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Correlation between Evaluation of Palatability by Sensory Test and Physicochemical Properties in Chinese *japonica–type* Rice

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To obtain basic information on the breeding for palatability of *japonica–type* paddy rice in China, we collected 28 varieties from the northern area of China and examined the correlation between evaluation by sensory test (appearance, aroma, taste, stickiness, hardness and overall eating–quality) and physicochemical properties (amylose content and protein content of polished rice, breakdown value of polished rice flour and hardness/adhesion ratio of cooked rice). The overall eating–quality in the sensory test was highly correlated with appearance and taste, and not with hardness. Appearance, aroma, taste, stickiness and overall eating–quality were negatively correlated with protein content and hardness/adhesion ratio, and positively correlated with breakdown value. Amylose content did not significantly correlated with any evaluation items in sensory test. About 46% of the varietal difference in overall eating–quality was explained by protein content, breakdown value and hardness/adhesion ratio. Contribution ratio of protein content, breakdown value and hardness/adhesion ratio to overall eating–quality was estimated about 37%, 29% and 34%, respectively.

Key words: Chinese *japonica–type* rice varieties, Contribution ratio, Palatability, Physicochemical properties, Sensory test

INTRODUCTION

The most reliable method for palatability evaluation of rice is the sensory test (Matsue, 2012). In Japan, the sensory test is generally conducted according to the Food Agency's guideline. In this guideline, 24 panelists with different ranges of age and sex did distinction taste with four samples of cooked rice including standard rice and evaluate the appearance, aroma, taste, stickiness, hardness and overall eating–quality. To conduct a sensory test, therefore, we had to insure 24 panel members and prepare the cooked rice for evaluation. In addition, before the test is conducted, the rice must be polished, washed, soaked, cooked and steamed. Furthermore, since four samples including standard rice are used at each test, only three samples are used for evaluation. Thus, for the sensory test, a large amount of cooked rice and long time for preparation are required, and the number of tasting samples is limited. Therefore the sensory test of palatability is difficult when many samples are to be tested.

On the other hand, in Japan, the palatability of rice has been found to be influenced by some chemical components and physical properties (Inatsu, 1988; Matsue, 1993; Cui *et al*., 2000). Among the chemical components, amylose content and protein content strongly influence palatability, and the lower their contents, the higher the palatability. Concerning physical properties, the maximum viscosity and breakdown value related to amylogram properties of polished rice flour and hardness/adhesion ratio related to texture properties of cooked rice are firmly concerned in palatability; the higher the maximum viscosity and breakdown value, and the lower the hardness/adhesion ratio, the better the palatability. When the number of samples is large, palatability is evaluated indirectly by physicochemical properties. Thus, at present, palatability is evaluated by both sensory test and physicochemical properties in Japan.

In China, studies on rice palatability are increasing (Xu *et al*., 2005; Xie *et al*., 2013; Li *et al*., 2014), but the sensory test has rarely been used (Cui *et al*., 2011). Studies on the relationship between physicochemical properties and the results of sensory tests are extremely limited. Only Cui *et al*. (1999a, 1999b, 2000) analyzed the palatability of Chinese rice varieties cultivated in Japan by the sensory test by a Japanese panel.

In this study, Chinese rice varieties produced in various areas in China were used, and the relationship between physicochemical properties and the results of sensory test by a Chinese panel was analyzed. The sensory test was conducted by a modification of the method designed by the Food Agency in Japan, and we examined whether this method is useful or not in China.

MATERIALS AND METHODS

Varieties and cultivation method

This study was conducted at the China–Japan Joint Research Center on Palatability and Quality of Rice in

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Tianjin Agricultural University in 2011 using 28 varieties and lines (simply called varieties, hereafter) produced in northern area of China. They were 6 varieties from Tianjin Municipality, 6 varieties from Heilongjiang Province, 5 varieties from Jilin Province, 6 varieties from Liaoning Province and 5 varieties from Jiangsu Province. They were cultivated by the customary method in each area.

