Taxonomic Study of Cyperaceae V**

by Tetsuo KOYAMA*

小山鉄夫: カヤツリグサ科の分類学的研究 5

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§ 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 groups, *Machaerina*, *Baumea*, *Vincentia*, *Chapelliera* etc., which were chiefly based upon their external appearances especially on inflorescences and leaves. Some taxonomists including Bockeler, 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 cor.ay 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.

Fig. 6. Pollen grains of *Cladium* sensu lato (offered by Miss Ikuse): A-C. *Cladium chinense* Nees: A & B, lateral views; C, polar view. D. *Machaerina nipponensis* Ohwi et T. Koyama (= *Cladium nipponense* Ohwi) lateral view. $\times 770$.

Furhter, 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.

Cladium

ACHENE: Somewhat drupelike, the stylebase almost inconspicuous, corky, smooth.

Machaerina, *Vincentia* & *Baumea*

Hard, 3-angled, the apex crowned by a distinct beak usually hispid or scabulous, not corky.

STAMENS:	2.	3 (very rarely 2, but always?).
PARTIAL INFLORES- CENCES:	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, domi- nant 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 three 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.

Genus **Cladium** P. Br., Hist. Jamaic.: 114 (1756); Schrad., Fl. Germ. 1: 74 (1806); Kunth, Enum. Plant. 2: 303 (1837); Steudel, Synops. Plant. Glumac. 2: 152 (1855); Böckeler in Linnaea 38: 231 (1874); Benth. et Hook. fil., Gen. Plant. 3: 1065 (1883), pro pte.; Engler et Plantl, Nat. Pflanzenfam. 2-2: 116 (1889), ex pte.; C. B. Clarke in Kew Bull. add. ser. 8: 124 (1908), ex pte.; Ohwi in Mem. Coll. Sci. Kyoto Imper. Univers. ser. B, 18, no. 1: 10 (1943), pro pte. Species typica: *Cladium jamaicense* Cranz.

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 obsito, 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, nuce trigona coriacea glabra apice rostro coronata, rostro conicolanceolato vel interdum subdepresso semper plus

minus hispidoscabro, stigmatibus 3, perigonii phyllis in setas breves scabras reductis vel nullis, antheris plerumque 3. Caeteroquin sicut *Cladium* sensu stricto. Species typica: *Machaerina restioides* Vahl.

Sect. **Machaerina** (Vahl) — Genus *Cladium* aubgen. *Machaerina* (Vahl) C. B. Clarke l. c. 124 (1908).

Sect. **Vincentia** (Gaudich.) T. Koyama, comb. nov. — Genus *Vincentia* Gaudich., Freyc. Voy. Bot. 416 (1826); Kunth l. c. 314; Steudel l. c. 156; Böckeler l. c. 247 — Genus *Cladium* sectio *Vincentia* (Gaudich.) Benth. et Hook. f., Gen. Plant. 3: 1066 (1883).

Sect. **Baumea** (Gaudich.) T. Koyama, comb. nov. — Genus *Baumea* Gaudich., Freyc. Voy. Bot. 417 (1826); Thw., Enum. Pl. Zeyl. 353 (1864); Böckeler l. c. 237 (1874) — Genus *Chapelliera* Nees in Linnaea 9: 417 (1834) — Genus *Cladium* subgen. *Baumea* (Gaudich.) C. B. Clarke l. c. 124 — Genus *Cladium* sectio *Baumea* (Gaudich.) Benth. et Hook. f., l. c. 3: 1065 (1943); Ohwi l. c. 10 (1943).

1. **Machaerina angustifolia** (Gaudich.) T. Koyama, comb. nova
Vincentia angustifolia Gaudich. Freyc. Voy. Bot. 417 (1826).
2. **Machaerina arfakensis** (Rendle) T. Koyama, comb. nova
Cladium arfakense Rendle in L. S. Gibbs, Phytogeogr. & Flor. Arfak. Mts. 90 (1917).
3. **Machaerina aromatica** (Merrill) T. Koyama, comb. nova
Cladium aromaticum Merrill in Philip. Journ. Sci. 9: 59 (1914).
4. **Machaerina arthropphylla** (Nees) T. Koyama, comb. nova
Chapelliera arthropphylla Nees in Lehm. Plant. Preiss. 2: 77 (1846) — *Cladium arthropphyllum* (Nees) F. V. Müller, Fragm. Phytogr. Austral. 9: 14 (1875).
5. **Machaerina articulata** (R. Br.) T. Koyama, comb. nova
Cladium articulatum R. Br. Pradr. Fl. Nov. Holl. 237 (1810).
6. **Machaerina aspericaulis** (Kükenth.) T. Koyama, comb. nova
Cladium aspericaule Kükenth. in Bull. Jard. Bot. Buitenz. 3^e sér., 16: 309 (1940).
7. **Machaerina australis** (Rich.) T. Koyama, comb. nova
Vaüthiera australis Richard, Ess. Flor. N. Zél. 107, t. 20 (1832) — *Cladium Vauthiera* C. B. Clarke ex Cheeseman, Man. N. Z. Flor. 788 (1906).
8. **Machaerina Bidwellii** (Stapf) T. Koyama, comb. nova
Vincentia Bidwellii Stapf in Dept. Marine Biol. Carnegie Inst. Wash. 20: 111 (1924), in obs.
9. **Machaerina boninsimae** (Nakai) T. Koyama, comb. nova
Cladium boninsimae Nakai in Bot. Mag. Tokyo 25: 223 (1911).
10. **Machaerina borneensis** (C. B. Clarke ex Stapf) T. Koyama, comb. nova
Cladium borneense C. B. Clarke ex Stapf in Trans. Linn. Soc. Bot. 4: 245 (1894).
11. **Machaerina brevipaniculata** (Kükenth.) T. Koyama, comb. nova

