaleate (paleate in *Ch. javanica*), second floret present. Male spikelets: lower glume muticous 3

2a. Pairs of spikelets above the female ones neuter, not well developed. Female spikelets: first floret paleate, second floret absent. Male and neuter spikelets: lower glume awned ..... **2. Cyathorhachis**

b. Pairs of spikelets above the female ones male. Female spikelets: first floret epaleate, second floret present. Male and neuter spikelets: lower glume muticous ..... **3. Polytoca**

3a. Female spikelets: lower glume with or without lateral appendages, sometimes with an elongated tooth on each side; upper glume herbaceous or partly coriaceous. Fruit base truncate to retuse, hilum basal ..... **1. Chionachne**

b. Female spikelets: lower glume apically winged; upper glume coriaceous. Fruit base hollow, hilum dorsal ..... **4. Trilobachne**

1. CHIONACHNE

Chionachne R.Br. in Benn. & R.Br. (1838) 15. — Type: *Chionachne barbata* (Roxb.) R.Br. ex Aitch. (= *Chionachne gigantea* (J. König) Veldk.).

Sclerachne R.Br. in Benn. & R.Br. (1838) 15, t. 4. — Type: *Sclerachne punctata* R.Br. (= *Chionachne punctata* (R.Br.) Jannink).

Perennials. Spatheoles absent or present below each partial inflorescence, blade then well-developed to reduced. Spikes solitary or digitate, all mixed, distally with pairs of male spikelets. *Female part*: sessile spikelets embedded in or enveloping the joint. Lower glume more or less constricted at or below the middle, keeled, apex extended upwards or not, with or without lateral appendages, sometimes with an elongated tooth on each side. Lower glume margins clasping, overlapping the joint or not; upper glume herbaceous to partly coriaceous. First floret usually epaleate (paleate in *Ch. javanica*), sterile. Fruit dorso-laterally flattened, base truncate to retuse. Hilum basal. Pedicelled spikelets sterile, reduced to almost absent. *Male part*: sessile spikelets lower glume muticous. First palea keeled or not in the lower part. Pedicelled spikelets: lower glume

oblique to symmetric, keeled or not, apex unawned; upper glume and first palea keeled or not.

Distribution — 9 species from India, Sri Lanka to S China, Australia.

KEY TO THE SPECIES

1a. Female spikelet lower glume pear-shaped, with a strong constriction around the middle. Pedicelled spikelet glume margins smooth. Male part: sessile spikelet 2.5–4 mm long. — Racemes digitate 2

b. Female spikelet lower glume broadly fusiform, flattened botuliform, flattened clavate, with a slight constriction in the lower fifth or third. Pedicelled spikelet margins scabrid. Male part: sessile spikelet 5–13 mm long 3

2a. Female spikelet lower glume smooth, upper glume broadly-ovate. Pedicelled spikelet stipe fused with the joint. Male part: sessile spikelet lower glume ovate-elliptic to -oblong, 6–9-nerved. Pedicelled spikelet upper glume 7-nerved. — Thailand, Laos, N Vietnam, Hainan ..... **7. Ch. massiei**

b. Female spikelet lower glume pusticulate, upper glume ovate-elliptic. Pedicelled spikelet stipe not fused with the joint. Male part: sessile spikelet lower glume round, c. 16-nerved, pedicelled spikelet upper glume 8–10-nerved. — Java, Lesser Sunda Islands, Luzon ..... **8. Ch. punctata**

3a. Racemes digitate. — Auricles absent. Spatheoles enveloping each spike. Female part: pedicelled spikelet sterile, almost absent 4

b. Racemes solitary. — Female spikelet lower glume glabrous or margins ciliate 5

4a. Female spikelet lower glume keels not overlapping the joint, not extended upwards, with a sometimes elongated tooth on each side, margins papillose, otherwise smooth, upper glume 3.2–4.2 mm long. Fruit 2.2–2.5 by 1.2–1.5 mm. Male part: sessile spikelet lower glume ovate-oblong to -lanceolate, upper glume 5- or 6-nerved. — Philippines ..... **1. Ch. biaurita**

b. Female spikelet lower glume keels overlapping the joint, extended upwards, apex without lateral appendages, margins smooth or finely pusticulate, upper glume 6.5–7.5 mm long. Fruit 2.7–4.2 by 1.7–3.7 mm. Male part: sessile spikelet lower glume ovate-elliptic, upper glume 7-nerved. — Java, Lesser Sunda Islands, Australia ..... **4. Ch. hubbardiana**

5a. Spatheoles enveloping each spike. Joints glabrous. Female part: pedicelled spikelet almost absent. — Auricles, when present, free from the ligule. Indian Peninsula, Sri Lanka, SE Asian mainland, Java, Lesser Sunda Islands, Australia 6

b. Spatheoles enveloping only some of the spikes. Joints pilose. Female part: pedicelled spikelet male, similar to spikelets of the male part. — Auricles free from the ligule. Racemes 9–15(–18) cm long. Female spikelet lower glume flattened botuliform, sometimes slightly constricted in the lower third, finely pusticulate, keels extended upwards. Celebes, Moluccas, New Guinea ..... **6. Ch. macrophylla**

6a. Racemes 5–11 cm long. Female spikelet lower glume flattened botuliform, sometimes slightly constricted in the lower third, finely pusticulate, keels extended upwards 7

b. Racemes 1.3–4.2 cm long. Female spikelet lower glume broadly fusiform, sometimes with a slight constriction in the lower fifth, smooth, keels not extended up-

wards. — Female spikelets enveloping the joint, stipe fused with the joint. Male part: pedicelled spikelet lower glume oblique. Widespread in continental Asia ..... **3. Ch. gigantea**

7a. Auricles absent. Female spikelets enveloping the joint, stipe fused with the joint. Male part: pedicelled spikelet lower glume oblique. — Continental Asia or Australia 8

b. Auricles triangular. Female spikelets partly immersed in the joint, stipe not fused with the joint. Male part: pedicelled spikelet lower glume symmetric. — Spatheoles blades developed. Female spikelet lower glume keels not overlapping the joint, apex with a sometimes elongated tooth on each side, glabrous, upper glume 7–9-nerved. Male part: sessile spikelet lower glume 5–6.75 mm long, 11–15-nerved, upper glume 5–6.5 mm long, 6–9-nerved, pedicelled spikelet lower glume apex truncate. Java, Lesser Sunda Islands ..... **5. Ch. javanica**

8a. Blades base rounded or not. Spatheoles blades developed. Female spikelet lower glume keels not overlapping the joint, apex with a sometimes elongated tooth on each side, glabrous, upper glume 9–14-nerved. Fruit dorso-laterally flattened, concave-convex. Male part: sessile spikelet lower glume 10–11 mm long, 16- or 17-nerved, upper glume 10–10.5 mm long, 9–12-nerved, pedicelled spikelet lower glume apex acute. — Australia ..... **2. Ch. cyathopoda**

b. Blades base attenuate. Spatheoles blades reduced. Female spikelet lower glume keels overlapping the joint, apex without lateral appendages, margins ciliate, upper glume 15-nerved. Fruit dorso-laterally flattened. Male part: sessile spikelet lower glume 5.5–8.5 mm long, 10–15-nerved, upper glume 6–8 mm long, 3–5-nerved, pedicelled spikelet lower glume apex truncate. — Continental Asia ..... **9. Ch. semiteres**

1. Chionachne biaurita Hack. — Fig. 1

Chionachne biaurita Hack. (1906) 263. — Type: *BS 4282 (Merrill)* (holo W; B, BRI, K, L, NY, P, US), Philippines, Luzon, Prov. Benguet, Bued River, 2 October 1905.

Slender perennials. Culms 0.15–0.8 m tall, 1–3 mm wide at base, rooting at the lower nodes, glabrous to bbb-setulose. Nodes bearded. Sheaths 1.4–7 cm long, bbb-setulose. Auricles absent. Ligule 0.5–1.5 mm long. Blades ovate-linear-lanceolate to linear, 3.7–21 by 0.8–1.3 cm, glabrous to bbb-setulose or -pilose, base rounded to attenuate, 2–4(–5-)nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 1.4–1.8 cm long, auricles absent, ligule 0–0.75 mm long, blades 5–23 mm long. Racemes digitate, 2.4–4.3 cm long, at base with 3 or 4 female spikelets, distally with 1–7 pairs of male spikelets. Joints 2–5 mm long, glabrous to pilose. *Female part*: sessile spikelets enveloping the joint. Lower glume flattened clavate, sometimes slightly constricted in the lower third, 6–9 mm long, margins papillose, otherwise smooth, glabrous, keeled, keels not overlapping the joint, not extended upwards, with a sometimes elongated tooth on each side; upper glume herbaceous to partly coriaceous, ovate-elliptic to ovate-oblong, 3.25–4.25 mm long, 9–12-nerved. First lemma epaleate, ovate-oblong, 3–4 mm long, 3-nerved, anastomosing; second lemma and palea ovate-lanceolate; lemma 2.5–4 mm long, 1- or 2-nerved, anastomosing; palea c. 3 mm long. Fruit 2.25–2.5 by 1.25–1.5 mm. Hilum oval. Stipe glabrous, fused with the joint.

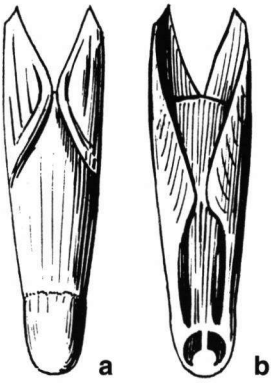

Fig. 1. *Chionachne biaurita* Hack. Sessile spikelet. a. Abaxial view; b. adaxial view (*BS 4282 (Merrill)* (type)).

Pedicelled spikelets sterile, almost absent, glume margins scabrid. *Male part*: sessile spikelets lower glume ovate-oblong to -lanceolate, 5.5–6 mm long, glabrous or dorso-(laterally) ciliolate, 10–12-nerved, anastomosing or not, muticous; upper glume 5–5.5 mm long, 5- or 6-nerved. First lemma ovate-oblong, 4.5–5.5 mm long, 3-nerved, anastomosing; palea ovate-oblong to -lanceolate, 4–5 mm long, lower part keeled, 2-nerved. Second lemma 4–5 mm long, 1-nerved; palea 4–5 mm long. Pedicelled spikelets lower glume oblique or symmetric, ovate-oblong to -lanceolate, 4–7 mm long, keeled or not, glabrous or dorso-laterally ciliate, 10- or 11-nerved, anastomosing or not, apex acute; upper glume ovate-oblong, 4–6 mm long, keeled, 7–10-nerved. First lemma and palea ovate-oblong; lemma 4–5.5 mm long, 3-nerved, anastomosing; palea 3.5–5 mm long, lower part keeled, 2-nerved. Second lemma and palea ovate-lanceolate; lemma 3–5.5 mm long, 1-nerved; palea 3–5 mm long.

Distribution — Philippines: Luzon (Benguet, Bontoc).

Habitat — Rocky, damp to dry places, along roads, rivers, locally fairly common, 1200–2930 m altitude.

Collector's note — Hairs itching the skin (pungent, not stinging).

Uses — Succulent grass, palatable to grazing animals (Santos, 1986: 64, t. 12).

Note — About 6 collections could be studied.

2. **Chionachne cyathopoda** (F. Muell.) F. Muell. ex Benth. — Fig. 2

Chionachne cyathopoda (F. Muell.) F. Muell. ex Benth. (1878) 516. — *Sclerachne cyathopoda* F. Muell. (1873) 116. — *Polytoca cyathopoda* F.M. Bailey (1902) 1849. — Lectotype: *F. von Mueller*, December 1855 (holo MELB; K; L, fragm.), Australia, Northern Territory, Victoria River, Sandy Is.; designated by Henrard (1931: 12, 17).