Sensory test and measurement of physicochemical properties

Rice samples for the sensory test were polished to 91–92%, and 1,000 g of polished rice were washed and soaked for 30 minutes. Then, 1350 ml of water was added and cooked with electric rice cooker, steamed for 20 minutes, and then tasted. Palatability was determined by the method of 10 test samples (Matsue, 1993). Standard variety was Jinyuan45 produced in Tianjin Municipality. Evaluation items were appearance, aroma, taste, stickiness, hardness and overall eating–quality. Appearance, aroma, taste, overall eating–quality were scored –3 (inferior to standard sample), –2 (considerably inferior to standard), –1 (slightly inferior to standard), 0 (standard level), +1 (slightly superior), +2 (considerably superior), +3 (superior). Stickiness was scored from –3 (low) to +3 (high), and hardness from –3 (soft) to +3 (hard). The panel consisted of 18 teaching staffs in Tianjin Agricultural University. They were 11 male and 7 female staffs. Three were in their twenties, 8 in their thirties, 3 in their forties and 4 in their fifties.

Protein and amylose contents of polished rice used for the sensory test were measured with an Auto Analyzer AA–3 (BRAN LUEBBE Co.). Protein content was shown on a dry weight basis. Breakdown of polished rice flour was measured with a Rapid Visco Analyzer RVA–4 (NEWPORT SCIENTIFIC Co.). Hardness and adhesion of cooked rice were measured with Rice Hardness–Viscosity Meter RHS–1A (SATAKE Co.).

RESULTS

Varietal difference in palatability evaluated by sensory test

Table 1 shows the evaluation scores of each item in the sensory test for each variety. Scores of overall eating–quality was highest (+1.78) in Ji803. It was >+1 in 8 varieties, in which 4 varieties, Ji105, Ji83, Ji803 and Ji88 were from Jilin Province, Jinchuan2 was from Tianjin Municipality, Yanjing218 was from Liaoning Province, and Lianjing7 and Xudao3 were from Jiangsu Province. The scores were the lowest (–2.24) in Wuyunjing 24 from Jiangsu province. The average was –0.06. The score of appearance varied from +2.19 in Jinchnan2 to –2.63 in Wuyunjing24 (average +0.17). The score of taste varied from +1.40 in Ji105 to +1.78 in Wuyunjing24 (average–1.78), stickiness was from +1.28 in Ji803 to –1.39 in Nanjing44 (average –0.05), hardness was from +0.97 in Jinyuann11 to –0.39 in Yanjing456 (average +0.24). The varietal difference in each score in each item (max. – min.) was 4.02 in overall eating–quality, 4.62 in appearance, 3.01 in aroma, 3.18 in taste, 2.67 in stickiness and 1.36 in hardness. The standard deviation was largest (1.36) in appearance and lowest (0.34) in hardness. In other items, standard deviation was around 1.

Table 2 shows the simple correlation coefficient between the evaluation of each item and overall eating–quality. The overall eating–quality showed a significantly high positive correlations with appearance, aroma, taste and stickiness at the 0.1% level, and a significant negative correlation with hardness at the 5% level. Table 3 shows the result of multiple regression analysis using appearance, aroma, taste, stickiness and hardness as explanatory variables and overall eating–quality as dependent variable. The multiple regression coefficient was as high as 0.991 and the coefficient of determination was 0.982. However, the standard partial regression coefficient of each evaluation item to the overall eating–quality was large in appearance and taste, and small in hardness. That is, the contribution ratio of each item to overall eating–quality was estimated 39.5% in appearance, 8.8% in aroma, 38.9 in taste, 12.2% in stickiness and 0.6% in hardness by the standard partial regression coefficient.

Varietal difference in physicochemical properties

Table 4 shows maximum, minimum, mean, standard deviation and coefficient of variation of amylose content, protein content, breakdown value and hardness/adhesion ratio. The amylose content was 19.4–15.7% (average 17.4%), protein content was 12.5–5.5% (average 7.6%), breakdown value was 103–56 RVU (average 79RVU) and hardness/adhesion ratio was 16.7–5.9 (average 9.6). The coefficient of variation was large in hardness/adhesion ratio, and small in amylose content.

