

Exploration and Collection of *Miscanthus* species in Kumamoto Prefecture, Japan

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Introduction

According to Osada (2002), several *Miscanthus* species are found in Japan. Among those, the species found in Kumamoto Prefecture are described below.

M. sinensis (Japanese name “Susuki”) is found from Hokkaido to the Ryukyus, in south Sakhalin, the southern Kurils, Korea, and the Chinese continent, and from Taiwan to Indochina. *M. sinensis* has leaf blades with scabrous margins, and culms densely tufted culms. Its heading period is from August to October.

M. floridulus is found warm-temperature regions; the Pacific side of central Honshu and westward, Shikoku, Kyushu, the Ryukyus, and the greater part of Southeast Asia. *M. floridulus* sometimes forms a very large hill with thick, short rhizomes. Its heading period is from July to August, earlier than that of other *M.* species. The leaves do not die, even in winter; the Japanese name “Tokiwa-susuki” is based on this characteristic (“Tokiwa” means “evergreen” leaves in Japanese).

M. sacchariflorus (Japanese name “Ogi”) is found from Kyushu to Hokkaido as well as in Korea, north China, and Far-Eastern Siberia. *M. sacchariflorus* has a hairy lower leaf sheath and forms a large bush with erect culms unlike those of other *M.* species. The most distinctively different feature from other *M.* species is that *M. sacchariflorus* is awnless or has very short awns on the spikelet. *M. sacchariflorus* tends to grow in humid soil such as near rivers or ponds. Its heading period is from September to October, a bit later than that of *M. sinensis*.

M. condensatus (Japanese name “Hachijyoh-susuki”) is found from Honshu to the Ryukyus as well as in Taiwan and the Philippines. Most of its characteristics are similar to those of *M. sinensis* except that it has leaf blades with weak or no scabrous margins. *M. condensatus* grows on rocks or gravel along the seashore.

In addition to these, *M. hackeli* var. *breviberbis* HONDA (Honda, 1931) collected in Uemura and *M. ogiformis* (Honda, 1939) collected in Nishinomura, near the Kumagawa River,

were reported from Hitoyoshi Basin in the southern part of Kumamoto Prefecture. *M. hackeli* var. *breviberbis* (Japanese name “Tsukushi-ooogi”) is similar to *M. sacchariflorus* of Korea and larger than common *M. sacchariflorus* of Japan. *M. ogiformus* (Japanese name “Ogi-susuki”) is similar to *M. hackeli* var. *breviberbis* and falls between *M. sacchariflorus* and *M. sinensis*. It has short awns on the spikelet that distinctively differ from those of *M. sacchariflorus*.

In Europe, *M. giganteus* (Lewandowski, 1997) is well known as a biomass plant by reason of its low environmental impact based on sterility. *M. giganteus* is known to have been carried from Japan to Denmark in 1935.

Kumamoto Prefecture has various climate patterns, from warm no-frost zones such as the sea coast area of the Amakusa Islands to cool areas with climate similar to the Touhoku area such as hilly and mountainous terrain like in the Aso area. In the hilly and mountainous areas, *Miscanthus* spp. is an important forage crop with extensive cultivation over a long period.

Beyond these, we thought that various ecotype plants of *M. spp.* should exist and that hybrid species between *M. spp.* probably exist in Kumamoto Prefecture. These would be useful materials for breeding forage or biomass crops, so we began to explore and collect them.

Exploration Methods

The collecting period was from early May 2009, at the beginning of growth, to December, after heading had finished. We searched mainly for *M. sacchariflorus* because the distribution of this species is rather more limited than *M. sinensis*. We also investigated whether *M. sinensis* exists near them and whether the heading times could be expected to overlap. Our GPS apparatus was a 12-channel Poke Navi (made by Garmin), and we used a WGS-84 system.

Results

Fig. 1 depicts the explored points, and the collections are listed in Table 1.