Slender to coarse perennials. Culms 1.5–3 m tall, 1–4 mm wide at base, rooting at the lower nodes, glabrous to bbb-setulose. Nodes glabrous to bearded. Sheaths 7–12.5 (–16.5) cm long, glabrous to bbb-setulose. Auricles absent. Ligule 1–2(–3) mm long. Blades ovate-lanceolate to linear, (25–)29–38(–52) by 0.5–1.4 cm, glabrous to bbb-setulose, base rounded or not, 4–6-nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 1.6–6.5 cm long, auricles present or not, ligule 0–0.75 mm long, blades 19–60 mm long. Racemes solitary, 7.5–11 cm long, at base with

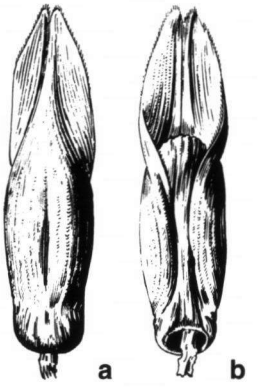

Fig. 2. *Chionachne cyathopoda* (F. Muell.) Benth. Sessile spikelet. a. Abaxial view; b. adaxial view (*F. von Mueller*, Dec. 1855 (type)).

(3–)4–6(–9) female spikelets, distally with up to 7 (or more) pairs of male spikelets. Joints 2–8 mm long, glabrous. *Female part*: sessile spikelets enveloping the joint. Lower glume flattened botuliform, sometimes slightly constricted in the lower third, 8–11 mm long, finely pusticulate, glabrous, keeled, keels not overlapping the joint, extended upwards, with a sometimes elongated tooth on each side; upper glume partly coriaceous, ovate-elliptic to -oblong, 4–8.5 mm long, 9–14-nerved. First lemma epaleate, ovate-elliptic, 5–7 mm long, 3–5-nerved, anastomosing. Second lemma ovate-elliptic to -oblong, 4.5–6.5 mm long, 1- or 2-nerved, not anastomosing; palea ovate-oblong, 4–6 mm long. Fruit 2–2.75 by 0.5–2.25 mm. Hilum circular to oval. Stipe glabrous, fused with the joint. Pedicelled spikelets sterile, almost absent, glume margins scabrid. *Male part*: sessile spikelets lower glume ovate-elliptic to -oblong, 10–11 mm long, muticous, glabrous, 16- or 17-nerved, anastomosing; upper glume 10–10.5 mm long, 9–12-nerved. First lemma ovate-oblong, 9–9.5(–11) mm long, 3-nerved, not anastomosing; palea ovate-lanceolate, 9(–11) mm long, lower part keeled, 3- or 4-nerved. Second lemma 8–8.5(–10) mm long, 1–3-nerved; palea 8(–10) mm long. Pedicelled spikelets lower glume oblique, ovate-lanceolate, 8–10(–14) mm long, keeled, apex acute, glabrous, (11–)12–15-nerved, anastomosing or not; upper glume ovate-oblong to -lanceolate, 8–12 mm long, keeled, 10–17-nerved. First lemma ovate-oblong to -lanceolate, 6.5–10 mm long, 3–5-nerved, anastomosing; palea ovate-lanceolate, 7–8 mm long, lower part keeled or not, (2- or) 3- or 4-nerved. Second lemma ovate-lanceolate, 6.25–7.5(–10) mm long, 1–3-nerved; palea ovate-linear-lanceolate, 6.25–7.5(–10) mm long.

Distribution — ? Malesia: Papua New Guinea (see notes), Australia: W Australia (?, see notes), Northern Territory (Victoria River, Darwin & Gulf Region), Queensland (South Kennedy, Burke, North Kennedy, Port Curtis, Cook, Mitchell, Moreton, Leichhardt District).

Habitat — Humid shaded places, swamps, silty banks of streams, irrigation drains, edge of open rain forest, Eucalypt forest, locally fairly common, 70–215 m altitude.

Collector's notes — In densely tufted tussocks. Culms more or less erect or nearly so, green, 3 m tall. Inflorescence rather paler.

Vernacular name — River grass.

Uses — Eaten to some extent by stock even though coarse in nature.

Notes — The species has been mentioned for W Australia (Gardner, 1952: 357; Simon, 1993: 84; Simon & Latz, 1994: 24), but we have not seen any specimens.

It has also been reported by Von Mueller (1885: 20) for Papua New Guinea ("Cloudy Mts. *Capt. Bridge*", Abau, C. Prov.). We have not seen this specimen (presumably in MELB). It could be misidentified *P. digitata* of which a single collection is known from the N Province.

About 24 collections could be studied.

3. Chionachne gigantea (J. König) Veldk., *comb. nov.* — Fig. 3

Coix gigantea J. König, Naturforscher (Halle) 23 (1788) 211, non Jacq. (1820) nec Roxb. (1832). — Type: *König s.n.* (BM, K, UPS, *Herb. Thunberg 21727*, IDC microfiche 1036), India, Andhra Pradesh, Circars (= E coast of Bay of Bengal).

Coix arundinacea J. König ex Willd. (1805–1806) 203, non Lam. (1791). — *Coix koenigii* Spreng. (1824) 239. — *Chionachne koenigii* Thwaites (1864) 357. — Type: *De Friedland s.n. in Herb. Willdenow 17098-b* (holo B, IDC microfiche 7440, fiche! 1229; K), India, Transchaur (sphalm. for Tranquebar?).

Coix barbata Roxb. [(1814) 66, nomen] (1832) 569. — *Chionachne barbata* R.Br. ex Aitch. (1869) 157; Benth. (1878) 515; Duthie (1883) 11, isonyms. — *Polytoca barbata* Stapf (1896) 102, nom. superfl. (*Ch. koenigii* Spreng. cited). — Type: *Herb. Roxburgh s.n.* (holo BM, sh. 47254; G, P; CAL, K, *Icon. Ined. 871*; = *Wallich Cat. 8626-A*: K, IDC microfiche 7394), India, Andhra Pradesh, Circars (= E coast of Bay of Bengal).

Coix crypsioides Müll.Hal. (1861) 334. — Type: *Griffith s.n.* (B†; K), India, Bengal.

Slender perennials. Culms 1.3–3 m tall, 2–6(–7) mm wide at base, rooting at the lower nodes, glabrous to bbb-setulose. Nodes bearded. Sheaths 2.8–16.5 cm long, glabrous to bbb-setulose. Auricles absent or triangular, 1–1.5 mm long. Ligule 1–2 (–3) mm long. Blades linear, 6–60(–80) by 0.4–1.4(–2.2) cm, glabrous to bbb-setulose, base rounded to attenuate, 3–6(–8-)nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 1.1–2.1 cm long, auricles absent, ligule 0.5–1 mm long, blades (4–)9–16 mm long. Racemes digitate, 1.3–4.2 cm long, at base with 1 (or 2) female spikelets, distally with 1(–3) pairs of male spikelets. Joints 1–3(–4) mm long, glabrous. *Female part*: sessile spikelets enveloping the joint. Lower glume broadly fusiform, sometimes with a slight constriction in the lower fifth, 4–6(–7) mm long, smooth, glabrous, keels overlapping the joint, not extended upwards, without lateral appendages; upper glume herbaceous and partly coriaceous, ovate-elliptic, 3.5–5 mm long, 5–11-nerved. First lemma epaleate, ovate-elliptic, 3–4 mm long, (2–)3–5-nerved,

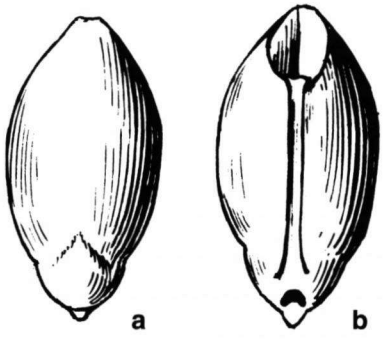

Fig. 3. *Chionachne gigantea* (J. König) Veldk. Sessile spikelet. a. Abaxial view; b. adaxial view (*T. Thomson s.n.*).

anastomosing. Second lemma ovate-oblong to -lanceolate, 3–4 mm long, 1–3-nerved, anastomosing; palea ovate-oblong to -lanceolate, 3–3.5 mm long. Fruit 1–3 by 0.6–2 mm. Hilum oval. Stipe glabrous, fused with the joint. Pedicelled spikelets sterile, almost absent, glume margins scabrid. *Male part*: sessile spikelets lower glume ovate-oblong to -lanceolate, 6.5–8(–11) mm long, glabrous or pilose, 9–13-nerved, anastomosing, muticous; upper glume 6.5–8(–10) mm long, 5–9-nerved. First lemma ovate-oblong to -lanceolate, 7–10 mm long, 3- or 4-nerved, anastomosing; palea ovate-oblong to -lanceolate, (5–)7–8.5 mm long, lower part keeled or not, 2- or 3-nerved. Second lemma 6–9 mm long, 1–3-nerved; palea 6–8 mm long. Pedicelled spikelets lower glume oblique, ovate-elliptic to -oblong, 6.5–8.5(–10) mm long, glabrous or dorsolaterally ciliate, keeled, apex truncate, 9–13-nerved, anastomosing; upper glume ovate-oblong, 6.5–8(–10) mm long, keeled, 6–9-nerved. First lemma ovate-oblong, 5.5–8(–9.5) mm long, 3–5-nerved, anastomosing; palea ovate-lanceolate, 5.25–7.5(–9) mm long, lower part keeled, 2-nerved. Second lemma ovate-linear-lanceolate, 7–8 mm long, 0–2-nerved; palea ovate-linear-lanceolate, 6–7.5 mm long.

Distribution — Sri Lanka, N Pakistan (Kashmir, Punjab), India (Andhra Pradesh, Assam, Bengal, Bihar, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Orissa, Punjab, Tamil Nadu, Uttar Pradesh), Bangladesh, Upper Burma, and again in N Vietnam (Ki-Luong). Note the disjunct distribution.

Habitat — In shade in wettish places, often sporadic in jungle clearings, tussock grassland and open woodland, savannah tracts, near pools, marshes, and rice fields, disturbed areas, stony soil, sandy loam, locally abundant, 60–1065 m altitude.

Collector's notes — Tufted to mat-forming, stilt-rooted. The sheaths and leaves are covered with irritating hairs, making it a plant to be avoided. Grazing animals do not like it for obvious reasons. The margins of the leaves are razor-sharp. Panicle open, with drooping branches; spathas more or less purple. Spikelets white. Stamens brown. Stigmas dark brown.

Uses — Considered to be poor fodder because of the stiff hairs on sheaths and leaves, only palatable when young. "Cattle do not eat it" (Roxburgh). The stony 'fruits' (i.e. sessile female spikelets) are used as rosary beads, just as those of *Coix lacryma-jobi* (Anonymous, 1992: 475).

Chromosome number — 2n = 20, 40.

Notes — Cope (1982: 351) reported the species for Java, Celebes, and as possibly introduced in Australia (Queensland). This seems to be based on misidentifications for *Polytoca digitata* and *Ch. hubbardiana*, respectively.

About 62 collections could be studied.

4. **Chionachne hubbardiana** Henrard — Fig. 4

Chionachne hubbardiana Henrard (1938) 162, f. — Type: *F. von Mueller s.n.* (holo K; fragm. L; MELB), Australia, Queensland, Sturt's Creek.
Chionachne barbata R.Br. sensu Benth., pro specim.
Chionachne cyathopoda auct. non Benth.
Polytoca cyathopoda auct. non F.M. Bailey.

