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Genetic Relationships among Korean Brown Frog Species (Anura, Ranidae), with Special Reference to Evolutionary Divergences between Two Allied Species Rana dybowskii and R. huanrenensis

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ABSTRACT—Allozyme analysis for 41 populations of brown frog species, *Rana dybowskii*, *R. huanrenensis*, and *R. amurensis* from Korea and three reference species (Chinese *R. chensinensis* and Japanese *R. dybowskii* and *R. tsushimensis*), were performed to clarify taxonomic status of Korean brown frogs. The level of average genetic differentiation (Nei's D) among local populations of each species in Korea was very low (D<0.012) and Korean and Japanese *R. dybowskii* also showed conspecific level of differentiation (D=0.070). Whereas, much larger, discrete genetic differences were detected in the interspecific comparisons (D>0.370). In the genetic relationships among five species examined, the 24 chromosome brown frogs (*R. dybowskii*, *R. huanrenensis*, and *R. chensinensis*) did not form a monophyletic group. *Rana dybowskii* with the chromosome number of 2n=24 was grouped together with *R. amurensis* with the chromosome number of 2n=26. The hypothesis of reversal change from 24 to 26 in Korean *R. amurensis* seems to better explain the phylogenetic relationships of east Asian brown frogs than the assumption of parallel reduction in chromosome number from 2n=26 to 24 in *R. dybowskii* and in the common ancestor of *R. huanrenensis* and *R. chensinensis*. The genetic, morphological, and reproductive divergences between Korean *R. dybowskii* and *R. huanrenensis* were compared.

Key words: allozyme, brown frog, chromosome number, genetic differentiation, phylogenetic relationship

INTRODUCTION

The Eurasian brown frogs are a morphologically conservative assemblage consisting of the Eurasian *Rana temporaria* and a large number of similar species considered to be related (Frost, 1985; Borkin and Kuzmin, 1988; Green and Borkin, 1993; Nishioka *et al.*, 1992; Maeda and Matsui, 1999). The chromosome number of great majority of *Rana* species is 26 and most of brown frog species have the same number. Some of brown frogs, however, are unique in having diploid chromosomes of 2n=24 (Matsui, 1991; Green and Borkin, 1993; Xie *et al.*, 1995). These 24 chromosome brown frogs include the European *R. arvalis* and several

dybowskii, R. ornativentris, R. pirica, and R. huanrenensis (Kobayashi, 1962; Seto, 1965; Wu, 1982; Green, 1983; Luo and Li, 1985; Lee and Park, 1986; Ma, 1987; Wei et al, 1990; Liu et al., 1993; Green and Borkin, 1993; Xie et al., 1995; Lee and Lee, 1998). These east Asian brown frogs are quite similar in morphology, and are very difficult to identify (Nakamura and Ueno, 1963; Matsui et al., 1993, 1998; Xie et al., 1995; Yang et al., 2000). Indeed, most of them were originally described on the basis of slight morphological differences. Recently, taxonomic status of each species was made clearer by lines of additional information, such as considerable genetic divergences among them (Matsui, 1991; Green and Borkin, 1993; Tanaka-Ueno et al., 1998; Matsui et al., 1998; Kim et al., 1999; Yang et al., 2000). Although extensively studied in the laboratory (Kawamura et al., 1981), the direct evidence of reproductive isolation in the field among these allied species have never been reported

east Asian species allied to R. chensinensis, such as R.

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because of their geographic isolation due to allopatric distribution

Until recently, it has been reported that *R. dybowskii* (a 24 chromosome member) and *R. amurensis coreana* (a 26 chromosome member) are distributed in South Korea (Yang and Yu, 1978; Sengoku, 1979; Green and Borkin, 1993; Matsui *et al*, 1998). Most recently, we (Yang *et al.*, 2000) reported a new Korean brown frog member (*R. huanrenensis* Fei, Ye and Huang, 1990) which was morphologically and karyologically (2n=24) very similar to *R. dybowskii*.

