Taxonomic Study of Cyperaceae V**

by Tetsuo KOYAMA*

§ 12. A new classification of the genus Cladium in a wide meaning.***

The purpose of this article is to divide the genus Cladium (sensu lato) into two natural groups which I have recently recognized to be very distinct from each other by their morphological characters including the pollen grains. The genus Cladium in a wide meaning consisting of nearly fifty species distributed in the tropical, subtropical and warmer regions of the both hemispheres, is not a very homogeneous group of the family Cyperaceae just as the genus Scirpus. Because of its heterogeneousness, up till now, under the category of Cladium sensu lato were created several similar group: Machaerina, Baumea, Vincentia, Chapelliera etc., which were chiefly based upon their external appearances especially on inflorescences and leaves. Some taxonomists including Böckeler, Palla, Stapf and Nees, who created or referred to them, treated all these groups as different genera respectively. Almost all the specialists concerned are, however, of opinion that these groups are attributed to the infrageneric status of the genus Cladium sensu lato; for example, Bentham and Hooker in their Genera plantarum, Vol. 3, regarded Baumea and Vincentia as sections, while C. B. Clarke placed Baumea, Vincentia and Machaerina as the subgenera under the genus Cladium.

In the Japanese floristic region including the Ryukyus and the Bonin Islands occur five species of these groups, one in Cladium (sensu stricto), three in Baumea and one in Machaerina. According to my observations on these five species and a considerable number of the tropical species, Cladium jamaicense, Cladium chinense and Cladium Mariscus, members of Cladium sensu stricto, are quite different from the other species belonging to Baumea, Vincentia and Machaerina in a very distinct character which corresponds to some characters in their vegetative parts. Speaking on the Japanese species, Cladium chinense has achenes almost drupe-like when living and crowned by an inconspicuous somewhat corry stylebase at apex, 3-ranked leaves dorsiventrally compressed, and the corymbose partial inflorescences,

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whereas the others, viz. *Cladium nipponense*, *Cladium brevistigma* and *Cladium boninsimae* have hard achenes terminated by a distinct usually scabrous beak, spike-like or paniculate partial inflorescences and 2-ranked leaves terete or bilaterally compressed and sometimes reduced into bladeless sheaths only. The former characters are only seen in *Cladium* in a broad meaning, while *Baumea*, *Vincentia* and *Machaerina* fall under the latter category. Further, an interesting matter is recently offered me by Miss M. Ikuse who is studying on pollen grains and examined those of the three Japanese species, *Cladium chinense*, *Cladium nipponense* and *Cladium brevistigma* in detail. According to her investigation, the pollen grains of *Cladium* (sensu lato) are highly interesting and those of *Baumea* are so peculiar that she reexamined some other samples from different specimens. As seen in Fig. 6, the pollen grains of *Baumea* are of polyforate type, while those of *Cladium* sensu stricto are of 1-6-aperture type bearing a terminal pore and six sidal ones. Also the differences in somewhat delicate characters of inflorescence and the shape of achene which are of secondary value in the classification of this group are seen among *Machaerina*, *Baumea* and *Vincentia*, that is to say, *Machaerina* is based upon rather inconspicuously 3-angled achenes usually subabruptly narrowed both at apex and at base and paniculate loose inflorescence often large-sized, *Vincentia* is characterized by comparatively sharply 3-angled achenes gradually narrowed to apex, and gradually attenuate below to a stipelike base, and *Baumea* is separated from *Vincentia* mainly by the cuneate to pyramidal base of achenes sometimes crowned by a depressed stylebase and often densely disposed spikelets.