Slender annuals or perennials (see note). Culms 0.2–1 m tall, 1–3(–5) mm wide at base, rooting at the lower nodes or not, glabrous or pilose or bbb-setulose. Nodes partially pilose to bearded. Sheaths 3.2–12 cm long, glabrous to bbb-setulose. Auricles

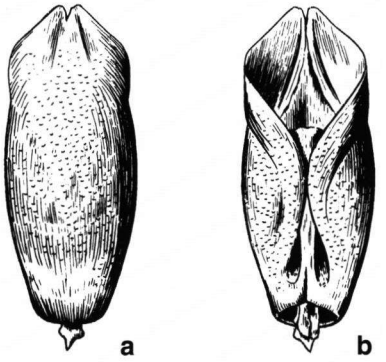

Fig. 4. *Chionachne hubbardiana* Henrard. Sessile spikelet. a. Abaxial view; b. adaxial view (*F. von Mueller s.n.* (type)).

absent. Ligule 1–1.5 mm long. Blades linear, 9–24 by 0.3–1.1 cm, glabrous to bbb-setulose, base rounded or not, 3–5-nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 1.3–3.2 cm long, auricles absent, ligule 0–0.75 mm long, blades 10–57 mm long. Racemes digitate, 2.2–3.5 cm long, at base with 1–5 female spikelets, distally with 1(–3) pairs of male spikelets. Joints 2–6 mm long, glabrous. *Female part*: female spikelets enveloping the joint. Lower glume flattened botuliform, sometimes slightly constricted in the lower third, 8–12 mm long, smooth to finely pusticulate, glabrous, keeled, keels overlapping the joint, extended upwards, without lateral appendages; upper glume partly coriaceous, ovate-elliptic, 6.5–7.5 mm long, 11–13-nerved. First lemma epaleate, ovate-elliptic, 6–7.5 mm long, 3–5-nerved, anastomosing. Second lemma ovate-elliptic to -oblong, 4.5–6 mm long, 2-nerved, anastomosing or not; palea ovate-oblong, 4.5–5 mm long. Fruit 2.75–4.25 by 1.75–3.75 mm. Hilum circular to oval. Stipe glabrous, fused with the joint. Pedicelled spikelets sterile, almost absent, glume margins scabrid. *Male part*: sessile spikelets lower glume ovate-elliptic, 6–7.5 mm long, muticous, glabrous, 12–16-nerved, anastomosing; upper glume 6–7.5 mm long, 7-nerved. First lemma ovate-oblong, 5.5–7.5 mm long, 3-nerved, anastomosing; palea ovate-oblong to -lanceolate, 5.25–6.5 mm long, lower part keeled, 2-nerved. Second lemma 5–6.5 mm long, 1- or 2-nerved; palea 5–6.5 mm long. Pedicelled spikelets lower glume oblique or symmetric, ovate-oblong to -lanceolate, 6–9.5 mm long, glabrous, keeled or not, apex acute or attenuated, 10–13-nerved, anastomosing; upper glume ovate-oblong, 5.5–9 mm long, keeled, 8–12-nerved. First lemma ovate-oblong to -lanceolate, 5–8.25 mm long, 3–5-nerved, anastomosing; palea ovate-oblong to -lanceolate, 3.5–6.5 mm long, lower part keeled, 2-nerved. Second lemma ovate-lanceolate, 4.5–7.5 mm long, 1–3-nerved; palea ovate-lanceolate to -linear-lanceolate, 4.5–7 mm long.

Distribution — Malesia: E Java: Besuki (Baluran, Panarukan, Semongkrong), Lesser Sunda Islands (Sumbawa), Australia: Western Australia (North-West, Kimberly Research Station), Northern Territory (Darwin & Gulf, Victoria, and Barkly Tablelands Region), Queensland (Burke, Cook, Gregory North, North and South Kennedy, Leichhardt Distr.). Said to have been introduced in N America (Watson & Dallwitz, 1992), but JFV and USA colleagues could not discover any voucher.

Habitat — Humid to wet areas, rice fields, on clayey loam, 218–335 m altitude.

Uses — Eaten by banteng.

Collector's notes — Green caespitose annual (*Blake 11432, 11550, 17848*). Locally (e.g. on the Baluran, Besuki) vegetation forming.

Notes — Several authors and collectors reported this species to be an annual (Backer, 1928: 30–32; Gardner, 1952: 357 (also perennial); Simon, 1993: 84). As Gardner already pointed out, *Durack April 1916* seems perennial by the presence of well-developed cataphylls.

About 7 collections could be studied, most lacking their bases.

5. **Chionachne javanica** (Henrard) Clayton — Fig. 5

Chionachne javanica (Henrard) Clayton (1981) 813. — *Polytoca javanica* Henrard (1939) 241, t. 1, 2. — Type: *Backer 36799* (holo L, sh. 938.297-134; BO, G, K, SING), Java, Besuki, S coast near Puger, base of the G. Watangan, 1 April 1929.

Slender perennials. Culms c. 0.75 m tall, 1–2 mm wide at base, rooting at the lower nodes or not, glabrous. Nodes glabrous. Sheaths (2.8–)3.7–8.6(–9.6) cm long, glabrous to ciliate. Auricles triangular, 0.75–1 mm long. Ligule 0–1 mm long. Blades ovate-lanceolate to -linear-lanceolate, (4–)7–11(–16.5) by 1.2–2.5 cm, glabrous, base rounded to attenuate, 4–5(–8-)nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 3.1–9.6 cm long, auricles absent, ligule 0.5–0.75 mm long, blades 5–50 mm long. Racemes solitary, up to 7 cm long, at base with 3 or 4 (or more?) female spikelets, distally with an unknown number of pairs of male spikelets. Joints (2–)4–9(–10) mm long, glabrous. *Female part*: sessile spikelets partly immersed in the joint. Lower glume flattened botuliform, sometimes slightly constricted in the lower third, 6–9 mm long, finely pusticulate, glabrous, keeled, keels not overlapping the joint, extended upwards, with a sometimes elongated tooth on each side; upper glume partly coriaceous, ovate-elliptic, 5.5–6.5 mm long, 7–9-nerved. First lemma ovate-elliptic, 5.5–6 mm long, 3-nerved, not anastomosing; palea ovate-lanceolate, 5–5.5 mm long,

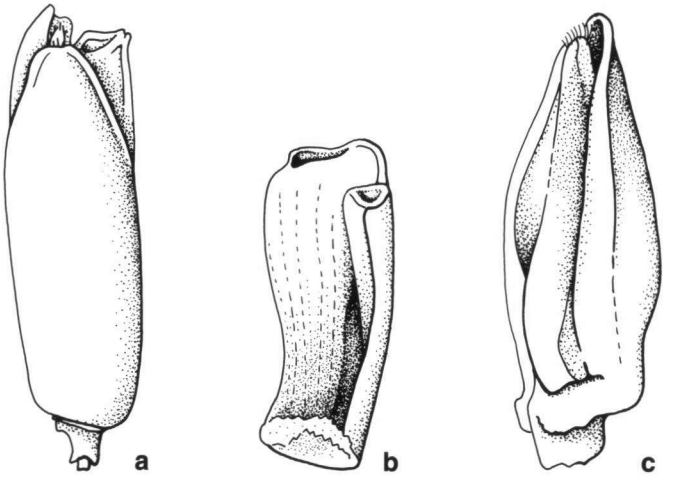

Fig. 5. *Chionachne javanica* (Henrard) Clayton. a & c. Sessile spikelet; a. abaxial view; c. adaxial view. – b. Joint and pedicel, adaxial view (*Backer 36799* (type)).

2-nerved. Second lemma ovate-elliptic, 6–6.5 mm long, 2- or 3-nerved, anastomosing; palea ovate-oblong, 5.5–6.5 mm long. Fruit 2.75–3 by 1–1.25 mm (immature). Stipe glabrous, free. Pedicelled spikelets sterile, almost absent, glume margins scabrid. *Male part*: sessile spikelets lower glume ovate-elliptic to -oblong, 5–6.75 mm long, muticous, glabrous, 11–15-nerved, anastomosing or not; upper glume 5–6.5 mm long, 6–9-nerved. First lemma ovate-oblong, 4.5–6 mm long, 2- or 3-nerved, not anastomosing; palea ovate-lanceolate, 4.5–5.5 mm long, lower part keeled, 2-nerved. Second lemma 4.5–5.5 mm long, 3-nerved; palea 4–4.5 mm long. Pedicelled spikelets lower glume symmetric, ovate-elliptic to -oblong, 4.5–6 mm long, glabrous, keeled, apex truncate, 12–16-nerved, anastomosing or not; upper glume ovate-oblong, 4.5–6 mm long, keeled or not, 6–14-nerved. First lemma ovate-elliptic to -oblong, 4–5.5 mm long, 3-nerved, not anastomosing; palea ovate-lanceolate, 3.5–4.5 mm long, keeled or not, 2-nerved. Second lemma ovate-elliptic to -oblong, 3.5–5 mm long, 3-nerved; palea ovate-oblong to -linear-lanceolate, 3.5–4.5 mm long.

Distribution — E Java (Besuki, Puger); Lesser Sunda Islands (Alor, Flores).

Habitat — Primary forest on limestone, lightly shaded paths, locally frequent, 25–800 m altitude.

Collector's note — Culms robust, bamboo-like, erect, reiterately branched.

Note — Only 4 collections could be studied.

6. **Chionachne macrophylla** (Benth.) Clayton — Fig. 6

Chionachne macrophylla (Benth.) Clayton (1981) 814. — *Polytoca macrophylla* Benth. (1881) 52. — Lectotype: *MacGillivray 460* (holo K, sheet 1), Louisiade Archipelago, 26 June 1849, designated here.

Coarse perennials. Culms 1.3–3 m tall, 6–15 mm wide at base, rooting at the lower nodes or not, glabrous. Nodes glabrous to partially pilose. Sheaths 7–38 cm long, bbb-setulose. Auricles triangular, free from the ligule, 0.5–1 mm long. Ligule c. 0.25 mm long. Blades ovate-linear-lanceolate, 20–80 by 2–5.8 cm, glabrous, base rounded, 7–13-nerved on each side of the midrib. Spatheoles enveloping only some of the spikes, sheath 7–17 cm long, auricles present, ligule c. 0.25 mm long, blades 4–65 mm long. Racemes solitary, 9–15(–18) cm long, at base with 7–16 female spikelets, distally with up to 7 (or more?) pairs of male spikelets. Joints 2–10(–12) mm long, pilose. *Female part*: sessile spikelets enveloping the joint. Lower glume flattened botuliform, sometimes slightly constricted in the lower third, 8–17 mm long, finely pusticulate, glabrous, keeled, keels overlapping the joint or not, extended upwards, with a sometimes elongated tooth on each side; upper glume partly coriaceous, ovate-oblong, 8–10 mm long, 5–9(–17-)nerved. First lemma epaleate, ovate-oblong, 6.5–8 mm long, 3–6-nerved, anastomosing. Second lemma ovate-lanceolate, 6.5–8.5 mm long, 1- or 2-nerved, then anastomosing; palea ovate-lanceolate, 5–7 mm long. Fruit 2.25–4.1 by 1.25–2.7 mm. Hilum circular. Stipe glabrous, fused with the joint. Pedicelled spikelets male, similar to spikelets in the male part, ovate-lanceolate, 7–16 mm long, glume margins scabrid. *Male part*: sessile spikelets lower glume ovate-oblong, 7–13 mm long, muticous, glabrous, 8–18-nerved (when even, midrib absent), anastomosing; upper glume 8.5–11 mm long, 4–7-nerved. First lemma ovate-lanceolate, 8–9 mm long, 3-nerved, anastomosing; palea ovate-oblong, 8–8.5 mm long, 2-keeled. Second

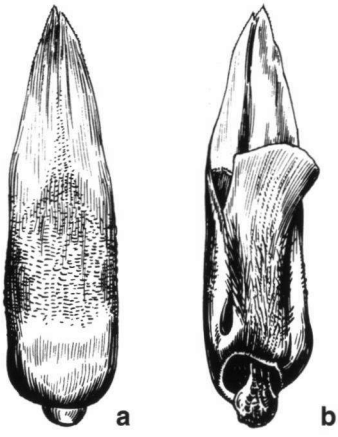

Fig. 6. *Chionachne macrophylla* (Benth.) Clayton. Sessile spikelet. a. Abaxial view; b. adaxial view (*Lauterbach 990*).

lemma 7–8.5 mm long, 1-nerved; palea 7.5–8.5 mm long. Pedicelled spikelets: glumes, lemmas, and paleas ovate-lanceolate; glumes keeled; lower glume oblique, 7–16 mm long, apex retuse or acute, glabrous, 10–13-nerved, anastomosing; upper glume 10–13 mm long, 5–11-nerved. First lemma 8.5–11 mm long, 3- or 4-nerved, anastomosing; palea 7–9 mm long, lower part keeled, 2-nerved. Second lemma 7.5–10 mm long, 0–3-nerved; palea 7.5–9 mm long.