In this study, we investigate the degree of inter- and intraspecific genetic variation and to clarify the genetic relationships among three species of Korean brown frogs. For comparisons, Japanese *R. dybowskii* and *R. tsushimensis* and Chinese *R. chensinensis* are also incorporated to the analysis. In addition, we surveyed the levels of morphological, genetic, and reproductive divergence between sympatricsamples of *R. dybowskii* and *R. huanrenensis* from South Korea.

MATERIALS AND METHODS

Collection and field notes

Five brown frogs were collected from 41 localities in Korea, Japan, and China (Table 1). During most collecting trips in Korea and Japan, the notes and photographs on color pattern of each specimen and records of each breeding site were taken.

Protein Electrophoresis

For an electrophoretic examination, a total of 849 specimens belonging to 41 populations of five species were employed. These include 10 populations of *Rana huanrenensis* from South Korea, 17 populations of *R. dybowskii* from South Korea and Japan, 2 populations of *R. chensinensis* from China, 11 populations of *R. amurensis* from South Korea, and 1 population of *R. tsushimensis* from Japan (Table 1).

Live samples were transported to the laboratory and were stored at -70°C until use. In the laboratory, the tissues of liver, heart and skeletal muscle were removed from each specimens and homogenized by glass homogenizer in an equal volume of distilled water and were centrifugated at 18,000 rpm for 30 min at 4°C to obtain the supernatant for electrophoresis. Voucher specimens were fixed in 10% formalin, preserved in 70% ethanol, and deposited in Yang's collection at Inha University. The supernatant was subjected to horizontal starch-gel (12%) electrophoresis and histochemical staining procedures (Yang *et al.*, 1997: Appendix I). Multiple loci were numbered sequentially, and alleles were designated alphabetically with "a" being the fastest migrant.

Individual genotypes were used to calculate allele frequencies for each population, these in turn were used to calculate matrices of genetic similarity (Rogers, 1972) and genetic distance (Nei, 1978). Three different methods were employed to infer relationships among populations. First, Nei's (1978) distance was clustered according to the UPGMA algorithm (Sneath and Sokal, 1973). Then, modified Rogers' distance (Wright, 1978) was analyzed by the Neighbor-joining (NJ) method (Saitou and Nei, 1987), and finally, we employed Felsenstein's (1993) DNAML procedure with allele frequencies for the maximum-likelihood (ML) analysis. These analyses were performed by use of BIOSYS-1 (Swofford and Selander, 1981) and PHYLIP vers. 3.5 C computer packages (Felsenstein, 1993).

Morphology

In order to detect morphological differences between Korean *Rana dybowskii* and *R. huanrenensis*, conditions of vocal sacs and the pattern of coloration on the body were examined for these two species.

RESULTS

Genetic variation and relationships among brown frogs

Genetic variation—By-products of 18 loci were scored from 13 enzymes and general proteins. Observed allelic frequencies are given in Appendix II.

Based on allelic frequencies listed in Appendix II, the degree of genetic variation of each population was estimated (Table 2). The genetic variability of R. dybowskii was P=26.0% (22.2-33.3%), Ho=0.118 (0.070-0.183), and He=0.122 (0.078-0.153). The genetic variabilities of R. huanrenensis and R. amurensis were P=22.2% (16.7–27.8%), Ho=0.063 (0.046-0.073), He=0.067 (0.058-0.081) and P=22.2% (5.6-33.3%), Ho=0.080 (0.029-0.120), He=0.086 (0.035-0.124), respectively. In Korean brown frogs, Kanseong population of R. dybowskii had the highest genetic variability (P=36.4%, Ho=0.165, He=0.165) while Koseong population of R. amurensis showed the lowest variability (P=9.1%, Ho=0.048, He=0.042). On the other hand, Chinese R. chensinensis, a reference species, showed P=22.3%, Ho=0.078, He=0.075. Another reference species Japanese R. tsushimensis, was more variable, with P=27.8%, Ho=0.094, He=0.097, than in Korean brown frog species.