We collected twentyone *M. sacchariflorus* plants, seven *M. sinensis* plants, and three *M. floridulus* plants. *M. sinensis* is common with a wide range of differences in various characteristics even on a same place, for example the plant height, heading period, and angle of culms, especially among plants grown on roadsides, the slopes of roads, or river banks.

Specific notes are given below.

In Koshi City, one earlyheading *M. sinensis* plant (August 10) was collected in the field at the National Agricultural Research Center for Kyushu Okinawa Region (Col. No. 26). In the Kyusyu Regional Breeding Office, which adjoins the Agricultural Research Center for Kyushu Okinawa Region, two *M. sacchariflorus* plants were collected. One forms a large bush with erect culms similar to other *M. sacchariflorus* (Col. No. 4), and the another one is not so tall with spread culms (Col. No. 5, Photo 1) from a less humid field. Some *M. sinensis* plants were found near these, and the heading time was expected to overlap (Photo 1).

In Takamori Town, one *M. Sacchariflorus* plant (Col. No. 27) and one *M. sinensis* plant (Col. No. 28) were collected in the same place.

Along the Midorikawa River, we could easily find *M. sacchariflorus* at the mouth of the river as well as to upstream. They sometimes formed a large bush (Col. No. 8-10, Photo 2).

The Kumagawa River runs in a V-shaped valley, so quiet water areas were limited to Hitoyoshi