Distribution — Moluccas (Ternate), Kai Is., Irian Jaya (Fakfak, Jayapura, Manokwari, Yapen, Waropen), Papua New Guinea (East & West Sepik, Madang, Morobe, Western & Eastern Highlands, Western, Gulf, Central, Northern, Milne Bay, New Britain, New Ireland), Solomon Islands (Bougainville, Santa Isabel, Guadalcanal, Malaita, San Cristobal). Experimentally cultivated in Java as a fodder plant, in Fiji, Hawai'i (Oahu), Trinidad (in 1945) from where Nirodi (1955) received her specimen.

Habitat — Savanna, near water, disturbed areas, coconut plantations, alang fields, roadsides, fire-resistant, rocky to gravely soil, peaty clay, limestone, locally common, forming dense thickets, 0–1450 m altitude.

Collector's notes — Tall, erect to slanting, coarse perennial, somewhat similar to maize, strongly branched from the base. Culms solitary to tufted, with spongy white pith. Leaf sheaths and margins of petiole purple, with stiff and irritant hairs. Blades pale green. Spikelets white to bright green with a more or less purplish tinge. Anthers light brown. Stigmas long, exserted, pale yellow to bright white.

Uses — Good, soft fodder of sufficient nutritive quality.

Chromosome number — 2n = 40.

Note — About 75 collections could be studied.

7. **Chionachne massiei** Balansa — Fig. 7

Chionachne massiei Balansa (1890) 78, '*massii*'. — *Polytoca massiei* M. Schenck ex Henrard (1931) 9, '*massii*'. — Lectotype: *Massie s.n.* (L), Sontay, Tonkin, 1886; designated here, Henrard's previous selection (1931: 9) being too vague.

Polytoca punctata auct. non Stapf.

Sclerachne punctata auct. non. R.Br.

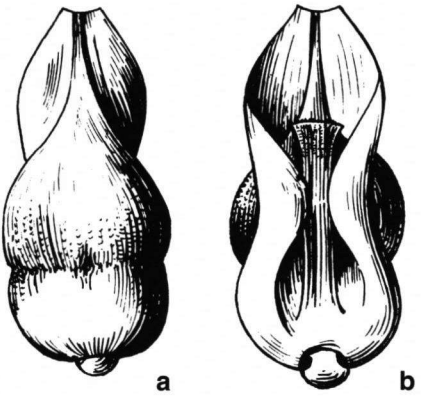

Fig. 7. *Chionachne massiei* Balansa. Sessile spikelet. a. Abaxial view; b. adaxial view (*Balansa 312*).

Slender perennials. Culms 0.2–0.75 m tall, 1–2 mm wide at base, rooting at the lower nodes, glabrous. Nodes bearded. Sheaths 1.3–5(–9.4) cm long, glabrous. Auricles absent or triangular, 0–0.5 mm long. Ligule 0.5–1.5 mm long. Blades ovate-linear-lanceolate to linear, (3.4–)9–27(–39) by 0.7–1 cm, glabrous to bbb-setulose, base rounded to attenuate, 2–4(–5-)nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 1–1.8 cm long, auricles absent, ligule 0–0.25 mm long, blades 5–31(–46) mm long. Racemes digitate, 0.8–1.3(–2.1) cm long, at base with 1–3 female spikelets, distally with 1(–3) pairs of male spikelets. Joints 4–5 mm long, glabrous. *Female part*: sessile spikelets enveloping the joint. Lower glume pear-shaped, with a strong constriction around the middle, 7–9(–10) mm long, smooth, glabrous, keels overlapping the joint, extended upwards, without lateral appendages; upper glume herbaceous and partly coriaceous, broadly-ovate to rounded, 4.5–5.25 mm long, 15–17-nerved. First lemma epaleate, ovate-elliptic, 4.5–5 mm long, 3- or 4-nerved, anastomosing. Second lemma ovate-oblong, 4–4.5 mm long, 1- or 2-nerved, then anastomosing; palea ovate-oblong, 3–4 mm long. Fruit 2–3 by 1.75–3.75 mm. Hilum circular. Stipe glabrous, fused with the joint. Pedicelled spikelets sterile, reduced, ovate-lanceolate to -linear-lanceolate, 1.5–3.25 mm long, glume margins smooth. *Male part*: sessile spikelets lower glume ovate-elliptic to -oblong, 2.5–4 mm long, muticous, glabrous, 6–9-nerved, anastomosing; upper glume 3–3.5 mm long, 3–7-nerved. First lemma ovate-oblong, 2.75–3.5 mm long, 3-nerved, not anastomosing; palea ovate-oblong, 2.5–3 mm long, 2-nerved, lower part keeled. Second lemma 2.5–3 mm long, 1-nerved; palea 2.5–3 mm long. Pedicelled spikelets lower glume oblique or symmetric, ovate-elliptic to -oblong, 3.5–5 mm long, keeled, apex truncate to acute, glabrous, 7–14-nerved, ? not anastomosing (nerves inconspicuous); upper glume ovate-oblong to -lanceolate, 3–4.5 mm long, keeled or not, 7-nerved. First lemma ovate-oblong, 3–4 mm long, 3-nerved, anastomosing or not; palea ovate-oblong, 2.75–3.5 mm long, lower part keeled, 2-nerved. Second lemma ovate-lanceolate, 3–3.5 mm long, 1–3-nerved; palea ovate-lanceolate, 3–3.5 mm long.

Distribution — Thailand (N: Chiang Mai, Nakhon Sawan; C: Saraburi Prov.), Laos (Mekong, Luang-prabang), N Vietnam (Sontay), China (Hainan, possibly introduced, fide Chen (1997: 284, t. 71, f. 8–10)).

Habitat — Dry evergreen forest, humid soils, near water, e.g. rice fields, waste places, locally common, 30–350 m altitude.

Collector's notes — Culms loosely branched, mostly prostrate. Glumes green.

Notes — The epithet is generally misspelled as '*massii*', but as it is in honour of Joseph Massie (?–1794), an English pharmacist in the French Navy, who made c. 581 collections in Tonkin (in P), it should be '*massiei*' as is also used for 3 other species named after him (and 2 as '*massieana*', but not in the genus *Massia*, also by Balansa).

The species is not mentioned by Schmid (1958) and Hô (1993), possibly because Stapf (1896) and Camus (1922) synonymised it with *Polytoca punctata* and *Sclerachne punctata*, respectively.

About 20 collections could be studied.

8. Chionachne punctata (R.Br.) Jannink, *comb. nov.* — Fig. 8

Sclerachne punctata R.Br. in Benn. & R.Br., Pl. Jav. Rar. (1838) 15, t. 4. — *Polytoca punctata* Stapf (1896) 102, quoad basion. — Type: *Horsfield s.n.* (holo BM), Java, near Surakarta, village Jebus.

Slender perennials (sometimes recorded as annual). Culms 0.5–1 m tall, 1–3 mm wide at base, rooting at the lower nodes, glabrous. Nodes bearded. Sheaths 3–14.2 cm long, glabrous to bbb-setulose. Auricles absent. Ligule 1–2 mm long. Blades linear, (6–)20–70 by 0.6–1.5 cm, glabrous, bbb-setulose or -pilose, base attenuate, 3–5-nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 1.7–2.8 cm long, auricles absent, ligule 0–0.5 mm long, blades 1.2–24 mm long. Racemes digitate, 1.1–2.2 cm long, at base with 1 (or 2) female spikelets, distally with 1(–3) pairs of male spikelets. Joints 3–5 mm long, glabrous. *Female part*: sessile spikelets enveloping the joint. Lower glume pear-shaped, with a strong constriction around the middle, 9–11 mm long, pusticulate, glabrous, keels overlapping the joint, extended upwards, without lateral appendages; upper glume partly coriaceous to herbaceous, ovate-elliptic, 6–8 mm long, 9–15-nerved. First lemma epaleate, ovate-elliptic, 5–6.5 mm long, 3-nerved, anastomosing. Second lemma ovate-oblong to -lanceolate, 5–5.5 mm long, 1-nerved; palea ovate-oblong to -lanceolate, 4–4.5 mm long. Fruit

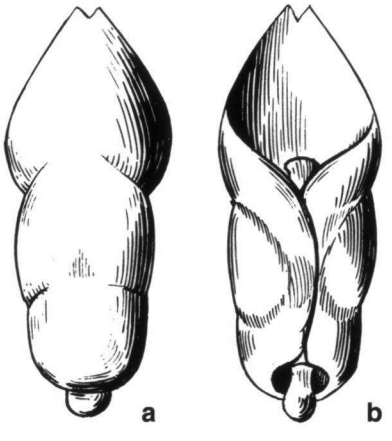

Fig. 8. *Chionachne punctata* (R.Br.) Jannink. Sessile spikelet. a. Abaxial view; b. adaxial view (*R. Brown s.n.*).

2.5–3.5 by 1.5–3 mm. Hilum circular. Stipe glabrous, free. Pedicelled spikelets almost absent, glume margins smooth. *Male part*: sessile spikelets lower glume round, c. 4 mm long, muticous, glabrous, c. 16-nerved, anastomosing; upper glume c. 3.75 mm long, 5-nerved. First lemma ovate-oblong, c. 3.75 mm long, 3-nerved, anastomosing; palea ovate-oblong, c. 3.5 mm long, lower part keeled, 2-nerved. Second lemma c. 3.5 mm long, 1-nerved; palea c. 3.5 mm long. Pedicelled spikelets lower glume symmetric, ovate-oblong, 4.5–6.5 mm long, keeled or not, apex acute, glabrous to dorso-laterally ciliate, 11–13-nerved, not anastomosing; upper glume ovate-oblong, 4.25–6.25 mm long, not keeled, 8–10-nerved. First lemma ovate-oblong to -lanceolate, 4.25–6 mm long, 3- or 4-nerved, anastomosing; palea ovate-oblong to -lanceolate, 3.5–5 mm long, lower part keeled, 2-nerved. Second lemma ovate-lanceolate, 3.5–5 mm long, 1-nerved; palea ovate-lanceolate, 3.5–4.75 mm long.

Distribution — Java (Banyumas, Bogor, Madiun, Pasuruan, Semarang, Surabaya), Madura, Kangean Is., Philippines (Luzon: Batangas Prov., San Juan, *PNH 36220 (Sulit)*, L), Lesser Sunda Islands (Sumbawa, Timor).

Habitat — Apparently a drought species, found in teak forest, dry sunny areas on bare soil, disturbed places, abandoned rice fields, loam, heavy soil, temporarily very dry, locally common, 10–300 m altitude.

Uses — "The only grass still green in the dry season. Producing a considerable amount of foliage readily eaten by horses, which probably is the cause that it is praised as a good fodder, but its nutritive value is considerably below average" (Backer, 1950: 150). Terrible weed, hard and difficult to eradicate (*PNH 36220 (Sulit)*).

Collector's notes — Much-branched annual (!). Tufts green, c. 10 cm diam., spiny. Culms in exposed sunny places prostrate, in shady places ascendingly erect. Spikelets whitish. Dispersed by ants (*Monod de Froideville 1458*, L).

Chromosome number — 2n = 20.

Notes — New record for the Philippines. Note the resulting disjunction, reminiscent of that of *Chrysopogon subtilis* (Steud.) Miq. from E Java, Sumba, Luzon, and the pantropical *Diectomis fastigiata* (Sw.) Kunth, in Malesia: E Java, Philippines (Busuanga Is., Hermana Mayor Is., Luzon, Palawan).

About 27 collections could be studied.

9. **Chionachne semiteres** (Benth. ex Stapf) Henrard — Fig. 9

Chionachne semiteres (Benth. ex Stapf) Henrard (1931) 16; C.E.C. Fisch. (1934) 1706, isonym. — [*Tripsacum ? semiteres* Wall. (1848) 8628, nomen]. — *Polytoca semiteres* Benth. [(1883) 1113, nomen] ex Stapf (1896) 101. — Lectotype: *Herb. Wallich 8628* (holo K, microfiche IDC 7394), Burma, Taong-dong hills near Ava (near Mandalay), 25 November 1826; designated here.