Genetic relationships—Based on allelic frequencies listed in Appendix II, average genetic similarities (Rogers' S) and distances (Nei's D) among populations of five brown frog species were calculated (Appendix III). In the Korean brown frogs, *R. huanrenensis*, *R. dybowskii* and *R. amurensis*, the degree of genetic differentiation within a species was small (D=0.034: Appendix III), but differentiations among these Korean brown frogs were very distinct (D=0.584 between *R. huanrenensis* and *R. amurensis*, and D=0.788 between *R. huanrenensis* and *R. amurensis*, and D=0.500 between *R. dybowskii* and *R. amurensis*) due mainly to *Gp-4*, *aGpd*, *Mdh*, and *Ldh-1* loci that were ascertained as diagnostic among these Korean species.

When populations of 24 chromosome species from outside of Korea were included, genetic dissimilarities between *R. huanrenensis* (populations 1–10; Appendix III) and *R. dybowskii* (pops. 11–30) included fixed allelic differences at *Gp-4*, *Mdh*, and *Iddh* loci and diagnostic differences at the 95% confidence level (Ayala and Powell, 1972) at *Ldh-1* locus. *Rana huanrenensis* and *R. chensinensis* (pops. 28 and 29) included fixed allelic difference at *Ldh-1* locus and diagnostic differences at *Iddh*, *Aat-1*, and *Acoh*. Fixed allelic differences at *Gp-4*, *Ldh-1*, *Mdh*, and *Iddh* and diagnostic differences at *Aat-1* were found between *R. dybowskii* and *R. chensinensis* (Appendix II). Among populations of three brown frog species with 24 chromosomes (Appendix III),

Table 1. Collection localities, collection dates, and sample sizes (N) for electrophoretic and morphological analyses of *Rana huanrenensis*, *R. dybowskii*, *R. chensinensis*, *R. amurensis*, and *R. tsushimensis* from Korea, Japan, and China.