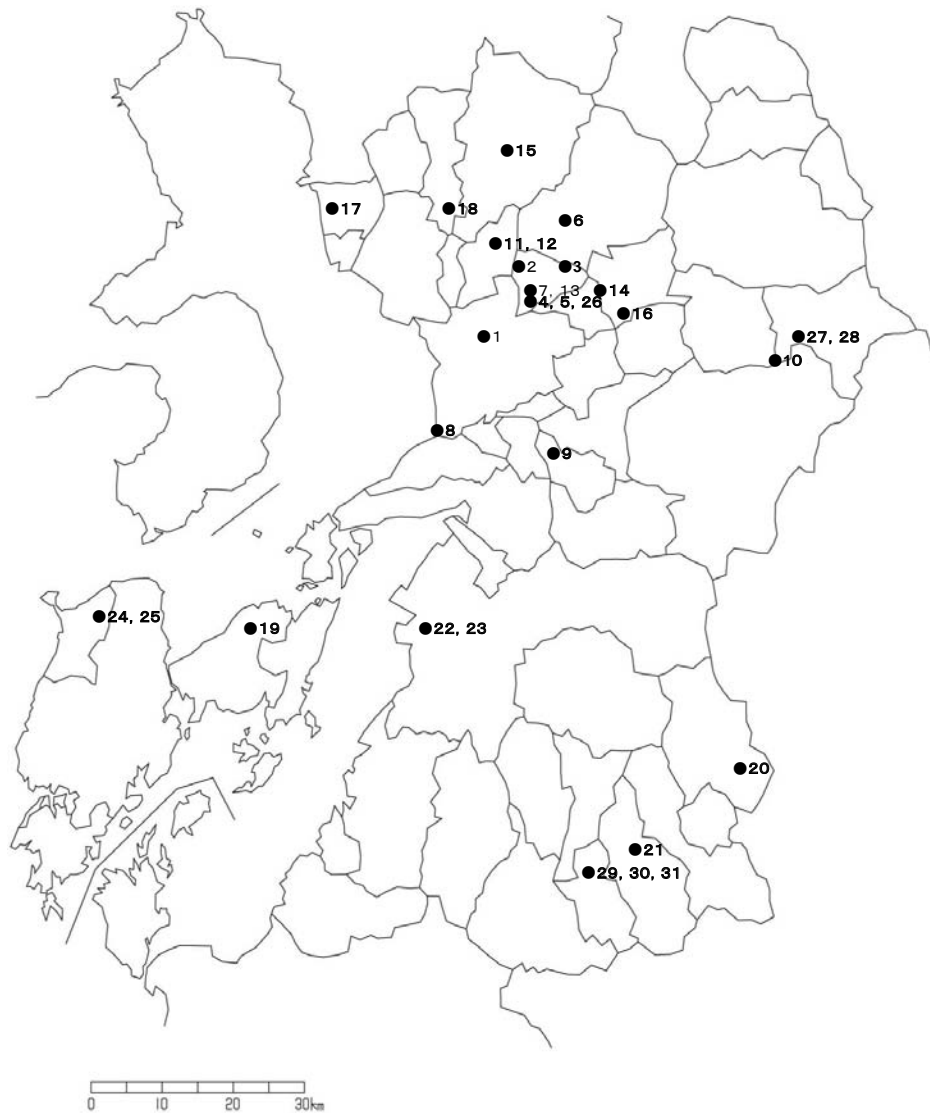


Fig 1. Exploration sites in Kumamoto prefecture

● : collection sites and collection number

Basin and the mouth of the river in Yatsushiro City. *M. sacchariflorus* and *M. sinensis* grew in the same place, at the mouth of the Kumagawa River in Yatsushiro City (Col. No. 22- 23). One very tall *M. sacchariflorus* plant (height nearly 5 m.) was collected in Nishiki Town in Hitoyoshi Basin (Col. No. 29, Photo 3). *M. floridulus* was collected even at high altitudes of about 700 m near Ichifusa Dam in Mizukami Village (Col. No. 20, Photo 4), in the upper reaches of the Kumagawa River.

Discussion

M. sinensis plants have wide differences even on the same place, so it was difficult to select the best plant. *M. sacchariflorus* plants have stable characters in a same colony. And a triploid plant which is a hybrid between *M. sacchariflorus* and *M. sinensis* seems to be similar to *M. sacchariflorus*, since its genome which 1n is from *M. sinensis* and 2n is from *M. sacchariflorus*. So we thought to weight to collect *M. sacchariflorus*.

In this field trip, we did not find *M. condensatus* because we explored mainly inland areas of Kumamoto Prefecture, omitting the seashore area. *M. condensatus* is expected to have salt

tolerance, so we need further efforts to collect them.

Determining whether one very tall *M. sacchariflorus* plant (Col. No. 29, Photo 3) collected in Nishiki Town is *M. hackeli* var. *breviberbis* will require further examination.

The plants that we collected are expected to be useful materials for breeding new varieties for extensive cultivation and as bio-mass material.

According to Osada (2002), *M. sinensis* has $2n=35, 36, 38, 40, 41,$ and 42 chromosomes; *M. floridulus* has $2n= 36, 38,$ and 57 ; *M. sacchariflorus* has $2n=57, 64,$ and 76 ; and *M. condensatus* has $2n=38$. Most *M. sinensis* plants are expected to have 38 chromosomes (Adati et. al., 1955). If the basic number of chromosomes of *M. spp.* is 19, *M. sacchariflorus* demonstrates that a tetraploid ($2n=76$), and a triploid ($2n=57$) exist in *M. floridulus* and *M. sacchariflorus*. Furthermore, we need more investigation which combination would make various chromosome numbers of *M. spp.* not equal to a multiple of 19 ($2n=38, 57,$ and 76).

M. giganteus has 57 chromosomes and is thus a hybrid between *M. sinensis* and *M. sacchariflorus* (Lewandowski, 1997). The existence of various chromosome numbers for various *M. species* and the wide difference in characteristics among *M. sinensis* plants is believed to be caused by their selfincompatibility (Hirayoshi, 1955). We need to examine the chromosome numbers for the *M. spp.* plants we collected. Furthermore, *M. giganteus* is known to have been carried from Japan to Denmark in 1935 (Lewandowski, 1997). We need to further investigate this plant's origin in Japan. If the condition, for example climate, soil, or specific cross between specific plants, is clarified, the result will give us worthwhile information to breed new triploid varieties efficiently.

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和文摘要

多様な気候型が存在する熊本県において、ススキ属の遺伝資源の探索を行った。その結果、ススキ (*Miscanthus sinensis*) 7点、トキワススキ (*M. floridulus*) 3点、オギ (*M. sacchariflorus*) 21点を収集した。これらの材料は粗放栽培型牧草品種育成やバイオマス資源用品種育成に有効であると考えられた。

Table 1. The list of collected *Miscanthus* spp.