Thus it seems to be reasonable that the genus *Cladium* in a broad meaning is divided into two independent genera, *Cladium* (sensu stricto) and *Machaerina* including *Baumea* and *Vincentia*. The different characters of these two genera are shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Cladium</th>
<th>Machaerina, Vincentia &amp; Baumea</th>
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<tbody>
<tr>
<td>ACHENE</td>
<td>Somewhat drupelike, the</td>
<td>Hard, 3-angled, the apex crowned by a</td>
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<tr>
<td></td>
<td>stylebase almost inconspicuous,</td>
<td>distinct beak usually hispid or sca-</td>
</tr>
<tr>
<td></td>
<td>corky, smooth.</td>
<td>berulous, not corky.</td>
</tr>
</tbody>
</table>
STAMENS: 2. 3 (very rarely 2, but always ?).  
PARTIAL INFLORESCENCES: Corymbose. Slender or conical compound panicle. 
LEAVES: 3-ranked, the blades dor-siventrally compressed, coriaceous, prominently scabrous on margins. 2-ranked, the blades equifacial, terete or bilaterally compressed, smooth-margined or nearly so, rarely wanting. 
POLLEN: 1-6-aperture type. Polyforate type. 
DISTR. AREA: Warmer to temperate reg. Tropical to subtropical regions, dominant in Oceania.

The genus Cladium created in 1756 by P. Brown is appropriate to a group of Twig-rush represented by the left column of the above table in its original sense. The genus Mariscus which was effectively published in 1757 based also on the same group of Twig-rush with Cladium, therefore, it should be reduced to the synonymy of Cladium. Concerning the generic name of the group represented by the right column of the table, Vincentia is frequently adopted because the species belonging to Vincentia are a little more than those of Machaerina. The genus Machaerina, however, was published in precedence of Baumea and Vincentia, and moreover any of these genera has never been proposed for ' nomen conservandum '. Accordingly, it may be said that Machaerina is legitimate under the present Code of Nomenclature, when these three groups are treated as a genus separated from Cladium in a narrow sense.


Cladium chinense Nees, Cladium Mariscus R. Br., Cladium jamaicense Cranz, Cladium leptostachyum Nees et Meyen, Cladium mariscoides Torrey.

Genus Machaerina Vahl, Enum. Plant. 2: 228 (1806); Kunth, Enum. Plant. 2: 313 (1837); Böckeler in Linnaea 38: 251 (1874), emend. T. Koyama.

Genus Cladium (non P. Br.): Benth. et Hook. f. l. c., pro pte.; Engl. et Plantl c., pro pte.; C. B. Clarke l. c., pro pte.; Ohwi l. c., pro pte.

Perennis elata vel mediocris saepe stolonifera, culmo obscure trigono subnudo basi foliis vaginisve obsoito, foliis angustis teretibus vel a latere compressis interdum elaminatis, ligulis haud evolutis, inflorescentia paniculata composita decompositave et aut densa aut laxa, paniculis partialibus spicato- vel vere paniculatis sed non corymbosis multispiculatis, spiculis paucisquamatis, nupe trigona coriacea glabra apice rostro coronata, rostro conicolanceolato vel interdum subdepresso semper plus


10. Machaerina brevipescula (Kukenth.) T. Koyama, comb. nova Cladium brevipescula (Kukenth.) T. Koyama, comb. nova Vincentia brevipescula (Kukenth.) T. Koyama, comb. nova.
12. *Machaerina brevistigma* (Nakai ex Tuyama) T. Koyama, comb. nova


13. *Machaerina complanata* (Bergg.) T. Koyama, comb. nova


15. *Machaerina crassa* (Thw.) T. Koyama, comb. nova


16. *Machaerina crinita* (Stapf) T. Koyama, comb. nova


17. *Machaerina cubensis* (Kükenth.) T. Koyama, comb. nova


18. *Machaerina cyperoides* (Merrill) T. Koyama, comb. nova


19. *Machaerina Deplanchei* (Böcklr.) T. Koyama, comb. nova

*Baumea Deplanchei* Böckeler in *Flora* 61: 143 (1878).

20. *Machaerina dissoluta* (Stapf ex Setchell) T. Koyama, comb. nova


22. *Machaerina Ekmanii* (Kükenth.) T. Koyama, comb. nova


23. *Machaerina ensifolia* (Böcklr.) T. Koyama, comb. nova

*Elynanthus ensifolius* Böckeler in *Linnaea* 38: 264 (1874).


