

Spikelet Morphology of Cyperaceae and its Taxonomic Implication

Morfologi Spikelet Cyperaceae dan Implikasi Taksonomi

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Abstract

A morphological study of 13 species of sedge (Cyperaceae) was conducted in selected areas of Perak. The research objective was to determine the diagnostic morphological characters of spikelet that could be used for species identification. Samples were collected from three different ecological areas including open areas, wetlands, and limestone representing northern, middle and southern parts of Perak. A taxonomic key for the species based on spikelet characters was successfully constructed. The diagnostic characters of spikelet structure were proven to be taxonomically significant and hence confirmed useful for species identification, and supported previous classifications.

Keywords cyperaceae, spikelet, morphology, taxonomic key

Abstrak

Kajian morfologi ke atas 13 spesies rusiga (Cyperaceae) telah dijalankan di kawasan terpilih di Perak. Objektif kajian adalah untuk mengenal pasti ciri-ciri morfologi diagnostik pada spikelet untuk pengecaman spesies. Pengumpulan sampel dilakukan di tiga kawasan ekologi yang berbeza termasuk kawasan terbuka, tanah becah dan batu kapur yang mewakili bahagian utara, tengah, dan selatan Perak. Sebuah kekunci taksonomi untuk spesies berdasarkan ciri-ciri spikelet telah berjaya dibina. Ciri-ciri diagnostik spikelet terbukti mempunyai nilai taksonomi yang signifikan dan maka dengan itu telah disahkan berguna untuk pengecaman spesies dan menyokong pengelasan terdahulu.

Kata kunci cyperaceae, spikelet, morfologi, kekunci taksonomi

INTRODUCTION

Cyperaceae Juss., commonly referred to as sedge is the third largest family of the monocotyledons, which comprises approximately 5,000 species in about 104 genera (Goetghebeur, 1998). Cyperaceae are well resided in temperate, sub-arctic, and especially tropical regions worldwide from the sea-level to over 5000 m. The family has several very large cosmopolitan genera including *Carex* L. (ca.2000 spp.) and *Cyperus* L. (ca.600 spp.) (Goetghebeur, 1998). Typically being one of the largest families in most floristic

treatments, it is probably the seventh largest worldwide (Reznicek, 2009). Henderson (1974) reported 24 genera and about 154 species recorded from Peninsular Malaysia, many of them are very common weeds of rice-fields and other wet lands. While Turner (1995) had recorded 176 species within 29 genera of Cyperaceae mostly widespread in Peninsular Malaysia.

There has been no comprehensive study of Cyperaceae of Peninsular Malaysia since Ridley in 1925. Turner had listed the genera and species but a comprehensive study of the taxonomy and morphology of Cyperaceae was not conducted. Yet, not much taxonomic research on Cyperaceae has been carried out in Malaysia. The current revision is very important to record the status of sedges in Peninsular Malaysia. Study on molecular aspects on this family by Muasya et al. (2008) had not solved the problem and classification of this family is uncertain. Members in this family shown reduced flowers and complicated patterns of morphological variation make the identification vastly challenging (Naczi, 2008). As a result, many have avoided studying Cyperaceae. Hence, the urgent need to recognize the species diversity in Malaysia especially those important in agriculture.

The spikelet as the basic inflorescence unit in Cyperaceae together with other evidences form the basis for classification within the family (Archer, 2000). The most important feature is the interpretation of the structure of the spikelet and the role of the prophyll (Kern, 1974). Because of the minute size of spikelets and the inflorescence complexity, species interpretation becomes difficult and controversial over recognition of subfamilies, tribes and genera (Archer, 2000). Most novice cyperologists must first familiarize with the myriad of inflorescence and spikelet arrangement of the families in order to use the diagnostic keys, for accurate species identification. This task is complicated by the extremely contracted inflorescences and reduced floral parts. The family, though well defined, comprises many taxonomically challenging taxa.

This research had focused on morphological studies of spikelets of Cyperaceae in selected areas of Perak. The goal was to review and to diagnose the significance of spikelet structure as the most appropriate and applicable morphological characteristic in species identification of Cyperaceae.

MATERIAL AND METHODS

The spikelets of 13 species from three representative genera of Cyperaceae (*Bulbostylis*, *Cyperus* and *Fimbristylis*) were included in this study. Sampling was aimed to include multiple species within each genus as in the *Cyperus* to represent a wide range of morphological and geographical diversity. Samples were purposely selected from four areas in the state of Perak, namely Tanjong Malim, Ipoh, Kuala Kangsar, and Gerik, representing different ecological surrounding including open land, wetland, and limestone hills. Studies on the spikelets were strictly concentrated on the size, structure and presence of appendages such as trichomes, glands, wings using light microscopy. Details of the spikelet were illustrated using technical pen (sizes 0.2 – 0.5 mm, Faber-Castell).