[*Chionachne wightii* Munro ex Benth. (1883) 1113, nomen; (1878) 516, nomen. — Voucher: *Wight KD 3318 ('3315')* (C, K, L, NSW, P, US), India, Tamilnadu, Tirunelveli Distr., Palamcottah, April 1835 (see note)].

Slender perennials. Culms (0.3–)1–1.5 m tall, 2–3 mm wide at base, rooting at the lower nodes, glabrous. Nodes bearded. Sheaths 5.5–8.5 cm long, glabrous. Auricles absent. Ligule 0.75–2 mm long. Blades linear, (5–)30–36 by 0.3–0.9 cm, glabrous, pilose, bbb-setulose above, base attenuate, 3–5-nerved on each side of the midrib. Spatheoles enveloping each spike, sheath 2.3–4.2 cm long, auricles, ligule, blades

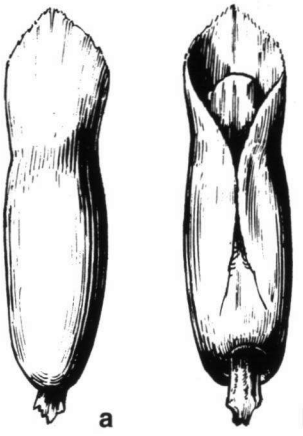

Fig. 9. *Chionachne semiteres* (Hook.f.) Henrard. Sessile spikelet. a. Abaxial view; b. adaxial view (*Wight 3318*, voucher for *Chionachne wightii* Benth.).

absent. Racemes solitary, 5–9 cm long, at base with 3–5 female spikelets, distally with up to 7 (or more?) pairs of male spikelets. Joints 2–6 mm long, glabrous. *Female part*: sessile spikelets enveloping the joint. Lower glume flattened botuliform, sometimes slightly constricted in the lower third, 8–10 mm long, finely pusticulate, margins ciliate, keels overlapping the joint, extended upwards, without lateral appendages; upper glume partly coriaceous to herbaceous, ovate-elliptic, 6–7 mm long, 15-nerved. First lemma epaleate, ovate-elliptic, c. 6 mm long, 3-nerved, anastomosing. Second lemma ovate-oblong to -lanceolate, 4–5.5 mm long, 2-nerved, anastomosing; palea ovate-lanceolate, 4–5 mm long. Fruit c. 2 by 1.5 mm. Hilum circular. Stipe glabrous, fused with the joint. Pedicelled spikelets almost absent, glume margins scabrid. *Male part*: sessile spikelets lower glume ovate-oblong to -lanceolate, 5.5–8.5 mm long, muticous, glabrous to (dorso-laterally) ciliolate, 10–15-nerved, anastomosing or not; upper glume 6–8 mm long, 3–5-nerved. First lemma ovate-oblong, 6–8 mm long, 3-nerved, anastomosing; palea ovate-oblong to -lanceolate, 5.5–7.5 mm long, lower part keeled, 2–4-nerved. Second lemma 5.5–7 mm long, 1-nerved; palea 5.5–6.5 mm long. Pedicelled spikelets lower glume oblique, ovate-oblong to -lanceolate, 5.75–8.5 mm long, keeled, apex truncate, glabrous to (dorso-laterally) ciliate, 9–12-nerved, anastomosing or not; upper glume ovate-oblong to -lanceolate, 6–8.25 mm long, 5–11-nerved, keeled or not. First lemma ovate-lanceolate, 6–7.5 mm long, 3- or 4-nerved, anastomosing; palea ovate-lanceolate, 5.5–7.25 mm long, lower part keeled or not, 2–4-nerved. Second lemma ovate-lanceolate, 5.5–7 mm long, 0- or 1-nerved; palea ovate-lanceolate, 5.25–6.5 mm long.

Distribution — W and S India: Maharashtra (Osmanabad), Tamil Nadu (S Arcot, Coimbatore, Tirunelveli), Burma (Mandalay). Note the disjunct distribution.

Habitat — Rare, in hedges around fields, road sides, dry hill slopes, occasionally in pure formations (Matthew, 1983), altitude not recorded.

Collector's note — None recorded.

Uses — Cultivated for fodder (Anonymous, 1992: 475).

Chromosome number — 2n = 20.

Notes — We agree with Henrard (1931: 16) that *Ch. wightii* Munro ex Benth. was not validly described, as there was only a joint diagnosis for this and *Ch. cyathopoda*, and no indication how the two would differ.

The species is more variable than described here, as we have only seen 3 collections. Hence also the (near) absence of data on habitat and collector's notes.

2. CYATHORHACHIS

Cyathorhachis Nees ex Steud. (1854) 403. — Type: *Cyathorhachis wallichiana* Nees ex Steud.

Annual or perennial. Spatheoles present below and enveloping each partial inflorescence, with a developed blade. Spikes digitate, lateral branches male, terminal branch mixed, distally with pairs of reduced, sterile spikelets. *Female part*: second floret absent. Fruit dorso-laterally flattened, base truncate to retuse. Hilum circular or oval. Stipe fused with the joint to free. Pedicelled spikelets sterile, reduced. *Male part*: sessile spikelets lower glume awned. First palea keeled. Pedicelled spikelets lower glume oblique or symmetric, apex awned, keeled or not; upper glume not keeled. First palea keeled.

Distribution — 1 species in Sikkim, Burma, and E Thailand.

1. Cyathorhachis wallichiana Nees ex Steud. — Fig. 10

Cyathorhachis wallichiana Nees ex Steud. (1854) 403. — *Polytoca wallichiana* Benth. (1881) 52. — Lectotype: *Herb. Wallich 8629-B* (holo B; K, microfiche IDC 7394; fragm. ex B in L), Burma, Moalmyne, January 1827; designated by Henrard (1931: 9).

[*Gramen olyraceum* Wall. (1848) 8629-A is not a name, but a temporary designation for a collection from Burma, Prome, Irawaddy, September 1826].

Culms 0.75–3 m tall, (1.5–)2–8 mm wide at base, rooting at the lower nodes, glabrous to pilose or bbb-setulose. Nodes bearded. Sheaths (5.2–)7–19 cm long, glabrous to bbb-setulose. Auricles triangular, 0.5–2 mm long. Ligule 1–3 mm long. Blades linear, (13–)38–60(–107) by 1.2–3.6 cm, glabrous to bbb-setulose, base attenuate, 3–7-nerved on each side of the midrib. Spatheole sheath (2.9–)3.6–6.3(–9.8) cm long, auricles present or not, ligule 0.5–1 mm long, blades (2–)4–26(–65) mm long. Terminal branch 1.5–5.6 cm long. Joints (1–)2–6(–8) mm long, pilose. *Female part*: sessile spikelets enveloping the joint. Lower glume flattened botuliform, sometimes slightly constricted in the lower third, (5–)6.5–8.5 mm long, smooth, glabrous or setose, ciliate, and with longer tufts where the apex attenuates, keeled, keels not overlapping the joint, apex extended upwards, without lateral appendages; upper glume ovate-elliptic, 4–5.5 mm long, partly coriaceous, 13–15-nerved. First lemma paleate, ovate-elliptic, 3.5–5 mm long, 5–7-nerved, anastomosing; palea ovate-elliptic, 2–3.5 mm long, 0- or 1-nerved. Fruit 1.75–3.25 by 1.25–2.5 mm. Stipe pilose. Pedicelled spikelets ovate-linear, 14–21 mm long, margins smooth. *Male part*: sessile spikelets lower glume ovate-oblong, 5–7 mm long, awns c. 15 mm long, glabrous or dorso-(laterally) ciliolate, 6–8(–9-) nerved, anastomosing or not; upper glume 5–6.5 mm long, 6–8-nerved. First lemma ovate-oblong, 4.5–6 mm long, 3- or 4-nerved, anastomosing; palea ovate-oblong to -lanceolate, 4.5–6 mm long, keeled, 2-nerved. Second lemma 3.5–6 mm long, 1-nerved; palea 3.5–5.5 mm long. Pedicelled spikelets lower glume oblique or symmetric, ovate-

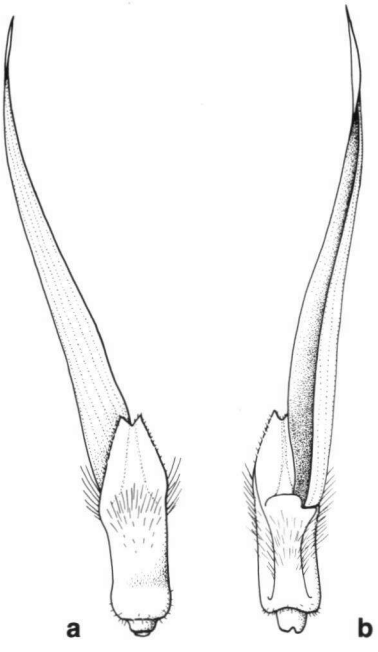

Fig. 10. *Cyathorhachis wallichiana* Nees ex Steud. Sessile female and pedicelled sterile spikelet. a. Abaxial view; b. adaxial view (*Kostermans 1223*).

oblong, 5–7 mm long, glabrous or ciliate, keeled or not, 6(–9-)nerved, anastomosing or not; upper glume ovate-elliptic to -oblong, 5–6.5 mm long, not keeled, 5–7-nerved. First lemma ovate-oblong to -lanceolate, 4–6 mm long, 3-nerved, anastomosing; palea ovate-lanceolate, 4.5–6 mm long, keeled, 2-nerved. Second lemma ovate-lanceolate, 3–6 mm long, 0- or 1-nerved; palea ovate-lanceolate, 3–5.5 mm long.

Distribution — Bhutan, Sikkim, Bangladesh (Chittagong, Sylhet), NE India (Mizoram), Burma (widespread), Thailand (N: Chiang Mai, Nakhon Sawan; SW: Ratchaburi, Kanchanaburi Province).

Habitat — Deciduous primary and secondary forest; along streams, edge of or in swamp, roads, on limestone, clayey sand, 100–915 m altitude.

Collector's notes — Culms dark brown near the base. Leaf sheath purplish. Inflorescence green. Spikelets greenish brown, red, purplish. Awn green with purplish apex. Anthers yellow with brown margins. Styles white with purple hairs.

Note — About 22 collections could be studied.

3. POLYTOCA

Polytoca R.Br. (1838) 20. — Type: *Polytoca bracteata* R.Br. (= *P. digitata* (L.f.) Druce).

Perennials. Spatheoles present below and enveloping each partial inflorescence, with or without a developed blade. Spikes digitate, lateral branches male, terminal branch mixed, proximally usually with pairs of sterile spikelets, then with a zone with female sessile and sterile pedicelled spikelets, distally with pairs of male spikelets, often ending with pairs of sterile spikelets. *Female part*: sessile spikelets enveloping the

joint. First lemma epaleate. Fruit dorso-laterally flattened, base truncate to retuse. Hilum basal, circular. Stipe free or fused with the joint. Pedicelled spikelets sterile, reduced. *Male part*: sessile spikelets lower glume muticous. First palea keeled. Pedicelled spikelets lower glume oblique, keeled, apex unawned; upper glume not keeled. First palea keeled or not.

Distribution — 1 species in SE Asia and Malesia.

1. **Polytoca digitata** (L.f.) Druce — Fig. 11

Polytoca digitata (L.f.) Druce (1917) 641; Henrard (1931) 10, isonym. — *Apluda digitata* L.f. (1782) 434. — Type: *Thunberg in Herb. Linn. 1213-6* (holo LINN, microfiche IDC), 'India', most likely from Java, not found in *Herb. Thunberg* (microfiche IDC 1036).

Coix heteroclita Roxb. [(1814) 66, nomen], (1832) 572. — *Polytoca heteroclita* Koord. (1911) 99. — Type: *Kyd s.n., A° 1810, in Herb. Roxburgh* (holo BM; CAL, K: *Icon. Ined. 2550*; = *Wallich Cat. 8627-A*: K, IDC microfiche 7394), E Bengal.