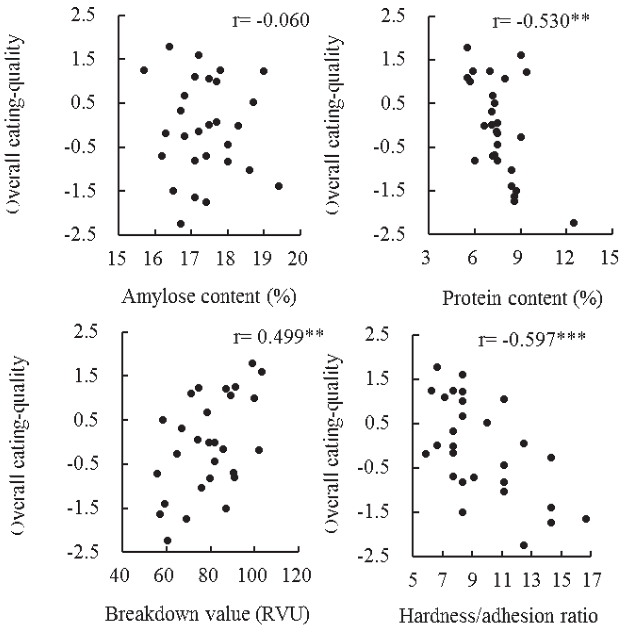

Fig. 1. Correlation of physicochemical properties with overall eating–quality in sensory test.
,*: Significant at 1% and 0.1% level, respectively.

Correlation of physicochemical properties with evaluation items in sensory test

Fig. 1 shows the correlation of amylose content, protein content, breakdown value and hardness/adhesion ratio with overall eating–quality. The overall eating–quality showed significant negative correlations with protein content and hardness/adhesion ratio, and significant positive correlation with breakdown value, but no significant correlation with amylose content.

Table 5 shows the correlation coefficient of physicochemical properties with each evaluation item. Amylose content did not significantly correlate with any evaluation items. Protein content showed significant negative correlations with overall eating–quality, appearance, aroma, taste and stickiness, but did not correlate with hardness. Breakdown value showed significant positive correlations with overall eating–quality, aroma, taste and stickiness. Hardness/adhesion ratio showed significant negative correlations with overall eating–quality, appearance, aroma, taste and stickiness, and significant positive correlation with hardness.

Thus, in this study, amylose content showed only a weak correlation with each evaluation item in the sensory test. Therefore, using physicochemical properties except amylose content (protein content, breakdown value and hardness/adhesion ratio) as an explanatory variables, and evaluation items in the sensory test as dependent variables, we performed multiple regression analysis. Table 6 shows the result. Significant multiple correlation coefficients were observed in all items. In overall eating–quality, the multiple correlation coefficient was 0.676, coefficient of determination was 0.457. The multiple correla-

Table 1. Evaluation of each item in the sensory test for palatability

No.	Variety	Cropping location	Overall eating–quality	Appea–rance	Aroma	Taste	Sticki–ness	Hard–ness
1	Longjing21	Heilongjiang Province	0.67	0.38	0.38	0.54	0.31	0.04
2	Longjing26	Heilongjiang Province	–0.71	–1.15	–0.08	–0.50	–0.64	0.38
3	Longjing25	Heilongjiang Province	0.06	–0.29	0.32	–0.03	–0.40	0.36
4	Longjing31	Heilongjiang Province	–0.82	–1.17	–0.03	–0.44	–0.67	0.28
5	Kongyu131	Heilongjiang Province	–0.01	–0.36	0.14	0.26	–0.03	–0.04
6	Kendao12	Heilongjiang Province	0.51	0.61	0.78	0.49	0.10	0.60
7	Ji105	Jilin Province	1.10	1.40	0.82	1.40	0.99	0.25
8	Ji83	Jilin Province	1.24	1.65	0.58	1.18	1.08	–0.11
9	Ji803	Jilin Province	1.78	2.00	0.64	1.38	1.28	0.11
10	Ji88	Jilin Province	1.00	1.42	0.32	0.81	0.76	0.21
11	Changbai9	Jilin Province	0.32	0.54	0.46	0.19	0.11	0.33
12	Yanfeng47	Liaoning Province	–0.69	–0.89	0.19	–0.36	–0.17	–0.33
13	Yanjing218	Liaoning Province	1.25	1.03	0.86	0.83	0.72	0.28
14	Yanjing456	Liaoning Province	–0.19	–0.75	0.11	–0.03	0.25	–0.39
15	Shennong9903	Liaoning Province	–1.03	–1.10	–0.32	–0.79	–0.69	0.31
16	Tiejing7	Liaoning Province	–0.15	0.26	0.25	0.10	–0.11	0.22
17	Liaoxing1	Liaoning Province	–1.74	–1.58	–0.89	–1.21	–1.00	0.50
18	Jinyuan45	Tianjin Municipality	0	0	0	0	0	0
19	E28	Tianjin Municipality	–1.50	–2.17	–0.50	–0.75	–0.69	0.92
20	Jinyuan5	Tianjin Municipality	–0.44	–0.67	–0.08	–0.22	–0.39	0.53
21	Jinyuan11	Tianjin Municipality	–0.81	–1.36	–0.33	–0.42	–0.81	0.97
22	Jinyuan17	Tianjin Municipality	–1.39	–2.19	–0.06	–0.86	–0.86	0.86
23	Jinchuan2	Tianjin Municipality	1.60	2.19	0.97	1.22	1.26	0.04
24	Lianjing7	Jiangsu Province	1.06	0.97	0.92	0.86	0.56	0.11
25	Nanjing44	Jiangsu Province	–1.64	–2.00	–0.83	–1.36	–1.39	0.33
26	Huaidao5	Jiangsu Province	–0.26	0.28	–0.06	–0.18	–0.49	0.25
27	Wuyunjing24	Jiangsu Province	–2.24	–2.63	–1.36	–1.78	–1.29	0.03
28	Xudao3	Jiangsu Province	1.22	1.31	1.65	1.32	0.68	–0.25
	Mean value		–0.06	–0.15	0.17	0.06	–0.05	0.24
	Standard deviation		1.10	1.36	0.64	0.87	0.76	0.34