25. *Machaerina ensigera* (Hance) T. Koyama, comb. nova


27. *Machaerina falcata* (Nees) T. Koyama, comb. nova


28. *Machaerina glomerata* (Gaudich.) T. Koyama, comb. nova


29. *Machaerina gracilis* (J. M. Black) T. Koyama, comb. nova

30. Machaerina Huttoni (T. Kirk) T. Koyama, comb. nova

31. Machaerina insularis (Benth.) T. Koyama, comb. nova
   Cladium insularis Bentham, Flor. Austral. 7: 403 (1878).

32. Machaerina iridifolia (Baker) T. Koyama, comb. nova

33. Machaerina iris (Ohwi) Ohwi et T. Koyama, comb. nova

34. Machaerina juncea (R. Br.) T. Koyama, comb. nova

35. Machaerina juncoideis (Elmer) T. Koyama, comb. nova

36. Machaerina latifolia (Merrill) T. Koyama, comb. nova

37. Machaerina latissima (F. v. Müller) T. Koyama, comb. nova

38. Machaerina laxa (Benth.) T. Koyama, comb. nova
   Cladium laxum Bentham, Flor. Austral. 7: 405 (1878).

39. Machaerina macrophylla (Böcklcr.) T. Koyama, comb. nova

40. Machaerina Maingayi (C. B. Clarke) T. Koyama, comb. nova

41. Machaerina Gaudichaudii (W. F. Wight) T. Koyama, comb. nova

42. Machaerina Melleri (Baker) T. Koyama, comb. nova

43. Machaerina micranthes (C. B. Clarke) T. Koyama, comb. nova
   Cladium micranthes C. B. Clarke in Kew Bull. add. ser. 8: 46 (1908).

44. Machaerina Milnei (C. B. Clarke) T. Koyama, comb. nova
   Cladium Milnei C. B. Clarke in Kew Bull. add. ser. 8: 46 (1908).

45. Machaerina monticola (Guillaumin) T. Koyama, comb. nova

46. Machaerina Muelleri (C. B. Clarke) T. Koyama, comb. nova

47. Machaerina monocarpa (J. M. Black) T. Koyama, comb. nova
48. **Machaerina malesiaca** (Stapf) T. Koyama, comb. nova  

49. **Machaerina nipponense** (Ohwi) Ohwi et T. Koyama, comb. nova  

50. **Machaerina nukuhivensis** (Forst) T. Koyama, comb. nova  

51. **Machaerina pantopoda** (Baker) T. Koyama, comb. nova  

52. **Machaerina philippinensis** (Merrill) T. Koyama, comb. nova  

53. **Machaerina ponapensis** (Ohwi) Ohwi et T. Koyama, comb. nova  

54. **Machaerina procerca** (S. T. Blake) T. Koyama, comb. nova  

55. **Machaerina riparia** (Benth.) T. Koyama, comb. nova  
*Cladium riparium* Bentham, Flor. Austral. 7: 405 (1878).

56. **Machaerina Robinsonii** (Merrill) T. Koyama, comb. nova  

57. **Machaerina rubiginosa** (Soland ex Forst) T. Koyama, comb. nova  

58. **Machaerina punctata** (R. Br.) T. Koyama, comb. nova  

59. **Machaerina samoensis** (C. B. Clarke ex Stapf) T. Koyama, comb. nova  

60. **Machaerina schoenoides** (R. Br.) T. Koyama, comb. nova  

61. **Machaerina scirpoidea** (Benth. et Hook. f. ex Hemsl.) T. Koyama, comb. nova  

62. **Machaerina Sinclairii** (Hook. fil.) T. Koyama, comb. nova  
*Cladium Sinclairii* Hook. fil., Handb. N. Zeal. Fl. 304 (1864).