	Collection localities	Date	Ν
	Rana huanrenensis (2n=24)		
1.	Jangseong: Bukha-myon, Jangseong-gun, Chollanam-do	Mar. 29, 1995	2
2.	Pohang: Bokyung-sa, Pohang-shi, Kyongsangbuk-do	Apr. 25, 1997	2
3.	Cheongsong: Daejeon-sa, Cheongsong-gun, Kyongsangbuk-do	Mar. 28, 1997	3
4.	Yeongdeog: Namjung-myon, Yeongdeog-gun, Kyongsangbuk-do	Apr. 25, 1997	2
5.	Pyeongchang: Chinbu-myon, Pyeongchang-gun, Kangwon-do	May 19, 1994	
6.	Hanso-ri: Hanso-ri, Bekjeon-myon, Jeongseon-gun, Kangwon-do	Apr. 27, 1995	2
7.	Oban-ri: Oban-ri, Dong-myon, Jeongseon-gun, Kangwon-do	Mar. 27, 1997	2
8.	Inje: Baekdam-sa, Buk-myon, Inje-gun, Kangwon-do	Apr. 14, 1995	
9.	Kapyeong: Hwaak-ri, Buk-myon, Kapyeong-gun, Kyonggi-do	Apr. 4, 1998	1
10.	Donghae: Bicheon-dong, Donghae-shi, Kangwon-do <i>R. dybowskii</i> (2n=24)	Feb. 26, 1998	3
11.	Yangpyeong: Yongmun-myon, Yangpyeong-gun, Kangwon-do	Apr. 3, 1997	1
12.	Cheongyang: Taechi-myon, Cheongyang-gun, Chungchongnam-do	Mar. 30, 1997	2
13.	Muju: Ansung-myon, Muju-gun, Chollabuk-do	Mar. 12, 1997	2
14.	Jangseong: Bukha-myon, Jangseong-gun, Chollanam-do	Mar. 29, 1995	3
15.	Kurye: Hwaom-sa, Kurye-gun, Chollanam-do	Mar. 6, 1994	1
16.	Haenam: Masan-myon, Haenam-gun, chollanam-do	Mar. 16, 1997	1
17.	Jeju: Sogwipo-shi, Jeju-do	Mar. 23, 1996	3
18.	Keoje: Shinhyun-up, Keoje-shi, Kyongsangnam-do	Mar. 15, 1997	2
19.	Hadong: Ssangkye-sa, Hadong-gun, Kyongsangnam-do	Mar. 15, 1997	2
20.	Yangsan: Naewon-sa, Yangsan-gun, Kyongsangnam-do	Mar. 10, 1995	2
21.	Donghae: Bicheon-dong, Donghae-shi, Kangwon-do	Mar. 21, 1997	2
22.	Inje: Baekdam-sa, Buk-myon, Inje-gun, Kangwon-do	Apr. 14, 1995	1
23.	Kanseong: Kanseong-up, Koseong-gun, Kangwon-do	Apr. 15, 1995	
24.	Keojin: Keojin-up, Koseong-gun, Kangwon-do	Mar. 2, 1997	2
25.	Kapyeong: Hwaak-ri, Buk-myon, Kapyeong-gun, Kyonggi-do	Apr. 4, 1998	1
26.	Wonju: Chiak-Mt., Wonju-shi, Kangwon-do	May 23, 1997	1
27.	Tsushima Isl.: Tokoya, Tsushima-Isl., Nagasaki-pref., Japan <i>R. chensinensis</i> (2n=24)	Mar. 9, 1998	
28*.	Ningxia Hui: Yinnan-pref., Ningxia Hui-prov., China	_	
29*.	Qinghai: Haidong-pref., Qinghai-prov., China <i>R. amurensis</i> (2n=26)	_	
30.	Haenam : Masan-myon, Haenam-gun, Chollanam-do	Mar. 16, 1997	2
31.	Kangwha: Naega-myon, Kangwha-gun, Incheon	Apr. 4, 1997	3
32.	Sorae : Sorae, Shihung-shi, Kyonggi-do	May 22, 1995	
33.	Yangpyeong : Yongmoon-myon, Yangpyeong-gun, Kyonggi-do	Sep. 26, 1997	2
34.	Cheongju : Sangdang-dong, Cheongju-shi, Chungchongbuk-do	Mar. 12, 1997	3
35.	Yeongdong : Chupungryong-myon, Yeongdong-gun, Chungchongbuk-do	Sep. 28, 1997	3
36.	Cheongyang : Chongsan-myon, Cheongyang-gun, Chungchongnam-do	Mar. 29, 1997	3
37.	Yangsan: Changan-up, Yangsan-gun, Kyongsangnam-do	Mar. 10, 1995	
38.	Kyeongju: Kangdong-myon, Kyeongju-shi, Kyongsangbuk-do	Jun. 20, 1997	3
39.	Kangnung : Yuchon-dong, kangnung-shi, Kangwon-do	Sep. 27, 1997	3
40.	Koseong : Keojin-up, Koseong-gun, Kangwon-do R. tsushimensis (2n=26)	Mar. 21, 1997	2
41.	Tsushima Isl.: Tokoya, Tsushima-Isl., Nagasaki-pref., Japan	Mar. 9, 1998	1

^{*} Part of frozen tissues (RM 5176, 5178, 5180, 5308, 5309, 5431, 5432, and 5435, and TP 19669 and 19670) deposited in the MVZ (Museum of Vertebrate Zoology, University of California, Berkely).

average genetic distances among local populations of a single species were low (D=0.008 in *R. huanrenensis*, D=0.005 in Korean *R. dybowskii*, D=0.070 in Korean and Japanese

