SOME PHYSIOLOGIC SPECIALIZATIONS OF *PIRICULARIA ORYZAE* CAV. IN TAIWAN[1]

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The physiologic races of blast disease have played an important role in rice breeding investigation. Their importance has also been emphasized by many scientists. So far, disease resistant varieties is considered to be a very practical method to control or limit the prevalence of this disease. But, while a resistant variety is developed and released for certain physiologic races occurring in certain area, a new physiologic race often replaces the original one, and attacks the new variety.

Hashioka (1952), tested the resistance of eight varieties to blast disease for five consecutive years, 1934–8, at seven different localities in Taiwan. In the first three years, Taichung No. 65 was the most resistant of all the varieties tested. In the next two years, Taichung No. 65 became moderately resistant. He stated that there were physiologic races of *Piricularia oryzae* with differing pathogenicity. Yamanaka (1957) described 9 races of this fungus in Japan, basing on the identity of the races on the reactions from 9 rice varieties. Nakanishi and Imamura (1960) isolated the physiologic races of *P. oryzae* from a single lesion. Latterell *et al.* (1954, 1960) differentiated 15 physiologic races of the fungus which were distinguished among 165 isolates from rice from all over the world, on the basis of their pathogenicity on 10 differentials. Atkins (1962) studied the prevalence and distribution of pathogenic races of *P. oryzae* in the United States. He found that the new race No. 16 differed from the 15 races which were previously identified by Latterell *et al.* in 1960. He also stated that several U. S. rice varieties were resistant to most races, but none of them was resistant to all. In Taiwan, Ou (1954), Ou and Lin (1958), Hsieh (1961), Oka (1957), Hung and Chien (1961), and Chien and Lin (1962) stated that there were physiologic races occurring in the island.

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This investigation was made of comparisons of the pathogenicity of several single spores isolated from the various rice varieties in Taiwan. The comparison was also made with the differentials and pathogenic races of blast fungus from Yamanaka of Japan (1957).

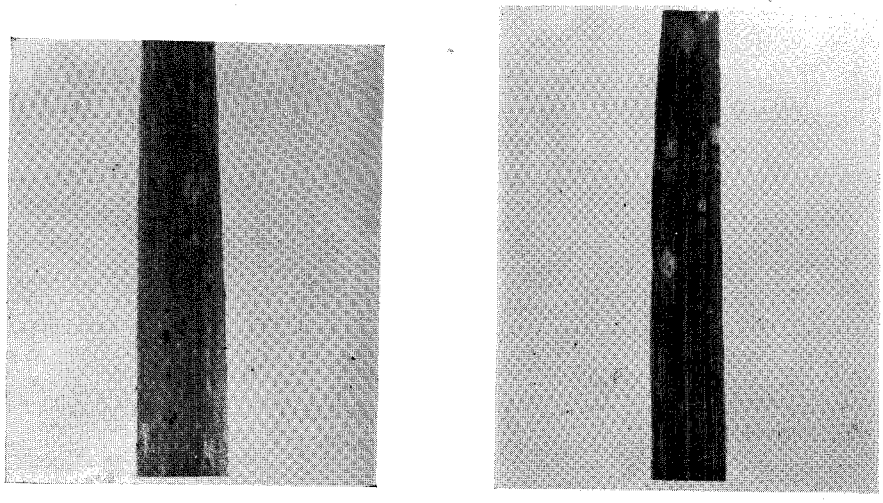
Materials and Methods

The pathogenicity of blast fungus was determined separately from 65 single-spore isolates collected from six rice varieties. The isolates obtained were from the lesions of the diseased leaves which were collected from several parts of Taiwan. They were: Nankang (南港), Taipei (臺北), Taichung (臺中), Chia-yi (嘉義), Tainan (臺南), Kaohsiung (高雄), and Pintung (屏東). All cultures were maintained on potato agar slant. Thirty-five rice varieties used in this experiment had been purified in this Institute. Plants grown for pathogenic tests were planted in four-inch pots in the greenhouse. Three to ten plants were used for the inoculation. The inoculation was done approximately three weeks after the planting. The spores taken for inoculation were prepared from cultures grown on barley media (Yamanaka, 1961). Spores were washed off in distilled water and adjusted to a concentration of 10–20 conidia found from examining under microscope's low power field (15×10). This spore suspension was applied to the plants by an electric paint sprayer in late afternoon. The quantity of the inoculation was quite ample to prevent any escaped plants. After the inoculation, plants were covered by a polyethylene plastic sheet fixed on wooden frame. The cover was removed 24 hours later. The temperature in the greenhouse had not been strictly controlled. Its range was from 24°C to 30°C which would favor the development of the disease. The scoring standard used was a modified one from that of Yamanaka (1957) and Abumiya (1955). These two workers classified the blast reactions into four categories. They were: R (resistant); RS (resistant-susceptible); MS (moderate-susceptible) and S (susceptible). In this country, the two extreme classes, R and S, showed very high stability. But the other two mesothetic classes showed somewhat unstable and were easily modified by environmental factors, especially the temperature. Of the experiences obtained from our repeated trials, the mesothetic reactions were finally become susceptible lesions. For this reason, it would be better to have a clear and consistent classification, so the blast reaction will not be studied till the seventh or eighth day when the final lesion occurs, and the mesothetic reactions RS or MS will be stablized and finally reveal susceptible lesions at that time. Therefore, the score used in this investigation was dichotomous instead of trichotomous. They were R (resistant) and S (susceptible) only. The so-called mesothetic reactions of Yamanaka (1957) or Abumiya (1955) were then placed into the susceptible class. R and S used in the study are shown in Figure 1

and described as follows.