RESULTS AND DISCUSSION

The spikelet structures showed taxonomic values (Figure 1) that helped to distinguish and delimit the species of sedges. From the spikelet's unique characteristics, the key of spikelets was successfully constructed. The character of spikelet for all genera and species was distinct and could be seen with the naked eye. Many researches supported that the morphology of spikelets is the best diagnostic characters (Koyama, 1961; Eiten, 1976; Dahlgren et al., 1985; Tucker, 1987; Bruhl, 1995; Goetghebeur, 1998).

The rachilla that influenced the spikelets structures produced a few to many flowers arranged along its axis that made the spikelet varied. Yet, there is no record that focused on the variation in the rachilla structure.

The results showed that spikelet diameter ranged in size from tiny plants less than 1.0 mm found in a number of species such as *Bulbostylis barbata*, *C. digitatus*, *C. iria*, *C. kyllingia*, *C. pulcherimus* and *F. miliacea* to the largest spikelets which could attain a diameter of 4.0 mm such as *C. distans*. The number of flowering nodes per module and the number of peduncles and spikes per node were also important in identifying the species. Spikelets were arranged into inflorescences of variable sizes and forms from small, tight heads to panicles, the usual form of the inflorescence to panicles as long as one metres or more could be found in some species of Cyperaceae. Leaflike bracts often underlied the major branches of the inflorescences. Many current classifications for the family used models of spikelet structure established by Eiten (1976), yet Eiten provided only a general typology of the ultimate inflorescence units found throughout the family and did not present evidence for the conclusions made other than a few verbal description of mature anatomy and illustration of dissection of mature spikelets. Thus, the present results obtained using spikelet structures agrees with Eiten (1976).

In this study, from the thirteen species examined, the spikelets of Cyperaceae were divided into two groups, namely short spikes (*Cyperus kyllingia*, *Fimbristylis dichotoma* and *F. miliacea*) and long spikes (*Bulbostylis barbata*, *Cyperus compressus*, *C. compactus*, *C. digitatus*, *C. distans*, *C. iria*, *C. pulcherrimus*, *C. pilosus*, *C. rotundus* and *C. sphacelatus*) (Figure 1). *Cyperus rotundus* obvious reddish brown spikelets was easily diagnosed from the other species whose spikelets were not reddish brown in key colour. *Cyperus pilosus* was the only species that have spikes with hairy axis. Other characteristics that could be used as a key is length; *Cyperus digitatus* have very long spikelets, but *Cyperus compactus* have much shorter spikelets, whole *Bulbostylis barbata* was the only species with hairy spikelets.

Figure 1 attempted to show the enormous variations in spikelet and inflorescence structure among the genera studied. The culms, leafy bracts, flowering peduncles, spikes and the arrangements of different sexes in the spike forming unique features of an inflorescence in Cyperaceae conforms to the report by Kukkonen (1984). The inflorescence is composed of one to many spikeletes borne either in a solitary head or variously clustered in panicles, umbels, or spikes similar to that illustrated by Robert (2001). Thus, this study agrees with Robert (2001) and Archer (2000) that the basic unit of sedges inflorescences is the spikelet.