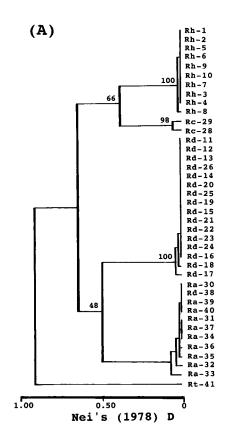
R.~dybowskii, D=0.053 in R.~chensinensis), whereas the average genetic distances among three species were distinctly high (D=0.584 between R.~huanrenensis and R.~

Table 2. Genetic variation of 41 populations in *Rana huanrenensis*, *R. dybowskii*, *R. chensinensis*, *R. amurensis* and *R. tsushimensis* from Korea, Japan, and China.

			Mean N	% Polymorphism	Mean Heterozygosity			
	Population	N	of Alleles (N)	(P)	Observed (Ho)	Expected (He)		
Rana hu	anrenensis							
1.	Jangseong	27	1.3	27.8	0.064	0.080		
2.	Pohang	28	1.6	22.2	0.046	0.060		
3.	Cheongsong	30	1.5	22.2	0.065	0.065		
4.	Yeongdeog	26	1.4	22.2	0.073	0.060		
5.	Pyeongchang	8	1.4	27.8	0.069	0.072		
6.	Hanso-ri	29	1.6	16.7	0.050	0.058		
7.	Oban-ri	29	1.6	16.7	0.073	0.066		
8.	Inje	7	1.3	22.2	0.063	0.081		
9.	Kapyeong	16	1.4	27.8	0.066	0.066		
10.	Donghae	30	1.6	16.7	0.063	0.058		
R. dybov	vskii							
11.	Yangpyeong	16	1.7	22.2	0.108	0.113		
12.	Cheongyang	21	1.9	22.2	0.138	0.120		
13.	Muju	21	1.8	22.2	0.116	0.131		
14.	Jangseong	33	2.0	22.2	0.121	0.131		
15.	Kurye	14	1.6	27.8	0.095	0.117		
16.	Haenam	14	1.4	27.8	0.087	0.118		
17.	Jeju	30	1.4	22.2	0.070	0.078		
18.	Keoje	27	1.6	27.8	0.130	0.122		
19.	Hadong	25	1.7	27.8	0.109	0.124		
20.	Yangsan	29	1.8	27.8	0.111	0.125		
21.	Donghae	29	1.9	22.2	0.113	0.109		
22.	Inje	14	1.6	22.2	0.119	0.120		
23.	Kanseong	7	1.5	27.8	0.183	0.153		
24.	Keojin	28	1.9	33.3	0.129	0.135		
25.	Kapyeong	13	1.7	27.8	0.120	0.123		
26.	Wonju	10	1.6	33.3	0.133	0.126		
27.	Tsushima Isl.	1	_	_	_	_		
R. chens	inensis							
28.	Ningxia	5	1.2	16.7	0.078	0.067		
29.	Quing	5	1.3	27.8	0.078	0.083		
R. amure	ensis							
30.	Haenam	26	1.4	16.7	0.068	0.070		
31.	Kangwha	30	2.1	33.3	0.107	0.115		
32.	Sorae	5	1.2	16.7	0.067	0.057		
33.	Yangpyeong	20	1.6	33.3	0.094	0.100		
34.	Cheongju	30	1.6	27.8	0.100	0.103		
35.	Yeongdong	30	1.6	22.2	0.083	0.082		
36.	Cheongyang	30	1.7	27.8	0.089	0.108		
37.	Yangsan	6	1.5	33.3	0.120	0.124		
38.	Kyeongju	35	1.7	22.2	0.076	0.084		
39.	Kangnung	30	1.3	16.7	0.044	0.058		
40.	Koseong	25	1.2	5.6	0.029	0.035		
R. tsushi	ŭ			3.0	3.320	2.500		
41.	Tsushima Isl.	10	1.3	27.8	0.094	0.097		

dybowskii, D=0.386 between R. huanrenensis and R. chensinensis, and D=0.485 between R. dybowskii and R. chensinensis).