Jinyuan45: Standard variety.

Table 2. Correlation coefficient between evaluation of each item and overall eating–quality in sensory test

	Appearance	Aroma	Taste	Stickiness	Hardness
Overall eating–quality	0.974***	0.906***	0.983***	0.960***	–0.400*

*, ***: Significant at 5% and 0.1% level, respectively.

Table 3. Standard partial regression coefficient of each item in sensory test with overall eating–quality

Multiple correlation coefficient	Coefficient of determination	Standard partial regression coefficient (ratio)				
		Appearance	Aroma	Taste	Stickiness	Hardness
0.991***	0.982	0.403(39.5)	0.090(8.8)	0.397(38.9)	0.125(12.2)	0.006(0.6)

***: Significant at 0.1% level.

Table 4. Variation of physicochemical properties

	Amylose content (%)	Protein content (%)	Breakdown value (RVU)	Hardness/ adhesion ratio
Maximun value	19.4	12.5	103	16.7
Minimun value	15.7	5.5	56	5.9
Mean value	17.4	7.6	79	9.6
Standard deviation	0.88	1.44	14.1	2.84
Coefficient of variation (%)	5.1	18.9	17.8	29.6

Table 5. Correlation coefficient of physicochemical properties with each evaluation item in sensory test

	Amylose content	Protein content	Breakdown value	Hardness/ adhesion ratio
Overall eating–quality	–0.060	–0.530**	0.499**	–0.597***
Appearance	–0.060	–0.487**	0.451*	–0.536**
Aroma	0.138	–0.431*	0.404*	–0.550**
Taste	–0.008	–0.557**	0.503**	–0.632***
Stickiness	–0.127	–0.514**	0.581**	–0.694***
Hardness	0.202	0.048	–0.341	0.451*

*, **, ***: Significant at 5%, 1%, 0.1% level, respectively.

Table 6. Standard partial regression coefficient of physicochemical properties with each item in sensory test

	Multiple correlation coefficient	Coefficient of determination	Standard partial regression coefficient (ratio)		
			Protein content	Breakdown value	Hardness/ adhesion ratio
Overall eating–quality	0.676***	0.457	–0.310(36.9)	0.243(28.9)	–0.287(34.2)
Appearance	0.613***	0.376	–0.293(38.4)	0.223(29.2)	–0.247(32.4)
Aroma	0.583**	0.340	–0.199(28.6)	0.131(18.8)	–0.366(52.6)
Taste	0.704***	0.496	–0.319(36.8)	0.216(24.9)	–0.332(38.3)
Stickiness	0.747***	0.558	–0.215(23.8)	0.272(30.1)	–0.417(46.1)
Hardness	0.511**	0.261	–0.265(29.6)	–0.095(10.6)	0.536(59.8)