1. Lesions of resistant (R) types: Lesions restricted in small area, size not larger than 1–1.5 mm. in diameter. Colors may be dark-brown, yellowish with or without necrotic center.
2. Lesions of susceptible (S) types: Expanding lesions, size larger than 1.5 mm. in diameter, grayish with necrotic center, water soaked appearance, spindle shape surrounded by a yellowish discolored margin.

Figure I. Showing of difference resistant and susceptible lesions.



Resistant lesions Susceptible lesions

Results and Discussion

Isolates collected from the commercial varieties in Taipei, Tainan and Kaohsiung were separately used in the preliminary seedling tests. Then, the host varieties were separated into groups according to their relative susceptibility or resistance to those isolates. The representative varieties from these groups were henceforth termed differential hosts. The differential hosts selected were Kwan-fu No. 401, Taichung special No. 6, Hsinchu No. 50, Chianan No. 8, Taichung No. 178, Chianung No. 280, Chianung No. 242, Pekan and Wu-Shung-Kan.

The reactions of the nine differentials to five blast races are given in Table 1. Of the data obtained in Table 1, five pathogenic groups are designated as races 1, 2, 3, 4, and 5. In race 1, the pathogens collected from Pintung, Tainan and Nankang were highly pathogenic to varieties Chianan No. 8, Taichung No. 178 and Chianung No. 242 and were weakly pathogenic to varieties Kwan-fu No. 401, Hsinchu No. 50, Taichung spe. No. 6 and Chianung No. 280. The isolates of race 2 were collected from Taipei and Kaohsiung. They were weakly pathogenic to the testers with the exception of variety Chianan No. 8. Race 3 isolates were collected from Taipei and Tainan. They were highly

Table 1. *Relation of differentials to Physiologic races.*

Varieties	Races, origins and No. of isolations					
	1	2	3	4	5	X
	6f,6g,6e, 8a,8d, 11a,11c.	1a,1b,1c, 1d,1f,1g, 1e, 10a,10b,	2a,2b,2c, 8c,8f, 9a,9b,9c, 9d,9e,9f	2d,2e,2f, 2g, 8b,	3b,3c,3d, 3e, 5b,5c,5d, 5e,	7a,7b,7c, 7d,7e,7f, 7g,7h, 6a,6b,6c, 5a,4a,4b, 4c,
Kwan-fu No. 401 Taichung spe. No. 6 Hsinchu No. 50	R	R	R	R	S	Pathogenicity unidentified
Chianan No. 8	S	S	S	R	S	Pathogenicity unidentified
Taichung No. 178 Chianung No. 242	S	R	S	S	R	Pathogenicity unidentified
Chianung No. 280	R	R	S	R	R	Pathogenicity unidentified
Pekan	R	R	R	R	R	Pathogenicity unidentified
Wu-Shung-Kan	S	S	S	S	S	Pathogenicity unidentified

Arabic figure represents the origin of the collection: 1, 2=Taipei; 3=Chia-yi; 4, 5=Taichung; 6, 7=Nankang; 8, 9=Tainan; 10=Kaohsiung; 11=Pintung.
English letter represents the single condium.

pathogenic to varieties Chianan No. 8, Taichung No. 178, Chianung No. 242 and Chianung No. 280. Race 4 collections were from Taipei and Tainan. They were highly pathogenic to Taichung No. 178 and Chianung No. 242 and were weakly pathogenic to Kwan-fu No. 401, Taichung spe. No. 6, Hsinchu No. 50, Chianan No. 8 and Chianung No. 280. Race 5 collections were from Taichung and Chia-yi. They differed from other races by their ability to infect Kwan-fu No. 401, Taichung spe. No. 6, Hsinchu No. 50 and Chianan No. 8. Of the nine differentials found, two testers with an extreme reaction were found. Wu-Shung-Kan was susceptible to all races tested so far, whereas Pekan was resistant. The isolates grouped in race X, as isolates 7s, 5s, 4s and some of the 6s, exhibited their pathogenicity mostly only on Wu-Shung-Kan or revealed only resistant lesions on a few hosts. For these reasons, those pathogens although have their own characteristics but can not yet be defined as a race. This speciality of pathogenicity may be due to the long duration of medium culture, and it would be considered as a major characteristics differing with other races.