- Cladium brevipaniculatum* Kükenth, in Fedde, Repert. 51: 176 (1942).
12. **Machaerina brevistigma** (Nakai ex Tuyama) T. Koyama, comb. nova
Cladium brevistigma Nakai ex Tuyama in Bot. Mag. Tokyo 49: 509 (1935).
13. **Machaerina complanata** (Bergg.) T. Koyama, comb. nova
Cladium complanatum Bergg. in Minnesks. Fisiog. Sallks. Lund. n. 8: 23 (1877).
14. **Machaerina capillacea** (Hook. fil.) T. Koyama, comb. nova
Chaetospora capillacea Hook. fil., Flor. Tasman. 2: 81, t. 141, A (1858), non Nees.
15. **Machaerina crassa** (Thw.) T. Koyama, comb. nova
Baumea crassa Thwait., Enum. Plant. Zeyl. 353 (1864).
16. **Machaerina crinita** (Stapf) T. Koyama, comb. nova
Vincentia crinita Stapf in Philip. Journ. Sci. 19: 65 (1921).
17. **Machaerina cubensis** (Kükenth.) T. Koyama, comb. nova
Cladium cubense Kükenth. in Fedde, Repert. 23: 213 (1926).
18. **Machaerina cyperoides** (Merrill) T. Koyama, comb. nova
Cladium cyperoides Merrill in Philip. Journ. Sci. 7: 74 (1912).
19. **Machaerina Deplanchei** (Böckl.) T. Koyama, comb. nova
Baumea Deplanchei Böckeler in Flora 61: 143 (1878).
20. **Machaerina dissoluta** (Stapf ex Setchell) T. Koyama, comb. nova
Vincentia dissoluta Stapf ex Setchell in Dept. Marine Biol. Carnegie Inst. Washingt. 20: 111 (1924).
21. **Machaerina disticha** (C. B. Clarke) T. Koyama, comb. nova
Cladium distichum C. B. Clarke in Philip. Journ. Sci. 2: 102 (1907).
22. **Machaerina Ekmanii** (Kükenth.) T. Koyama, comb. nova
Cladium Ekmanii Kükenth. in Fedde, Repert. 23: 213 (1926).
23. **Machaerina ensifolia** (Böckl.) T. Koyama, comb. nova
Elynanthus ensifolius Böckeler in Linnaea 38: 264 (1874).
24. **Machaerina elynanthoides** (F. v. Müller) T. Koyama, comb. nova
Cladium elynanthoides F. v. Müller, Fragm. Phytogr. Austral. 9: 31 (1875)
—*Elynanthus australis* Nees in Lehm., Pl. Preiss. 2: 79 (1846).
25. **Machaerina ensigera** (Hance) T. Koyama, comb. nova
Cladium ensigerum Hance in Journ. Bot. 23: 80 (1885).
26. **Machaerina ficticia** (Hemsley) T. Koyama, comb. nova
Cladium ficticium Hemsley, Bot. Challenger Voy. 3: 59, t. 60, f. 5-7 (1885), in obs.
27. **Machaerina falcata** (Nees) T. Koyama, comb. nova
Baumea falcata Nees in Hook, Kew Journ. 6: 29 (1854).
28. **Machaerina glomerata** (Gaudich.) T. Koyama, comb. nova
Baumea glomerata Gaudich., Freyc. Voy. Bot. 416, t. 29 (1826).
29. **Machaerina gracilis** (J. M. Black) T. Koyama, comb. nova