Between Korean *R. amurensis* (pops. 30–40) and Japanese *R. tsushimensis* (pop. 41), both with 26 chromosomes, genetic dissimilarities included fixed allelic differ-



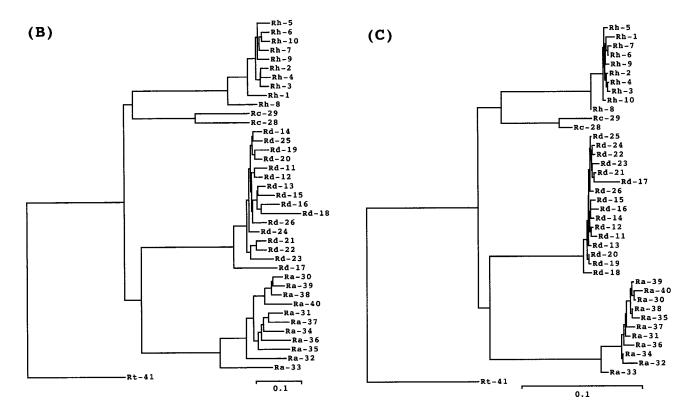


Fig. 1. A UPGMA tree (A), a neighbor-joining tree (B), and a maximum-likelihood tree (C) among a total of 41 populations of *Rana huanrenensis* (Rh), *R. dybowskii* (Rd), *R. chensinensis* (Rc), *R. amurensis* (Ra), and *R. tsushimensis* (Rt). For population number, refer to Table 1. Nodal values on the UPGMA tree (A) indicate percent support for branches in 100 bootstrap replicates.

ences at *Got-1*, *Gp-4*, *Idh*, *Sod*, *Ldh-1*, and *Ldh-2* loci and diagnostic differences (at the 95% confidence level) at *Mdh*, *Pgm-1*, and *Pgm-2* loci (Appendix II). The average genetic differentiation among these two 26 chromosome species were distinctly high (mean D=0.935).

Fig. 1A shows the UPGMA tree based on Nei's unbiased genetic distance. Although the bootstrap support for most of the nodes, except for monophyly of each species (not shown in the figure), was weak, *Rana tsushimensis* exhibited the earliest divergence among all populations examined. The remaining populations were divided into two distinct groups; One group included *R. huanrenensis* and *R.*

chensinensis, and the other included *R. dybowskii* and *R. amurensis*. Topologies of NJ (Fig. 1B) and ML (Fig. 1C) trees based on modified Rogers' distance and allele frequenicies, respectively, were similar to that of UPGMA tree in that *R. tsushimensis* first diverged and *R. amurensis* and *R. dybowskii*, and *R. chensinensis* and *R. huanrenensis*, respectively, formed a separate subcluster.

Comparisons between R. dybowskii and R. huanrenensis

Morphology — Intraspecific morphological variation was much less notable than interspecific one. Rana huanrenen-