63. **Machaerina pulchra** (Ridley) T. Koyama, comb. nova  

64. **Machaerina sinuata** (Ridley) T. Koyama, comb. nova  

65. **Machaerina stradbrokensis** (Domin) T. Koyama, comb. nova


Perennis. Culmus erectus 5-9 dm altus firmus a latere compressus stramineovires opacus praeter angulos scaberulos laevis striatus infra medium foliatus 3-4-nodosus, internodiis 10-17 cm longis vaginis foliorum fere obsitis. Folia caulina erecta quam inflorescentia paullo breviora vel aequantia, laminis ensiformibus a latere valde compressis 20-45 cm longis 4-5.5 mm latis subcoriaceis glaucoviridibus in sicco laevibus interdum margine sursum scaberulis apice abrupte contractis breviter subacutis basi in vaginas longas culminum subarcte circumdantes compressas vix attenuantibus, ligulis vix productis. Inflorescentia paniculata bis ter composita elata sed sublaxa 40-55 cm longa 3-5 cm lata; paniculæ secundariae plures 10-25 cm longæ ex unica bractæ 1-3-næ contiguae longe exsertæ vel subinclusæ pedunculatae valde ramosæ, pedunculis subcompressæ triquetris laevibus, bracteolis spatheis longiuscule vaginantibus, paniculis tertiaribus linearibus sublaxis plurispiculosis; bracteæ infertiores foliaceae paniculis partialibus suis breviores basi longae vaginatae, superiores in vaginam sursum ampliatam reductæ. Spiculae maturitate ovoideae ellipsoidae 3-4 mm longae 1.5-2 mm in diametro fuscae 3-4-squamatae unifloræ. Squamae imbricatim dispositæ ovatoellipticae vel ellipticae membranaceæ fuscescentes et fuscostrigatae naviculæs sursum hispidoscabrae spicæ subabruptæ angustatae acutæ mucronatae, carina uninnervata; summa vacua 2.5 mm longæ; sequens fertilitis summa paullo grandior; inferiores etiam vacuae eae superiores 2 similes sed paullo angustiores brevioresque dorso fere ex toto hispidæ. Nux ellipsoidæ 2-2.2 mm longæ 1.5 mm in diametro obtuse trigona facie fulvosucina nitida grosse rugosa basi subsessilis; stylodium rostriforme conicolineare cum 1/2-nucæ subaequans ex toto perdense tomentosohispidum alboascens; stylus gracilis longus erectus, stigmatibus 3 recurvis longiusculis papulosis. Stamina 3.


67. Machaerina tenax (Hook, fil.) T. Koyama, comb. nova

68. Machaerina teretifolia (R. Br.) T. Koyama, comb. nova

69. Machaerina tetragona (R. Br.) T. Koyama, comb. nova
Lepidosperma tetragonum R. Br., Prodr. 235 (1810).

70. Machaerina undulata (Thw.) T. Koyama, comb. nova

71. Machaerina vaginalis (Benth.) T. Koyama, comb. nova
Cladium vaginale Bentham in Benth. et Müller, Flor. Austral. 7: 408 (1878).
Summary

1. In this article, the author intended to divide the Genus *Cladium* in a wide meaning into two natural groups, *Cladium* sensu stricto and *Machaerina*, by their morphological characters including the pollen grains.

2. In the former group, leaves are coriaceous, dorsiventrally flattened and always 3-ranked, and achenes are somewhat drupe-like and not crowned by distinct beak at apex, whereas the latter has bilaterally compressed or terete leaves usually 2-ranked and has achenes crowned by a distinct beak often scabrous at tip.

3. This division also very well agrees with the features of pollen grains, which are represented by 1-6-aperturate type in the former and polyforate type in the latter.

4. Concerning the generic name of the latter, Vahl's *Machaerina* is legitimate.

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Studies on the Adaptation of Yeast to Copper XII.
Amino Acid Synthesis as a Copper Resistance Mechanism of a Variant.*

by Yutaka ARAKATSU** and Joji ASHIDA***

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In the preceding paper† culture conditions which favoured the growth and the brown pigmentation of *Saccharomyces ellipsoideus* in copper-containing media were reported, with the conclusion that the predominating copper-resistant substrain, R₁β, can synthesize glutamic acid and aspartic acid from ammonium sulfate even in copper media in which the parent strain cannot. Nitrogen metabolism seems to be important when one considers how yeast cells are injured by copper and how resistant cells can survive the copper injury. Hence some experiments have been made to see the effect of various amino acids on the inhibition of sensitive cells by copper. Here the results are reported.

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