- Cladium gracile* J. M. Black in Trans. & Proc. Roy. Soc. S. Austr. 53: 261 (1929).
30. **Machaerina Huttoni** (T. Kirk) T. Koyama, comb. nova
Cladium Huttoni T. Kirk in Trans. N. Z. Inst. 9: 551 (1877).
31. **Machaerina insularis** (Benth.) T. Koyama, comb. nova
Cladium insularis Benth. in Flor. Austral. 7: 403 (1878).
32. **Machaerina iridifolia** (Baker) T. Koyama, comb. nova
Cladium iridifolium Baker, Flor. Maurit. 424 (1877).
33. **Machaerina iris** (Ohwi) Ohwi et T. Koyama, comb. nova
Cladium iris Ohwi in Bot. Mag. Tokyo 41: 208 (1942).
34. **Machaerina juncea** (R. Br.) T. Koyama, comb. nova
Cladium junceum R. Br., Prodr. Fl. Nov. Holl. 237 (1810).
35. **Machaerina juncooides** (Elmer) T. Koyama, comb. nova
Cladium juncooides Elmer, Leaf. Philip. Bot. 3: 854 (1910).
36. **Machaerina latifolia** (Merrill) T. Koyama, comb. nova
Cladium latifolium Merrill in Philip. Journ. Sci. 2: 262 (1907).
37. **Machaerina latissima** (F. v. Müller) T. Koyama, comb. nova
Cladium latissimum F. v. Müller, Fragm. Phytogr. Austr. 9: 15 (1875).
38. **Machaerina laxa** (Benth.) T. Koyama, comb. nova
Cladium laxum Benth. in Flor. Austral. 7: 405 (1878).
39. **Machaerina macrophylla** (Böckl.) T. Koyama, comb. nova
Vincentia macrophylla Böckeler, Allg. Bot. Zeitschr. 112 (1896).
40. **Machaerina Maingayi** (C. B. Clarke) T. Koyama, comb. nova
Cladium Maingayi C. B. Clarke in Hook. f., Flor. Brit. India 6: 674 (1896).
41. **Machaerina Gaudichaudii** (W. F. Wight) T. Koyama, comb. nova
Cladium Gaudichaudii W. F. Wight in Contrib. U. S. Nat. Herb. 9: 230 (1905).
42. **Machaerina Melleri** (Baker) T. Koyama, comb. nova
Cladium Melleri Baker in Journ. Linn. Soc. 21: 451 (1885).
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
Vincentia monticola Guillaumin in Bull. Mus. Hist. Nat. Paris 2^e sér., 9: 304 (1937).
46. **Machaerina Muellieri** (C. B. Clarke) T. Koyama, comb. nova
Cladium Muellieri C. B. Clarke in Kew Bull. add. ser. 8: 47 (1908).
47. **Machaerina monocarpa** (J. M. Black) T. Koyama, comb. nova
Schoenus monocarpus J. M. Black in Trans. & Proc. Roy. Soc. S. Austr. 52: 225 (1928).