, *: Significant at 1% and 0.1% level, respectively.

tion coefficients in other items were 0.51–0.75. The coefficient of determination was 0.376 in appearance, 0.340 in aroma, 0.496 in taste, 0.558 in stickiness and 0.261 in hardness. Thus, it was large in stickiness and small in hardness. The contribution ratio of physicochemical properties to evaluation items in the sensory test was estimated from the standard partial regression coefficient. The contribution ratio of protein content to overall eating–quality was 37%, that of breakdown value was 29% and that of hardness/adhesion ratio was 34%. Contribution ratio of protein content, breakdown value and hardness/adhesion ratio to other evaluation items were 38, 29 and 32% in appearance, 29, 19 and 53% in aroma, 37, 25 and 38% in taste, 24, 30 and 46% in stickiness, and 30, 11 and 60% in hardness, respectively.

DISCUSSION

In this study, using the varieties collected from a wide area from Hilongjian to Jiangus Province, relationship between evaluation items in sensory test and physicochemical properties was analyzed.

In the sensory test, a large varietal difference was observed in overall eating–quality and appearance (Table 1). On the other hand, the varietal difference was small in hardness. The overall eating–quality was positively correlated with appearance, aroma, taste and stickiness, and negatively with hardness (Table 2). In multiple regression analysis using each evaluation items in sensory test as explanatory variables and overall eating–quality as dependent variable, multiple correlation coefficient was very high, and varietal difference in overall eating–quality was almost 100% explained by appearance, aroma, taste, stickiness and hardness (Table 3). However, for varietal difference in overall eating–quality, appearance and taste contributed less than 40%, aroma and stickiness about 10% and hardness did not contribute. It seems to be difficult to judge the varietal difference of hardness because the varietal difference in hardness was too small.

Physicochemical properties also varied with the variety, but the difference was large in hardness/adhesion ratio and small in amylose content (Table 4). The overall eating–quality was negatively correlated with protein content and hardness/adhesion ratio, and positively with breakdown value, but did not correlate with amylose content (Fig. 1). Appearance, aroma, taste and stickiness showed significant negative correlations with protein content and hardness/adhesion ratio, significant positive correlation with breakdown value (Table 5). Hardness had a significant positive correlation with hardness/adhesion ratio but no correlation with protein content and breakdown value. Thus, the varieties with low protein content and hardness/adhesion ratio, high breakdown value were considered to have high overall eating–quality due to good appearance, good aroma, good taste and high stickiness of cooked rice. However, amylose content did not show significant correlation with any items in sensory test. In this study, amylose content did not affect palatability directly. Hitherto in Japan, amylose content was considered to affect palatability (Inatsu, 1988; Matsue, 1993). However, it was difficult to judge varietal difference in palatability from amylose content in the plants widely distributed in large area (Matsue, 2012). In warm (hot) year or under conditions with a large amount of fertilizer, the effect of amylose content on palatability is decreased (Kusutani *et al.*, 1992; Matsue, 2012). In the present studies, palatability of rice collected from Heilingijing to Jiangen Province with different soil and weather conditions was examined. In addition, paddy field of China is fertilized with 3–4–times larger amount of nitrogen than in Japan (Cui *et al.*, 1999b). In this study, rice samples were collected from wide regions with a large amount of fertilizers applied. This may be why correlation of amylose content with palatability was weak.

To further analyze the relationship between physicochemical properties and sensory test, we performed multiple regression analysis using evaluation items in sensory test as dependent variables and physicochemical properties except amylose content as explanatory variables. When overall eating–quality was used as a dependent variable, a significant multiple correlation coefficient 0.676 was obtained, and 46% of the varietal difference in overall eating–quality was explained by protein content, breakdown value and hardness/adhesion ratio. Even when appearance, aroma, taste and stickiness were used as dependent variables, 35–55% of the varietal difference was explained by these three physicochemical properties. However, when hardness was used as a dependent variable, only 25% of the varietal difference was explained. It suggests that hardness was correlated with other properties.