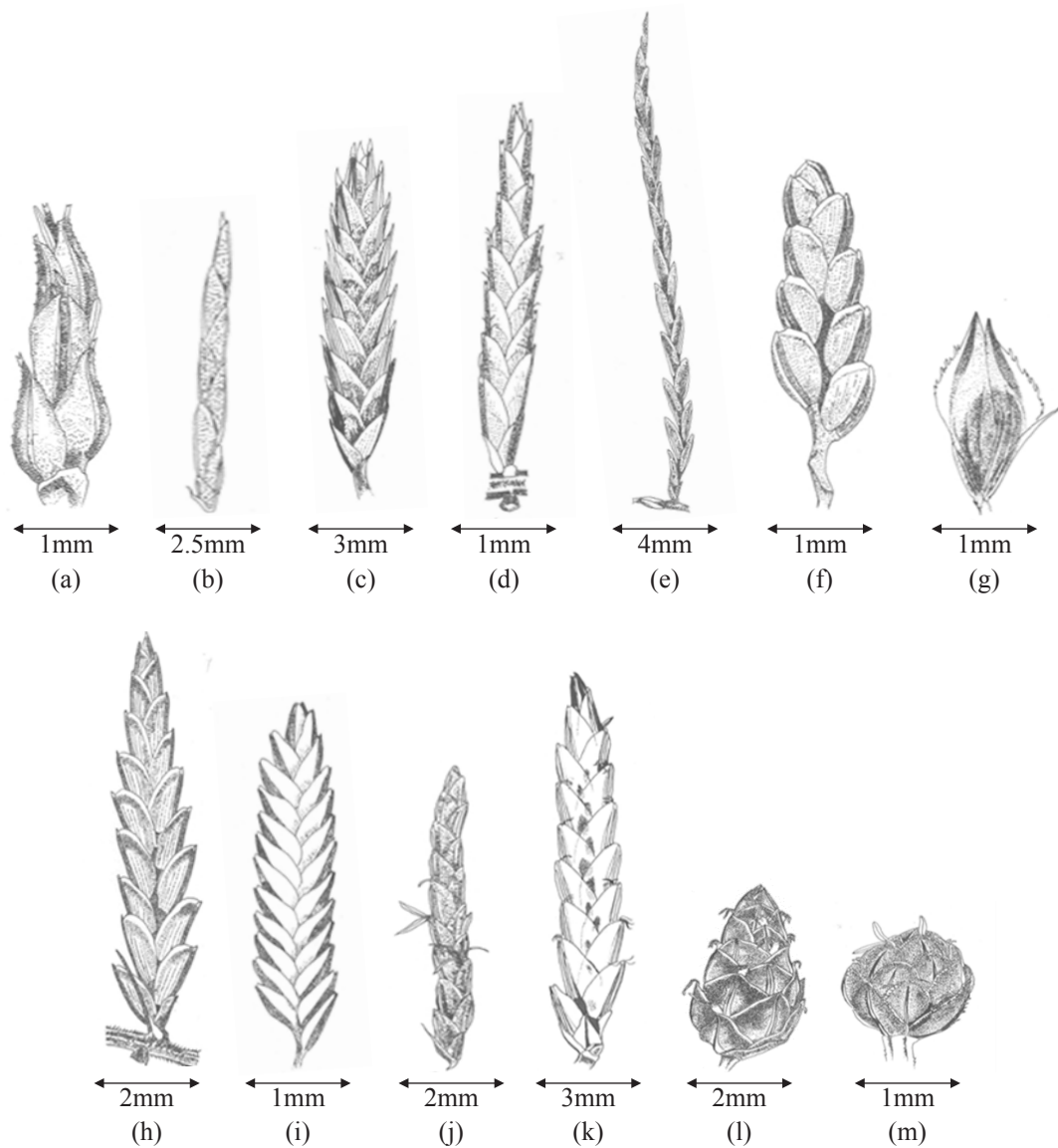


Figure 1 Spikelet structure of (a) *Bulbostylis barbata* (b) *Cyperus compactus* (c) *C. compressus* (d) *C. digitatus* (e) *C. distans* (f) *C. iria* (g) *C. kyllingia* (h) *C. pilosus* (i) *C. pulcherrimus* (j) *C. rotundus* (k) *C. sphacelatus* (l) *Fimbristylis dichotoma* and (m) *F. miliacea*

From the observations, spikelet is the best character to recognize species in Cyperaceae. The use of spikelets in the key constructed had allowed much easier and quicker determination of the species.

A dichotomous key to selected species of Cyperaceae based on spikelet is as follows:

1.	Spikelets in short spikes	2
1’.	Spikelets in long spikes	4
2.	Spikelets in round clusters	<i>Fimbristylis miliacea</i>
2’.	Spikelets not in round clusters	3
3.	Spikelets in single spikes	<i>Cyperus kyllingia</i>
3’.	Spikelets in several spikes	<i>Fimbristylis dichotoma</i>
4.	Spikelets obviously reddish brown	<i>Cyperus rotundus</i>
4’.	Spikelets not reddish brown	5
5.	Spikes axis hairy	<i>Cyperus pilosus</i>
5’.	Spikes axis not hairy	6
6.	Spikelets hairy	<i>Bulbostylis barbata</i>
6’.	Spikelets not hairy	7
7.	Spikelets arranged in a spike on a more or less elongated rachilla	<i>Cyperus digitatus</i>
7’.	Spikelets arranged like fingers or stellate on a very short spike	8
8.	Spikelets very few florets	<i>Cyperus sphacelatus</i>
8’.	Spikelets several to many florets	9
9.	Spikelets densely crowded	<i>Cyperus compactus</i>
9’.	Spikelets not crowded	10
10.	Spikelets rather far apart on the spike and spreading	<i>Cyperus pulcherrimus</i>
10’.	Spikelets rather close together on the spikes and pointing obliquely upward	11
11.	Spikelets longer to about in long	<i>Cyperus compressus</i>
11’.	Spikelets rather small in long	12
12.	Spikelets very narrow	<i>Cyperus distans</i>
12’.	Spikelets broader and shorter	<i>Cyperus iria</i>

CONCLUSION

This study has identified the different spikelet structures among selected species of Cyperaceae. The key to these species had successfully been constructed based on these characters. The spikelets had been proven to be the main diagnostic characters to recognize these species. This work has provided added support to previous classifications of Koyama (1961), Eiten (1976), Dahlgren et al. (1985), Tucker (1987), Bruhl (1995) and Goetghebeur (1998).

ACKNOWLEDGEMENT

The authors wish to acknowledge the sponsorship by the Ministry of Education, Malaysia Scholarship through MyBrain15 and FRGS (Project code 2010-0072-107-02).

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