In the meantime, one special phenomenon has to mention that is variety Taichung spe. No. 6 showing resistant reactions to four of the five races identified, while it is generally considered as a moderate susceptible variety to blast disease. On the other hand, variety Chianung No. 242 is being accepted as a blast resistant variety in the island, and it shows its susceptibility to three out

of the five races. This fact will not be hard to explain that the variations of infections are due to the differentiation of pathogens. Other words, some of the blast strains found here are not identical with those happening under natural condition. These evidences also give supports to the concept that phenotypic reactions are the presentation of final interrelation between host and parasite.

One weak point of Table 1 is that differential Kwan-Fu No. 401, Taichung spe. No. 6 and Hsinchu No. 50 as well as Taichung No. 178 and Chianung No. 242 have the same infection to the races. Those hosts may be able to differ some other new races occurring in the future.

Japan is a next-door neighbor to this country. Testers (Yamanaka, 1957)

Table 2. *Infections of Japanese races on Japanese testers.*
(Data copied from Yamanaka, 1957)

Varieties	Physiologic races									
	T	A_I	A_{II}	B_I	B_{II}	C_I	C_{II}	D_I	D_{II}	E
Woo-gen	R	R	R	R	R	R	R	R	R	R
PI No. 1	MS,RS	R	R	R	R	R	R	R	R	R
Kanto No. 51	MS,R	S	MS,RS	R	R	R	R	S,MS	R	R
Ishigari-Shirage	MS,R	MS	S,MS	S,MS	MS,RS	R	R	R	R	R
Ayanishiki	S,MS	MS	MS,RS	S,MS	MS,RS	S	MS,R	R	R	R
Ging-ga	MS,S	MS	MS,RS	S,MS	MS,RS	S	RS,R	S,MS	S,MS	R
No-ling No. 20	S	S	S,MS	S	S	S	R-S	S	S	R
No-ling No. 17	S	S	S	S	S	S	S,MS	R	R	R
Aichi-Asaih	S	S	S	S	S	S	S	R	R	R

Table 3. *Infection of Taiwan races on Japanese testers.*

Varieties	Physiologic races						
	1		2	3		4	5
	11 a	6 e		1 a	2 a		
Woo-gen	R	R	R	R	R	—	R
PI No. 1	R	R	R	R	R	—	R
Kanto No. 51	R	R	R	R	R	—	R
Ishigari-Shirage	S	R	R	S	S	—	R
Ayanishiki	R	R	R	R	R	—	R
Ging-ga	R	S	S	S	S	—	S
No-ling No. 20	R	S	S	S	S	—	S
No-ling No. 17	S	R	S	R	S	—	S
Aichi-Asaih	R	R	R	R	R	—	S

** The categories S, RS and MS used by Yamanaka (1957) were scored in a single category S in this investigation.

were shipped from Japan, and a comparison was made in order to understand the relation of the blast disease occurring in these two rice-eating countries. Of the data stated in Table 2 and 3, although the Yamanaka's races have not been directly tested and compared in Taiwan, it seems that they do show different pathogenicity,

Our isolates 11a and 6e of race 1 and 1a and 2a of race 3 showed various infections on the Yamanaka's testers (Table 3). The isolate 6e showed both resistant reaction to the Yamanaka's testers, Ishigari-Shirage and No-ling No. 17, and however, the isolate 11a was susceptible to the same two testers. Isolates 1a and 2a of race 3 showed resistant and susceptible reaction to differential No-ling No. 17. These results suggest that there are some minute variations involving in the genotypes of our races. The variations would be identified while other testers would have been found.

Summary

1. The isolates of blast fungus were collected from Taipei, Taichung, Chia-yi, Tainan, Kaohsiung, Pintung and Nankang.

2. Thirty-five commercial varieties had been tested artificially against those isolates. Within those varieties tested, nine varieties shown differential ability had been selected and purified as testers to differentiate the physiologic races of blast fungus.

3. The isolates obtained were placed into five main groups according to their virulency on the differentials. The five main groups were then termed races 1, 2, 3, 4 and 5 of Taiwan.

4. By using Yamanaka's differentials, few of races collected here differed in infection from those tested by Yamanaka.

臺灣稻熱病菌生理分化現象之研究

郭 宗 德　吳 旭 初　王 文 浩

1. 在臺灣的南港、臺北、臺中、嘉義、臺南、高雄及屏東等地區，採集水稻稻熱病害的新鮮標本，應用人工純系分離及培養的方法，固定該等病原菌。

2. 在溫室中 (28°C 左右，保持最大濕度) 將純系分離的稻熱病菌的孢子，以噴霧接種法，接種於 35 種純化的栽培稻上，由於寄主對不同病原菌的反應有差異，選出九種水稻當作"鑒別寄主"。

3. 純系分離的稻熱病病原菌，接種在選出的鑒別寄主上，得到五種病原性不同的生理小種，即1，2，3，4，及 5.

4. 將上述得到的五種生理小種，接種於 Yamanaka 的辨別寄主上，由其寄主的反應，發現與 Yamanaka 的試驗記載略有不同。（摘要）

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