48. **Machaerina malesiaca** (Stapf) T. Koyama, comb. nova
Vincentia malesiaca Stapf in Journ. Linn. Soc. 42: 178 (1914).
49. **Machaerina nipponense** (Ohwi) Ohwi et T. Koyama, comb. nova
Cladium nipponense Ohwi in Mem. Coll. Sci. Kyoto Imper. Univ. ser. B, 18, no. 1: 11 (1943).
50. **Machaerina nukuhivensis** (Forst) T. Koyama, comb. nova
Cladium nukuhivense Forst ex Brown in Bull. Bishop. Mus. Honolulu no. 84: 111 (1931).
51. **Machaerina pantopoda** (Baker) T. Koyama, comb. nova
Cladium pantopodum Baker in Journ. Linn. Soc. 21: 451 (1885).
52. **Machaerina philippinensis** (Merrill) T. Koyama, comb. nova
Cladium philippinense Merrill in Philip. Journ. Sci. 5: 171 (1910).
53. **Machaerina ponapensis** (Ohwi) Ohwi et T. Koyama, comb. nova
Cladium ponapense Ohwi in Journ. Jap. Bot. 18: 136 (1942).
54. **Machaerina procera** (S. T. Blake) T. Koyama, comb. nova
Cladium procerum S. T. Blake in Trans. Roy. Soc. S. Austr. 67: 57 (1943).
55. **Machaerina riparia** (Benth.) T. Koyama, comb. nova
Cladium riparium Benth. Flor. Austral. 7: 405 (1878).
56. **Machaerina Robinsonii** (Merrill) T. Koyama, comb. nova
Vincentia Robinsonii Merrill in Philip. Journ. Sci. 11: 258 (1916).
57. **Machaerina rubiginosa** (Soland ex Forst) T. Koyama, comb. nova
Schoenus rubiginosus Soland ex Forst, Prodr. 89 (1786)—*Cladium glomerata* R. Br., Prodr. Fl. Nov. Holl. 237 (1810).
58. **Machaerina punctata** (R. Br.) T. Koyama, comb. nova
Schoenus punctatus R. Br. Prodr. Fl. Nov. Holl. 232 (1810)—*Schoenus nudus* Steudel, Syn. Pl. Glumac. 2: 165 (1855).
59. **Machaerina samoensis** (C. B. Clarke ex Stapf) T. Koyama, comb. nova
Cladium samoense C. B. Clarke ex Stapf in Trans. Linn. Soc. Bot. 4: 245 (1894).
60. **Machaerina schoenoides** (R. Br.) T. Koyama, comb. nova
Cladium schoenoides R. Br. Prodr. Fl. Nov. Holl. 237 (1810).
61. **Machaerina scirpoidea** (Benth. et Hook. f. ex Hemsl.) T. Koyama, comb. nova
Cladium scirpoideum Benth. et Hook. f. ex Hemsley, Bot. Challenger Voy. 3: 59. f. 1-4 (1885).
62. **Machaerina Sinclairii** (Hook. fil.) T. Koyama, comb. nova
Cladium Sinclairii Hook. fil., Handb. N. Zeal. Fl. 304 (1864).
63. **Machaeria pulchra** (Ridley) T. Koyama, comb. nova
Cladium pulchrum Ridley in Journ. Federated Mal. States Mus. 6: 192 (1925).
64. **Machaerina sinuata** (Ridley) T. Koyama, comb. nova
Cladium sinuatum Ridley in Trans. Linn. Soc. Bot. 9: 243 (1916).
65. **Machaerina stradbokensis** (Domin) T. Koyama, comb. nova

Cladium stradbrokeense Domin in Bibliothec. Bot. 85: 476 (1915).

66. **Machaerina sucinonux** T. Koyama, spec. nova e sectione *Machaerina* (Vahl).

Perennis. Culmus erectus 5-9 dm altus firmus a latere compressus stramineo-virens 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 culmum subarcte circumdantes compressas vix attenuantibus, ligulis vix productis. Inflorescentia paniculata bis ter composita elata sed sublaxa 40-55 cm longa 3-5 cm lata; paniculae secundariae plures 10-25 cm longae ex unica bractea 1-3-nae contiguae longe exserte vel subincluse pedunculatae valde ramosae, pedunculis subcompressis triquetris laevibus, bracteolis spathaceis longiuscule vaginantibus, paniculis tertiaribus linearibus sublaxe plurispiculosis; Bracteae inferiores foliaceae paniculis partialibus suis breviores basi longe vaginatae, superiores in vaginam sursum ampliatae reductae. Spiculae maturitate ovoideae ellipsoideaeve 3-4 mm longae 1.5-2 mm in diametro fuscae 3-4-squamatae uniflorae. Squamae imbricatim dispositae ovatoellipticae vel ellipticae membranaceae fuscescentes et fuscostriatae naviculares sursum hispidosabrae spice subabrupte angustatae acutae mucronatae, carina uninervata; summa vacua 2.5 mm longa; sequens fertilis summa paullo grandior; inferiores etiam vacuae eae superiores 2 similes sed paullo angustiores brevioresque dorso fere ex toto hispidae. Nux ellipsoidea 2-2.2 mm longa 1.5 mm in diametro obtuse trigona facie fulvosucina nitida grosse rugosa basi subsessilis; stylopodium rostriforme conicolineare cum 1/2-nuce subaequans ex toto perdense tomentosohispidum albescens; stylus gracilis longus erectus, stigmatibus 3 recurvis longiusculis papulosis. Stamina 3.

Bonin: Ins. Hahajima (K. Sawatari, n. 86!—Holotypus in Herb. Univ. Tokyoensis).

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

Lamprocarya tenax Hook. fil., Flor. N. Zeal. 1: 277 (1853).

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

Cladium teretifolium R. Br. Prodr. Fl. Nov. Holl. 237 (1810).

69. **Machaerina tetragona** (R. Br.) T. Koyama, comb. nova

Lepidosperma tetragonum R. Br., Prodr. 235 (1810).

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

Cladium undulatum Thwaites, Enum. Plant. Zeyl. 353 (1864).

71. **Machaerina vaginalis** (Benth.) T. Koyama, comb. nova

Cladium vaginale Benth. 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.

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***

荒勝 豊・芦田譲治：酵母の銅に対する適応的変異現象の研究 XII.

銅耐性変異株の耐性機序としてのアミノ酸合成能

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In the preceding paper¹⁾ 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, R_{1b}, 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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