Collected No.	JP No.	Species	Collected Place	GPS data		Collected date m.d
				North latitude	East longitude	
1	239304	<i>M. sacchariflorus</i>	Kumamoto C. Ikegami	32.81805	130.71667	5. 4
2	239305	<i>M. sacchariflorus</i>	Kikuchi C. Shisuimachi Toyomizu	32.92848	130.76082	5. 5
3	239306	<i>M. sacchariflorus</i>	Koshi C. Kaminoshou	32.90135	130.78137	5.23
4	239307	<i>M. sacchariflorus</i>	Koshi C. Suya	32.88658	130.73500	8. 5
5	239308	<i>M. sacchariflorus</i>	Koshi C. Suya	32.88779	130.73347	8. 5
6	239309	<i>M. sacchariflorus</i>	Kikuchi C. Shichijyoumachi Kameo	32.94923	130.76740	8. 8
7	239310	<i>M. sacchariflorus</i>	Koshi C. Nakao	32.91025	130.74641	8.23
8	239311	<i>M. sacchariflorus</i>	Kumamoto C. Ujiguchimachi	32.71813	130.60962	8.26
9	239312	<i>M. sacchariflorus</i>	Kousa T. Tsushida	32.68948	130.79112	8.26
10	239313	<i>M. sacchariflorus</i>	Yamato T. Shakabaru	32.70078	131.12407	8.26
11	239314	<i>M. sacchariflorus</i>	Ueki T. Shimoda	32.93930	130.69505	9.16
12	239315	<i>M. floridulus</i>	Ueki T. Shimoda	32.93930	130.69505	9.16
13	239316	<i>M. sacchariflorus</i>	Koshi C. Miyoshi	32.89619	130.75297	9.22
14	239317	<i>M. sacchariflorus</i>	Kikuyou T. Haramizu	32.88072	130.81607	9.23
15	239318	<i>M. sacchariflorus</i>	Yamaga C. Naka	33.01627	130.70519	9.28
16	239319	<i>M. sacchariflorus</i>	Ozu T. Machi	32.85377	130.86576	9.29
17	239320	<i>M. sacchariflorus</i>	Arao T. Ushinomizu	32.95642	130.43541	10. 9
18	239321	<i>M. sacchariflorus</i>	Nagomi T. Hagiwara	32.96324	130.64946	10. 9
19	239322	<i>M. floridulus</i>	Amakusa C. Ariakemachi Akasaki	32.51590	130.33013	11. 8
20	239323	<i>M. floridulus</i>	Mizukami V. Yuyama	32.33283	131.07150	12.10
21	239324	<i>M. sacchariflorus</i>	Taragi T. Kurohiji	32.26108	130.94094	12.10
22	239325	<i>M. sacchariflorus</i>	Yatsushiro C. Uyanagi Motomachi	32.49194	130.59882	12.10
23	239326	<i>M. sinensis</i>	Yatsushiro C. Uyanagi Motomachi	32.49194	130.59882	12.10
24	239327	<i>M. sinensis</i>	Reihoku T. Tororo	32.43605	130.08963	12.11
25	239328	<i>M. sinensis</i>	Reihoku T. Tororo	32.45774	130.07933	12.11
26	239329	<i>M. sinensis</i>	Koshi C. Miyoshi	32.88784	130.74038	12.16
27	239330	<i>M. sacchariflorus</i>	Takamori T. Takamori	32.81204	131.13358	12.22
28	239331	<i>M. sinensis</i>	Takamori T. Takamori	32.81204	131.13358	12.22
29	239332	<i>M. sacchariflorus</i>	Nishiki T. Nishi	32.20633	130.80364	12.24
30	239333	<i>M. sinensis</i>	Nishiki T. Nishi	32.20708	130.80983	12.24
31	239334	<i>M. sinensis</i>	Nishiki T. Nishi	32.20187	130.80805	12.24

Table 1. The list of collected *Miscanthus* spp. in Japanese(ススキ属収集リスト).