The contribution ratios to palatability items in sensory test of protein content, breakdown value and hardness/adhesion ratio were different. Protein content, breakdown value and hardness/adhesion ratio correlated with overall eating–quality at a ratio of 37, 29 and 34%, respectively. The overall eating–quality was most strongly influenced by protein content (Kusutani *et al.*, 1992; Cui *et al.*, 2001) and most weakly by breakdown value. To the appearance, protein content most strongly contributed. On the other hand, to the aroma, stickiness and hardness, hardness/adhesion ratio most strongly contributed. To the taste, protein content and hardness/adhesion ratio contributed equally.

Thus, in this study, varietal difference in overall eating–quality in sensory test was about 46% explained by protein content, breakdown values and hardness/adhesion ratio. That is, without using the sensory test, palatability was estimated at a relatively high accuracy. Therefore in China also, in the early generation of selection with many lines, the lines should be roughly selected based on their physicochemical properties, and in the middle to late generation with a smaller number of lines, palatable lines should be selected by a sensory test.

REFERENCES

Cui, J., A. Yamamura, A. Kusutani, M. Toyota, M. Morokuma, A.

Asanuma and M. Ichii, H, Tanno, R. Zhang and D. Hong 1999a. Studies on Palatability of Chinese and Japanese Rice Cultivars – Comparison under the same cultivation condition–. Shikoku J. Crop Sci. **36**: 1–13*

Cui, J., A. Yamamura, A. Kusutani, M. Toyota, M. Morokuma, K. Asanuma, H. Tanno, J. Zhao, Y. Li and X. Chen 1999b. Studies on Palatability of Chinese and Japanese Rice Cultivars–Difference between producing districts, Kagawa in Japan and Tianjin in China–. Shikoku J. Crop Sci. **36**: 14–27*

Cui, J., J. Zhao, A. Kusutani, M. Morokuma, M. Toyota, K. Asanuma and H. Tanno 2000. Studies on Palatability of Rice Grown in Tianjin District, China–Varietal difference–. Jpn. J. Crop Sci. **69**: 314–319**

Cui, J., A. Kusutani, J. Zhao, J. Liu, X. Chen, M. Morokuma, M. Toyota and K. Asanuma 2001. Studies on Palatability of Chinese and Japanese Rice Cultivars–Characteristics with reference to grain–protein content–. Shikoku J. Crop Sci. **38**: 1–15*

Cui, J., Y. Matsue, A. Kusutani, D. L. Ding, X. Zhang and S. Morita 2011. Sensory Test on *Japonica–Ttype* Chinese Rice Cultivars by Japanese and Chinese Panels. Jpn. J. Crop Sci. **80**: 84–89**

Inatsu, O. 1988. Studies on Improving the Eating Quality of Hokkaido Rice. Report of Hokkaido Prefectural Agricultural Experiment Stations **66**: 1–89*

Kusutani, A., Asanuma. K., Kogure, K., Seki, M., Hirata. S. and Yanagihara. T. 1992. Yield and Eating Quality of Rice Cultivar Kinuhikari in Early Season Culture in Warmer Area. Jpn. J. Crop Sci. **61**: 603–609**

Li, H., S. C. Zhou, D. Q. Huang, S. C. Lai, Z. D. Wang, D. G. Zhou, and C. R. Wang 2014. Cognition and Breeding Practice for Good Eating Quality of Rice. Guandong Agricultural Science **41**: 15–18***

Matsue, Y. 1993. The Effects of Environmental Conditions on Palatability and Physicochemical Properties of Rice and the Evaluation of Good Eating Quality Rice Varieties. Rep. of Special Bull. of Fukuoka Agric. Res. Cent. **6**: 1–73**

Matsue, Y. 2012. Palatability Science of Rice. Yokendo, Tokyo, Japan: 1–141*

Xie, L. H., J. Luo, S. Q. Tang, N. Cheen, G. A. Jiao, G. N. Shao, X. J. Wei and P. S. Hu 2013. Proteins Affect Rice Eating Quality Properties and Its Mechanism. Chin. J. Rice Crop Sci. **27**: 91–96***

Xu, Z. J. , W, F, Chen, D. R. Ma, X. D. Wu, Y. Y. Zhen and J. Y. Wang 2005. Relationship between Eating Quality and other Quality Characters of Rice in Liaoning. Acta. Agronomica Sinica **31**: 1092–1094***

* :In Japanese.
** :In Japanese with English abstract.
***:In Chinese with English abstract.