Polytoca bracteata R.Br. (1838) 20, t. 5. — Type: *Horsfield 113* (holo BM), Java, Prowoto Hills, S of Semarang, A° 1809.

Chionachne koenigii auct. non Thwaites.

Chionachne semiteres auct. non Henrard.

Slender perennials. Culms 0.75–2.5 m tall, 1–5 mm wide at base, not rooting at the lower nodes, glabrous to bbb-setulose. Nodes bearded. Sheaths (4–)5.5–39 cm long, glabrous to bbb-setulose. Auricles triangular, 1–2(–4) mm long. Ligule (1–)2–3.5(–8) mm long. Blades linear, (11–)29–90 by (0.6–)1.2–3.8 cm, glabrous to bbb-setulose, base attenuate or not, (2–)5–8-nerved on each side of the midrib. Spatheole sheath (4–)5.2–8.1(–12) cm long, auricles present, ligule (0–)0.5–0.75 mm long, blades 0–61 mm long. Terminal raceme 3.7–9.5 cm long, at base with 0–16 pairs of male spikelets, then with 3–9 female spikelets, distally with 3–7 (or more) pairs of male spikelets. Joints 2–9(–11) mm long, pilose. *Female part*: female spikelets: lower glume (6–)7–9(–11) mm long, smooth, ciliate or setose with longer tufts where the top attenuates, keels not overlapping the joint, extended upwards or not, without lateral appendages or apically winged; upper glume partly coriaceous, ovate-elliptic to -oblong, (5–)5.5–8 mm long, (7–)11–17-nerved. First lemma ovate-elliptic to -oblong, 4–6.5 mm long, 5–9-nerved, anastomosing. Second lemma ovate-elliptic to -lanceolate,

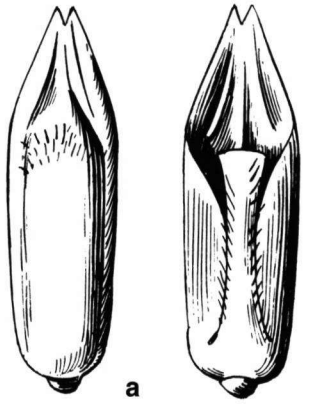

Fig. 11. *Polytoca digitata* (L.f.) Druce. Sessile spikelet a. Abaxial view; b. adaxial view (*Junghuhn s.n.*).

(2–)4.5–6 mm long, 1- or 2-nerved, anastomosing or not; palea broadly ovate to ovate-lanceolate, 2.75–4 mm long. Fruit 2.25–3.25 by 1.5–2.25 mm. Stipe pilose. Pedicelled spikelets ovate-lanceolate, (11–)14–15(–27) mm long, margins scabrid. *Male part*: sessile spikelets lower glume ovate-oblong to -lanceolate, (5–)7.5–8(–12) mm long, muticous, (dorso-laterally) ciliolate or pilose, 7–8(–11-)nerved, anastomosing or not; upper glume (5–)6.5–7.5(–10) mm long, 6–7(–9-)nerved. First lemma ovate-oblong to -lanceolate, (4.5–)6.5–7(–9) mm long, 3- or 4-nerved, anastomosing; palea ovate-oblong to -lanceolate, (3.5–)6–6.5(–8) mm long, keeled at least in the lower part, 2- or 3- (or 4-)nerved. Second lemma (4.5–)5.5–6.5(–8) mm long, 0–3-nerved; palea (3.5–)5.5–6.5(–8) mm long. Pedicelled spikelets lower glume oblique, ovate-lanceolate, (5–)8–9(–14) mm long, keeled, apex acute to attenuated, glabrous to ciliate, 8–9(–11-)nerved, anastomosing; upper glume ovate-oblong to -lanceolate, (4–)6–7(–10) mm long, not keeled, (6–)7–11-nerved. First lemma ovate-oblong to -lanceolate, (3–)5.5–6.5(–7.5) mm long, 3–5-nerved, anastomosing; palea ovate-oblong, (1–)5.5–6.5(–7.5) mm long, keeled or not, (0–)3–4-nerved. Second lemma ovate-lanceolate, (2.5–)5.5–6.5(–7.5) mm long, (0–)3(–5-)nerved; palea ovate-lanceolate, (1–)5.5–6(–7.5) mm long.

Distribution — Sikkim, India (Assam, W Bengal), Upper Burma, Thailand (N: Chiang Mai; NE: Loei; E: Chaiyaphum; SE: Prachin Buri; Peninsular: Satun Prov.), Cambodia, Vietnam, S China (Guangdong, Guangxi, Hainan), Java (Bogor, Ceribon, Kediri, Priangan, Surabaya), Madura, Philippines (Bohol, Busuanga Is., Mindanao), Celebes, Papua New Guinea (Northern Province).

Habitat — Especially in transitional sites between savannah or *Imperata* grassland and open forest (pine, oak, teak, and dry dipterocarp), disturbed areas, roadsides, on sand- and limestone, heavy poor red volcanic soil, granite, locally common, fire-resistant, 0–1500 m altitude.

Collector's notes — Small grass, culms tufted, much branched, green, brown. Leaf dark green above, green underneath; inflorescence axes maroonish. Spikelets white, green and red: female spikelets carmine, male spikelets brownish yellow, lower glume of pedicelled spikelets becoming maroonish in the lower half. Anthers pale purple, maroon. Styles red-purple, rarely white.

Uses — "Producing a considerable amount of foliage, fairly often used for fodder as without effort in a short time much can be cut, a characteristic always highly appreciated by cattle-farmers. However, this is its only recommendation, as not only is it very hard and sharp, but also the nutritive quality is far below average" (Backer, 1950: 149).

Chromosome number — 2n = 20.

Notes — Note the disjunct distribution and the new record for Papua New Guinea. It may have been found before in the Central Province, and identified as *Ch. cyathopoda* (q.v.).

In 1996 two collections (*1399, 1400*; BRI, L) were made in S Laos by J.B. Hacker (St. Lucia, Australia). The plants are smaller than usual for *P. digitata* and extremely pubescent. They are not different enough, however, to be regarded as a distinct taxon, and are here regarded as the first collections from Laos (see Hacker et al., 1996, 1998).

About 78 collections could be studied.

4. TRILOBACHNE

Trilobachne M. Schenck ex Henrard (1931) 4. — Type: *Trilobachne cookei* (Stapf) M. Schenck ex Henrard.

Annual? Spatheoles present below and enveloping each partial inflorescence, with a developed to reduced blade. Spikes digitate, mixed, distally with pairs of male spikelets. *Female part*: sessile spikelets enveloping the joint. First lemma epaleate. Fruit dorsolaterally flattened, base hollow. Hilum dorsal, oval. Stipe fused with the joint. Pedicelled spikelets sterile, reduced. *Male part*: sessile spikelets lower glume muticous. First palea lower part keeled. Pedicelled spikelets lower glume symmetric, not keeled, apex unawned; upper glume not keeled. First palea lower part keeled.

Distribution — 1 species in W India.

1. **Trilobachne cookei** (Stapf) M. Schenck ex Henrard — Fig. 12

Trilobachne cookei (Stapf) M. Schenck ex Henrard (1931) 7; Salunkhe (2000) 378, t. 8. — *Polytoca cookei* Stapf (1894) t. 2333. — Lectotype: *Stocks, Law, etc. s.n. in Herb. Hook.f. & Thomson* (holo K; C, G, L, US), India, Malabar, Concan, A° 1861; designated here.

Annual? (see note). Culms slender, c. 1 m tall, 4 mm wide at base, glabrous to pilose to bbb-setulose. Nodes bearded. Sheaths 11–13 cm long, ciliate and bbb-setulose. Auricles absent. Ligule 1.5 mm long. Blades linear-lanceolate, 30–45 by 1.4–5.2 cm, bbb-setulose and pilose, base attenuate, 7–11-nerved on each side of the midrib. Spatheole sheath 1.3–4 cm long, auricles absent, ligule 0.5–1 mm long, blades absent to up to 4.6 mm long. Racemes 3–5 cm long, at base with 1–3 female spikelets, distally with 3–7 pairs of male spikelets. Joints 3–6 mm long, pilose. *Female part*: sessile spikelets lower glume flattened botuliform, sometimes slightly constricted in the lower third, 7–9 mm long, smooth, setose, keeled, keels not overlapping the joint, apex extended upwards, 3-lobed; upper glume coriaceous, ovate-elliptic, 6.5–7 mm long, 9–13-nerved. First lemma ovate-elliptic, 6.5–8 mm long, 7- or 8-nerved, anastomosing. Second lemma ovate-oblong, 4–5 mm long, 1-nerved; palea ovate-lanceolate, 2–4 mm long. Fruit 4–5.5 by 2–3 mm. Stipe pilose. Pedicelled spikelets ovate-linear-lanceolate, 5–8.5 mm long, margins smooth. *Male part*: sessile spikelets lower glume

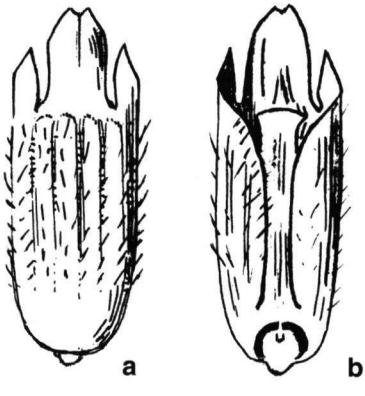

Fig. 12. *Trilobachne cookei* (Stapf) M. Schenck ex Henrard. Sessile spikelet. a. Abaxial view; b. adaxial view (*Stocks, Law, etc. s.n.* (type)).

ovate-oblong to -lanceolate, c. 8 mm long, muticous, ciliolate, c. 18-nerved, anastomosing; upper glume c. 7 mm long, 11-nerved. First lemma ovate-oblong, c. 7 mm long, 5-nerved, anastomosing; palea ovate-oblong, c. 5.5 mm long, lower part keeled, 4-nerved. Second lemma c. 3.5 mm long, 1-nerved; palea c. 3.5 mm long. Pedicelled spikelets lower glume symmetric, ovate-lanceolate, c. 8.5 mm long, not keeled, apex attenuate, ciliate, 13-nerved, not anastomosing; upper glume ovate-oblong, c. 6.5 mm long, not keeled, 11-nerved. First lemma and palea ovate-oblong to -lanceolate; lemma c. 6.5 mm long, 5-nerved, anastomosing; palea c. 5.5 mm long, lower part keeled, 4-nerved. Second lemma and palea ovate-lanceolate, c. 3.5 mm long; lemma 1-nerved.

Distribution — W India (Gujarat, Karnataka, Maharashtra, Kerala).

Habitat — Near water, on slopes, in forest, 600–1200 m altitude.

Collector's notes — None recorded.

Chromosome number — 2n = 20.

Notes — The description given above is based on only three badly annotated collections, and the species obviously is more variable (see for another description Salunkhe, 2000). It is reportedly annual (Salunkhe, Stapf), but no bases were available to verify this.

Salunkhe suggested that it is suffering from "natural extinction" because of its "highly asymmetrical karyotype ... dwindling and detoriating", but its demise seems more likely to the reduction of the populations as he also noted.

EXCLUDED SPECIES

1. *Chionachne sclerachne* F.M. Bailey (1891) 21. — *Polytoca sclerachne* F.M. Bailey (1902) 1849. — *Cleistochloa sclerachne* C.E. Hubb. (1933) t. 3209, p. 3. — Type: *Gulliver s.n. A° 1886* (holo BRI; fragm K), Australia, Queensland, Cape York Peninsula, Lloyd bay, April 1886 = **Cleistochloa sclerachne** (F.M. Bailey) C.E. Hubb.

ACKNOWLEDGEMENTS

This study was made by T.A. Jannink at the Nationaal Herbarium Nederland, Universiteit Leiden branch (L) as part of the requirements for a Master's degree. Dr. J.F. Veldkamp supervised the research and prepared the final version of the manuscript. Most observations have been based on the material present at L. The Keepers of A, AAU, B, BM, BRI, C, CANB, G, K, NSW, NY, P, U, UPS, US, WAG, and ZT are much thanked for sending additional material on loan. The collections in A, BRI, MO, NSW, NY, SING, SINU, and US were checked by JFV during brief visits. Dr. S.A. Renvoize (K) kindly provided some essential nomenclatural literature.