No.	GPS		採集時期	採集場所	町・字	備考	種	備考
	N	E	月・日	郡市				
1	32.81805	130.71667	5. 4	熊本市	池上町	井芹川河川敷	オギ	
2	32.92848	130.76082	5. 5	菊池市	泗水町豊水	合志川河川敷	オギ	
3	32.90135	130.78137	5.23	合志市	上庄	塩浸川土手	オギ	
4	32.88658	130.73500	8. 5	合志市	須屋	林木育種場圃場	オギ	大株
5	32.88779	130.73347	8. 5	合志市	須屋	林木育種場圃場	オギ	開株
6	32.94923	130.76740	8. 8	菊池市	七城町亀尾	耕作放棄地	オギ	大株
7	32.91025	130.74641	8.23	合志市	中尾	上生川土手	オギ	
8	32.71813	130.60962	8.26	熊本市	海路口町	緑川土手	オギ	
9	32.68948	130.79112	8.26	下益城郡	甲佐町・津志田	緑川土手	オギ	
10	32.70078	131.12407	8.26	上益城郡	山都町・仏原	大矢川土手	オギ	大株
11	32.93930	130.69505	9.16	鹿本郡	植木町・下田	豊田川横・耕作放棄地	オギ	
12	32.93930	130.69505	9.16	鹿本郡	植木町・下田	豊田川横・耕作放棄地	トキワススキ	
13	32.89619	130.75297	9.22	合志市	御代志	上生川土手	オギ	
14	32.88072	130.81607	9.23	菊池郡	菊陽町・原水	耕作放棄地	オギ	
15	33.01627	130.70519	9.28	山鹿市	中	耕作放棄地	オギ	
16	32.85377	130.86576	9.29	菊池郡	大津町・町	白川河川敷	オギ	
17	32.95642	130.43541	10. 9	荒尾市	牛水	耕作放棄地	オギ	
18	32.96324	130.64946	10. 9	玉名郡	和水町・萩原	用水路土手	オギ	
19	32.51590	130.33013	11. 8	天草市	有明町赤崎	空き地	トキワススキ	
20	32.33283	131.07150	12.10	球磨郡	水上村・船石	空き地	トキワススキ	標高約 700m
21	32.26108	130.94094	12.10	球磨郡	多良木町・黒肥地	球磨川河川敷	オギ	
22	32.49194	130.59882	12.10	八代市	植柳元町	球磨川河川敷	オギ	
23	32.49194	130.59882	12.10	八代市	植柳元町	球磨川河川敷	ススキ	
24	32.43605	130.08963	12.11	天草郡	苓北町・都呂々	天竺山中腹	ススキ	
25	32.45774	130.07933	12.11	天草郡	苓北町・都呂々	桂山中腹	ススキ	
26	32.88784	130.74038	12.16	合志市	御代志	九沖農研圃場	ススキ	早生
27	32.81204	131.13358	12.22	阿蘇郡	高森町・高森	空き地	オギ	
28	32.81204	131.13358	12.22	阿蘇郡	高森町・高森	空き地	ススキ	
29	32.20633	130.80364	12.24	球磨郡	錦町・西	球磨川河川敷	オギ	大株
30	32.20708	130.80983	12.24	球磨郡	錦町・西	球磨川土手下	ススキ	大株
31	32.20187	130.80805	12.24	球磨郡	錦町・西	肥後西村駅前・空き地	ススキ	大株



Photo 1. Back : *M. sacchariflorus* collected in Koshi (Col.No.5), Front : *M. sinensis*



Photo 2. *M. sacchariflorus* collected in Yamato (Col.No.10)



Photo 3. *M. sacchariflorus* collected in Nishiki (Col.No.29) ; The length of the car is 437cm.



Photo 4. *M. floridulus* collected in Mizukami (Col.No.20)