The compilation and subsequent analysis of the data was greatly facilitated by the DELTA and affiliated programs: TAXASOFT (by E.J. Gouda, Utrecht) for the general management of the data, INTKEY (Watson & Dallwitz, 1998) for the analyses, and DEDIT, KCONI, and KPRINT (Pankhurst, 1995) for the construction of the keys.

REFERENCES

Aitchison, J.E.T. 1869. A catalogue of the plants of the Punjab and Sindh: 157. Taylor & Francis, London.

Anonymous. 1992. Wealth of India, rev. ed. 3: 475. Publications & Information Directorate, CSIR, New Delhi.

Backer, C.A. 1928. Handboek voor de flora van Java 2: 30–32. Ruygrok & Co., Batavia.
Backer, C.A. 1950. In: K. Heyne, De nuttige planten van Indonesië: 149–150. Van Hoeve, 's-Gravenhage/Bandung.
Bailey, F.M. 1891. Contributions to the flora of Queensland. Queensland Dept. Agric. Bull. 7: 21.
Bailey, F.M. 1902. The Queensland Flora 6: 1849. Diddams & Co., Brisbane.
Balansa, B. 1890. Catalogue des Graminées de l'Indo-Chine française. J. Bot. (Morot) 4: 78.
Bennett, J.J. 1838, see Brown (1838).
Bentham, G. 1878. Flora australiensis 7: 515–516. Reeve & Co., London.
Bentham, G. 1881. Notes on Gramineae. J. Linn. Soc., Bot. 19: 52.
Bentham, G. 1883. In: G. Bentham & J.D. Hooker, Genera plantarum ... 3, 2: 1113. Reeve & Co., Williams & Norgate, London.
Beumée, J.G.B. 1927. Eenige vormen van elaiosomen aan zaden van tropische planten. Handl. 4e Congr. Ned.-Indië Nat. Wet.: 417–420.
Bor, N.L. 1940. Flora of Assam 5: 455–459. Prabasi Press, Calcutta.
Bor, N.L. 1960. The grasses of Burma, Ceylon, India and Pakistan. Internat. Ser. Monogr. Pure & Appl. Biol., Biol. 1: 264, 267.
Brown, R. 1838. In: J.J. Bennett & R. Brown, Plantae javanicae rariores ...: 15–22. Allen, London.
Camus, A.A. 1922. Graminées. In: P.H. Lecomte, Flore générale de l'Indo-Chine 7: 225. Masson, Paris.
Chen, S.-L. 1997. In: S.-L. Chen (ed.), Flora Reipublicae popularis sinicae 10, 2: 284, t. 71, f. 8–10. Science Press, Beijing.
Christopher, J. 1986. Karyomorphological studies on members of the tribe Andropogoneae; subtribe Rottboelliinae. Cytologia 51: 43–50.
Clayton, W.D. 1973. The awnless genera of Andropogoneae. Studies in the Gramineae 23. Kew Bull. 28: 53–55.
Clayton, W.D. 1981. Notes on the tribe Andropogoneae (Gramineae). Kew Bull. 35: 813–814.
Clayton, W.D. & S.A. Renvoize. 1986. Genera graminum. Kew Bull. Add. Ser. 13: 328, 371–372.
Connor, H. 1987. Reproductive biology in grasses. In: T.R. Soderstrom, K.W. Hilu, C.S. Campbell & M.E. Barkworth (eds.), Grass systematics and evolution: 125. Smithsonian Institution Press, Washington, London.
Cope, T.A. 1982. Gramineae. In: E. Nasir & S.I. Ali, Flora of Pakistan 143: 351. Department of Botany, University of Karachi, Karachi.
Craib, W.G. 1912. Contributions to the flora of Siam. Monocotyledones. Bull. Misc. Inform. 1912: 429.
Davidse, G. 1984. A new species of Rhytachne (Poaceae: Andropogoneae) from northern South America. Brittonia 36: 402–405.
Druce, G.C. 1917. Nomenclatural notes: chiefly African and Australian. Bot. Soc. Exch. Club Brit. Isles Rep. 1916: 641.
Duthie, J.F. 1883. A list of the grasses of North-Western India, indigenous and cultivated: 11. Thomason Civil Engineering College Press, Roorkee.
Esen, A. & K.W. Hilu. 1993. Prolamin and immunological studies in the Poaceae. IV. Subfamily Panicoideae. Canad. J. Bot. 71: 315–322.
Fischer, C.E.C. 1934. In: J.S. Gamble, Flora of the Presidency of Madras 3: 1706. West Newman & Co., Adlard & Son, London.
Gardner, C.A. 1952. Flora of western Australia 1, 1. Gramineae: 357. Wyatt, Perth.
Gould, F.W. 1994. Chionachne. In: M.S. Dassanayake, F.R. Fosberg & W.D. Clayton (eds.), A revised handbook of the flora of Ceylon 8: 111. Amerind Publishing Co., New Delhi.
Hackel, E. 1889. Andropogoneae. In: A. de Candolle, Monogr. Phan. 6: 1–716. Masson, Paris.
Hackel, E. 1906. Notes on Philippine Gramineae, II. Philipp. J. Sci. 1, Suppl. 4: 263.
Hacker, J.B., V. Phimphachanhvongsod, S. Novaha, P. Kordravang, J.F. Veldkamp & B.K. Simon. 1998. A guide to the grasses of Xieng Khouang Province, Lao PDR and some notes on ecology of grazing lands in the province. Genet. Res. Comm. 28: 21, t. 4C.
Hacker, J.B., B.K. Simon & V. Phengvichith. 1996. The pek savannas of the Lao People's Democratic Republic – ecology and floristics. Genet. Res. Comm. 23: 11, t. 2C.

Henrard, J.T. 1931. A contribution to the knowledge of the Indian Maydeae. Meded. Rijks-Herb. 67: 1–21.
Henrard, J.T. 1938. On a new Chionachne from Queensland. Blumea 3: 159–163.
Henrard, J.T. 1939. On a new species of Polytoca from Java. Blumea 3: 238–242.
Hilu, K.W. & K. Wright. 1982. Systematics of Gramineae: a cluster analysis study. Taxon 31: 9–36.
Hô, P.-H. 1993. Câyco Viêtnam 3, 2: 909, fig. Hô. Montreal.
Hubbard, C.E. 1933. Cleistochloa subjuncea C.E. Hubbard. Gramineae. Tribe Paniceae. In: Hooker's Icon. Pl.: t. 3209, p. 3.
Jacques-Félix, H. 1962. Les Graminées d'Afrique tropicale. 1. Bull. Sci. Inst. Rech. Agron. Trop. 8: 104.
Jacquin, J.F. 1820. Eclogae plantarum rariorum 3: 64, t. 40. Strauß & Sommer, Vienna.
Kellogg, E.A. & J.A. Birchler. 1993. Linking phylogeny and genetics: Zea mays as a tool for phylogenetic studies. Syst. Biol. 42: 415–439.
Kellogg, E.A. & L. Watson. 1993. Phylogenetic studies of a large data set. I. Bambusoideae, Andropogonodae, and Pooideae (Gramineae). Bot. Rev. 59: 273–343.
König, J. 1788. Botanische Bermerkungen aus Briefen des sel. Herrn D. Joh. Gerh. König. Naturforscher (Halle) 23: 211.
Koorders, S.H. 1911. Exkursionsflora von Java 1: 99. Fischer, Jena.
Lamarck, J.B.A.P. Monnet de. 1791. Encyclopédie méthodique. Botanique 3: 422. Panckoucke, Paris; Plomteux, Liège.
Linné, C. 1782. Supplementum plantarum: 434. Orphanotroph. Braunschweig.
Matthew, K.M. 1983. The flora of the Tamilnadu Carnatic 2: 1819. Rapinat Herbarium, Tiruchirapalli.
Möbius, M. 1927. Heinrich Schenck. Ber. Deutsch. Bot. Ges. 45: (89)–(101).
Moulik, S. 1997. The grasses and bamboos of India 1: 177. Scientific Publishers, Jodhpur.
Mueller, F. 1873. Fragmenta phytographiae Australiae 8: 116. J. Ferres. Melbourne.
Mueller, F. 1885. Descriptive notes on Papuan Plants 6: 20. Melbourne.
Müller (Halle), J.K.A. 1861. De graminibus novis vel minus cognitis. Bot. Zeitung (Berlin) 19: 334.
Nirodi, N. 1955. Studies of Asiatic relatives of maize. Ann. Missouri Bot. Gard. 42: 103–130.
Noltie, H.J. 2000. The grasses of Bhutan. Flora of Bhutan 3, 2: 837–838. Royal Botanic Garden Edinburgh, Royal Government of Bhutan.
Pilger, R. 1954. Das System der Gramineae (excl. Bambusoideae). Bot. Jahrb. Syst. 76: 281–384.
Roxburgh, W. 1814. Hortus benghalensis ...: 66. Mission Press, Serampore.
Roxburgh, W. 1832. Flora indica, ed. 2, 3: 569–572. Thacker & Co., Calcutta; Parbury et al., London.
Salunkhe, C.B. 2000. Endemic grass genera of Maharashtra State, Peninsular India. In: S.W.L. Jacobs & J. Everett, Grasses: systematics and evolution: 378–380, t. 8. CSIRO Publishing, Collingwood.
Santos, J.V. 1986. Philippine grasses. In: R.M. Umali et al., Guide to Philippine flora and fauna 4: 64, t. 12. Natural Resources Management Center, University of the Philippines.
Schenck, M. 1907. Ueber die sog. Hüllspelzen von Hordeum und Elymus. Bot. Jahrb. Syst. 40: 97–113.
Schmid, M. 1958. Flore agrostologique de l'Indochine. Agron. Trop. (Nogent-sur-Marne) 13: 149.
Shukla, U. 1996. Grasses of North-Eastern India: 295. Scientific Publishers, Jodhpur.
Simon, B.K. 1993. A key to Australian grasses, ed. 2: 84. Department of Primary Industries, Brisbane.
Simon, B.K. & P. Latz. 1994. A key to the grasses of the Northern Territory, Australia. N. Terr. Bot. Bull. 17: 24.
Sprengel, C.P.J. 1824. Systema vegetabilium, ed. 16, 1: 239. Dieterich, Göttingen.
Stafleu, F.A. & R.S. Cowan. 1985. Taxonomic literature, ed. 2, 5: 130–133. Bohn, Scheltema & Holkema, Utrecht/Antwerpen; Junk, The Hague, Boston.
Stapf, O. 1894. Polytoca cookei, Stapf. Gramineae. Tribe Maydeae. In: Hooker's Icon. Pl.: t. 2333.

Stapf, O. 1896. Polytoca. In: J.D. Hooker, Flora of British India 7: 100–102. Reeve & Co., London.
Stapf, O. 1897. Errata. In: J.D. Hooker, Flora of British India 7: 421. Reeve & Co., London.
Steudel, E.G. 1854. Synopsis plantarum glumacearum. Pars I. Gramineae: 403. Metzler, Stuttgart.
Thwaites, G.H.K. 1864. Enumeratio plantarum Zeylaniae ...: 357. Dalau & Co., London.
Vegetti, A.C. 1993. Tipología de la sinflorescencia en Hemarthria altissima (Andropogoneae, Poaceae). Parodiana 8: 69–75.
Veldkamp, J.F., R. de Koning & M.S.M. Sosef. 1986. Generic delimitation of Rottboellia and related genera (Gramineae). Blumea 31: 281–307.
Wallich, N. 1848. A numerical list of dried specimens ...: 8628, 8629-A. London.
Watson, L. & M.J. Dallwitz. 1992. Grass genera of the world: 38, 219–220, 735–736, 818–819. C.A.B. International, Wallingford.
Watson, L. & M.J. Dallwitz. 1998. DELTA grass file, vs. 3.14.
Willdenow, C.L. 1805–1806. Species plantarum, ed. 4, 4: 203. Nauk, Berlin.

INDEX TO COLLECTIONS

bia = *Chionachne biaurita* Hack.
coo = *Trilobachne cookei* (Stapf) M. Schenck ex Henrard
cya = *Chionachne cyathopoda* (F. Muell.) Benth.
dig = *Polytoca digitata* (L.f.) Druce
gig = *Chionachne gigantea* (J. König) Veldk.
hub = *Chionachne hubbardiana* Henrard
jav = *Chionachne javanica* (Henrard) Clayton
mac = *Chionachne macrophylla* (Benth.) Clayton
mas = *Chionachne massiei* Balansa
pun = *Chionachne punctata* (R.Br.) Jannink
sem = *Chionachne semiteres* (Stapf) Henrard
wal = *Cyathorhachis wallichiana* Nees ex Steud.

Aet & Idjan 689: mac — d'Alleizette Feb. 1908: mas; March 1908: mas; July 1908: dig; May 1909: gig; 390: mas; 7992: dig; 7993: gig.

Backer 903: dig; 11761: dig; 19082: dig; 19906: dig; 20957: pun; 24198: pun; 24244: pun; 27633: pun; 30071: pun; 36799 (T): jav; 37128: pun — Balansa 2 Aug. 1885: dig; Nov. 1886 (T): mas; 312: mas; 509: dig; 1785: dig; 4535: mas; 4556: mas; 4764: mas; 4919: gig; 4950: dig — Beauglehole 26 July 1966: cya — Beguin A° 1918: dig; 1383: mac — Belcher 720: gig — Bennett 9 June 1938: gig; 1 Nov. 1939: gig — Betche 178: mac — Blake 6311: cya; 8342: cya; 9217: cya; 10219: cya; 11432: hub; 11550: hub; 17692: hub; 17848: hub; 19954: gig — Bon 4039: dig — Bor A° 1939–1940: gig; 2634: mac; 16198: dig; 18106: gig — Bourne 3242: gig — Bradtke 5: mac — Brass 1203: mac; 2629: mac; 3617: mac; 5485: mac; 21746: mac; 23913: mac; 24424: mac; 25600: mac; 26011: mac; 27342: mac; 28066: mac; 28582: mac — Bremekamp 13 May 1917: pun — Brousemiche 312: mas — L.S. Brown w/40: mac — R. Brown April 1803: pun — BS series 4282 (Merrill) (T): bia; 10887 (Merrill): dig; 38484 (Ramos & Edaño): dig; 39226 (Ramos & Edaño): dig; 41267 (Ramos): dig; 42882 (Ramos): dig; 84859 (Ramos & Edaño): dig — BSIP series 135 (White): mac; 15513 (Hansell): mac — Bullock 752: gig — Burbidge 5772: hub — Burcham 70: mac; 126: mac — Burton G-50: mac.

Campbell 6: mac — Carr 11344: mac; 11573: mac; 14646: mac — Caum 9 May 1939: mac — CCC 7795 (McClure): dig — Chalmers A° 1880 (T): cya — Ching 6490: dig; 7350: dig — Clarke 7992: dig; 19251-A: dig; 19251-E, -F: dig; 24935-A: gig; 26727-B: dig; 31737-A: dig; 33997-D: gig; 34499-D: gig; 36578-B: dig; 40040-A, -B: dig; 40111-A, -D: dig; 40253: dig; 42115-B: gig; 44700-A: dig; 44700-G: dig — Clarkson & Simon 7209: cya — Clayton 5228: gig; 5799: gig — Clemens 4 Jan. 1928: bia; 10552A: mac; 17753: bia; 41608: mac — Coert 528: dig — Colani 29 Nov. 1926: dig — CP 3137 (Thwaites): gig — Craven & Schodde 528: mac — Cruttwell 1604: mac.

De Wilde & Vervoort 412: mac — DeKalb 5 Feb. 1943: cya; 23 May 1943: mac — Dissing 2634: mac — Dissing et al. 1920: mac — Docters van Leeuwen 11368: mac — Dorgelo 743: pun; in Herb. Jansen & Wachter 35742: pun — Drummond 21061: gig — Dupuy 282: mas — Durack April 1916: hub — Duthie 6146: gig; 8487: gig; 10020: gig.

Elmer 11026: dig — Eyma 437: dig.

Farinas 111: dig — FB 31502 (Franco): dig — Feilberg Oct. 1868: gig — Fimnon 32: dig — Flecker 31 March 1945: cya — Franck 90: dig.

Gaag 69: dig — Gallatly 38: wal — Gamble 28076: dig — Geesink et al. 7103: dig — Gjellerup 382: mac — Godefroy 591: dig — Gouv. Veearts 10: pun — Grassl 71: mac — Gressitt 927: dig — Griffith KD 6777: wal — Grutterink 3191a: dig.

Hacker 1399: dig; 1400: dig — Haines 3663: gig; 3665: gig; 3666: gig — Hawthorn June 1919: cya — Hayata 793: dig — Herre 198: mac — Heyligers 1581: mac — Hitchcock 18751: dig; 19035: dig; 19483: mas — Hochreutiner 2239: dig — Höft 3079: mac; 3080: mac — Hoogland 3365: mac — Hooker & Thomson 1932: dig; 2356: gig — Horsfield 113 (T): dig — Houwing 585: pun — Hugar 2660: gig — Huk 25 Aug. 1890: wal.

Iserentant 9377: mac.

Jaag 993: jav — Jacobs 359: cya; 1341: cya; 1556: cya; 7180: cya — Jacquemont 706 (T): coo; 1295: gig — Jeswiet 181: mac; 216: pun; 632: pun; 1949: pun; in Herb. Jansen & Wachter 43721: mac — Johns 7840: mac.

Kajewski 1989: mac — Kerr 1437: dig; 1694: mas; 2157: wal; 2219: dig; 2226: dig; 6350: dig; 9784: dig; 13771: dig; 19605: dig; 19696: wal — Kievits 1789: pun; 2736: pun — King 1080: dig — Kingdon-Ward 22626: dig — Koelz 19389: gig; 22664: dig; 26284: gig; 26421: dig — Koorders 35291: pun — Kostermans 1223: wal; 2714: mac — Kradenau 3404: dig — Kratzing & Ollerenshaw 1334: cya — Kuntze 9 Nov. 1875: gig — Kurz 1036: wal; 1136: dig; 2795: wal.

LAE series 50198n (Stevens): mac; 58614 (Stevens & Lelean): mac — Larsen 5931: mas; 8106: mas; 8559: wal; 9524: wal — Larsen et al. 2020: dig; 2747: wal; 31645: dig — Lauterbach 990: mac — Lazarides 3710: cya; 4454: hub; 7339: gig — Le Guillou 62: mac — Lemann A° 1845: gig — Levine 1571: dig; 10249: dig — Lichy 2 Sept. 1930: dig — LU series 15973 (Tsang Wai Tak 474): dig; 17154 (Tsang Wai Tak 405): dig.

MacGillivray 460 (T): mac — Maxwell 86-920: dig; 87-1171: dig; 91-79: dig; 93-1076: wal — McCann 4340: coo — McCarthy 44/33: cya — McClelland 9 Jan. 1854: wal — McClure 7795: dig — McKee 1623: mac — McKerral A 37: wal — McMillen 36: gig — Mohan RHT 11298: gig — Mokim 304: wal; 306: wal; 895: wal; 1457: gig; 1474: gig — Monod de Froideville 1458: pun — Mooney 187: gig — F. von Mueller Dec. 1855 (T): cya — Munro A° 1852: gig.

Nedi 221: pun — NGF series 3483 (Floyd): mac; 3946 (Fryar): mac — Nguyen Van Khiem 11 June 1971: dig — NSW series 49344 (Schoeffe): cya; 54836 (Beauglehole): cya; 152969 (Vickery): cya; 152971 (Beauglehole): cya.

Panigrahi & Arora 6793: gig — Parkinson 15064: wal — Perry 1020: cya; 2176: cya — Pételot July 1920: mas; 10: mas; 45: dig; 634: dig — Peterham 34: mac — Phengkhlai & Van Beusekom 1136: dig — Phloenchit 888: dig — Phuakam 83: dig — Pierre Sept. 1864: gig — PNH series 36220 (Sulit): pun — Polunin et al. 5870: gig — Proppe April 1922: pun — Pullen 614: mac; 994: mac; 5615: mac.

Rao 18540: gig? — Rappard 9-I: hub; 34: pun; 35: hub — Reeder 842: mac — Reynaud Dec. 1827–Jan. 1828: wal — Richards 1444: mac — Robbins 1304: mac; 2192: mac; 2212: mac; 2306: mac — Rottler 78: gig — RSS series 2675 (Hunt): mac — Russell 23 May 1942: mac.

Santapau 19666: gig; 20044: gig — Santos 4937: dig; 4987: dig; 6012: dig; 6551: dig; 6585: dig; 7659: dig; 7769: dig; 8188: bia — Saunders 69: mac — Schmutz 6747: jav; 7347: jav — Schoeffe June 1936: cya — Schröter 15 July 1927: pun — Sethe & Nege 25711: gig — Shah 660: gig — Sharam March 1986: cya — Shimizu et al. T-17895: mas — Simon 3369: cya — Simond 14 Feb. 1911: mas — Singh 6: gig — Smith NG-78 May 1944: mac; T-90: cya — Smitinand 3883: mas; 3954: dig — Smitinand & Ding Hou 10042: mas — Sørensen et al. 2281: dig; 2312: dig; 4724: dig; 5414: dig — Sri Ram 4 Oct. 1920: gig; 3 Nov. 1920: gig — Steel 8: mac — Stocks, Law, etc. A° 1861 (T): coo.

Takur 1596: dig — Thomson Oct. 1846: gig; Dec. 1846: gig; 1861: gig — Thorel 2529: mas — Thorogood Jan. 1936: cya — W.T. Tsang 405: dig; 474: dig — Tso 22225: dig.
UPNG series 180 (Pulsford): mac; 2089 (Frodin): mac — U Thein Lwin 285: wal; 636: gig — U Tiu 3302: sem.
Van Beusekom & Geesink 3581: wal — Van der Pijl 677: dig — Van Leeuwen GE-1: mac; KAB-1a: mac — Van Steenis 7533: dig; 17897: bia — Vanoverbergh 934 : bia — Vickery 15 May 1955: cya.
Wallich Cat. 8626A (T): gig; 8627A (T): dig; 8628 (T): sem; 8629A (T): wal; 8629B: wal — Walsh Green Ser. 49: pun — Wandama 38: mac — Weatherwax A° 1940: gig; 67: mas; 68: pun; 2964: mas — Wenger 354: wal — White 182: mac; 493: mac; 3387: cya; 12123: cya — Widjaja & Hamzah 2971: mac — Widjaja & Partomihardjo 6716: mac — Wight Herb. 213: gig; 3318: sem — Williams 2616: dig; 3028: dig — Winters & Higgins 323: mac — Wisner 98: gig — Wyne 71: cya.
Young 21 Nov. 1881: gig.

INDEX TO NAMES

The accepted names are in roman type, the synonyms in *italic* and the new names in **bold**. The abbreviation after each name refer to the abbreviated species as given in the list below. The excluded taxon is indicated by (excl.)

bia = *Chionachne biaurita* Hack.
coo = *Trilobachne cookei* (Stapf) M. Schenck ex Henrard
cya = *Chionachne cyathopoda* (F. Muell.) Benth.
dig = *Polytoca digitata* (L.f.) Druce
gig = *Chionachne gigantea* (J. König) Veldk.
hub = *Chionachne hubbardiana* Henrard
jav = *Chionachne javanica* (Henrard) Clayton
mac = *Chionachne macrophylla* (Benth.) Clayton
mas = *Chionachne massiei* Balansa
pun = *Chionachne punctata* (R.Br.) Jannink
sem = *Chionachne semiteres* (Hook.f.) Henrard
wal = *Cyathorhachis wallichiana* Nees ex Steud.
excl. = Excluded taxon