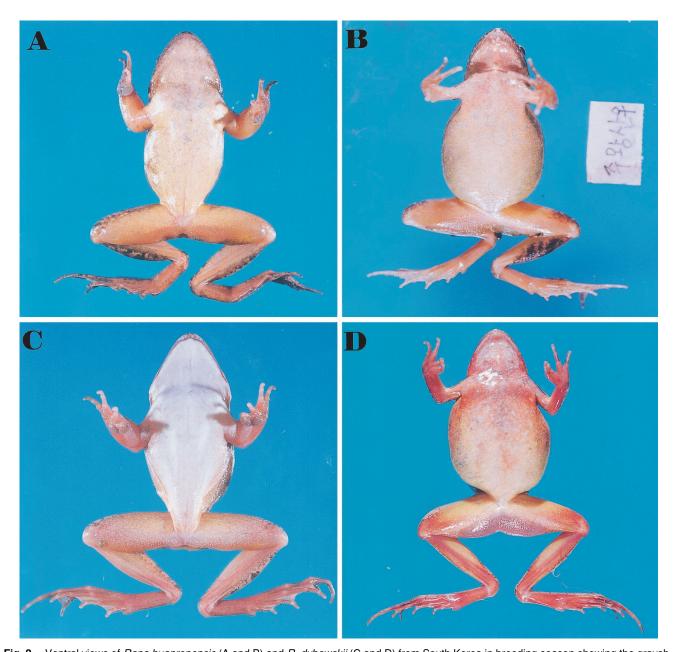


Fig. 2. Ventral views of *Rana huanrenensis* (A and B) and *R. dybowskii* (C and D) from South Korea in breeding season showing the grayshyellow throat and chest of male *R. huanrenensis* (A) compared to the milky-white throat and chest of male *R. dybowskii* (C) and the greenishyellow throat and chest of female *R. huanrenensis* (B) compared to the reddish-yellow throat and chest of female *R. dybowskii* (D).

aybowskii iii biccaiiig s	Cason							
Characters	Rana huanrenensis	Rana dybowskii						
Female ventral color	minute black dots densely distrib- uted over throat and yellowish green chest	red color patched over throat and chest						
Egg mass nature	relatively small and tightly clustered	relatively large and loose						
Egg deposition	egg mass attached on the sub- merged rock in montane streams	egg mass floating on still water mainly in rice field						

Table 3. Morphological and ecological diagnostic characters between *Rana huanrenensis* and *R. dybowskii* in breeding season

sis was morphologically very similar to *R. dybowskii*, but differs from the latter in the ventral color pattern (Fig. 2). In males, *R. dybowskii* had a milky white ground (Fig. 2C), whereas the ground color of male *R. huanrenensis* was yellowish gray with minute black dots densely distributed over the throat and chest (Fig. 2A). In the breeding season, females of *R. huanrenensis* had throat and chest covered with yellowish green (Fig. 2B), whereas in females of *R. dybowskii*, the red color patched over the throat and chest, which color turned to black patches in alcohol (Fig. 2D). In addition to these differences in coloration, male *R. dybowskii* had paired internal vocal sacs, while male *R. huanrenensis* lacked vocal sacs.

Protein electrophoresis—R. huanrenensis and R. dybowskii showed a discrete genetic difference (Nei's D=0.585: Appendix III) and no evidence of gene flow between these two species was found in the sympatric areas surveyed (Jangseong, Inje, Kapyeong, and Donghae; see Table 1, Appendix II).

Ecological notes—R. huanrenensis is sympatric with R. dybowskii in some parts of South Korea such as Tonghae, Inje, Jangseong, and Kapyeong (see Table 1), and therefore, ecological comparison of the two species is pertinent. R. dybowskii altitudinary ranges very wide, from plains to montane regions, where they breed in still waters in rice fields and small pools in early spring. On the other hand, R. huanrenensis occurs only at valley in relatively high montane regions, where the species spawn on the rocks in streams. Eggs of the species laid in relatively small and tightly clustered egg mass, and each egg mass is attached on the submerged rock in small streams in early spring (Table 3).

DISCUSSION

The Eurasian brown frogs are very difficult to classify (Matsui, 1991; Green and Borkin, 1993; Tanaka-Ueno *et al.*, 1998). Especially, members with 24 chromosomes are morphologically quite similar to each other and have a complicate taxonomic history, but now, taxonomic status of each member is made more clear than before by the presence of distinct genetic divergences among them (Matsui, 1991; Green and Borkin, 1993; Tanaka-Ueno *et al.*, 1998; Matsui *et al.*, 1998; Kim *et al.*, 1999). It has long been known that the frogs with 24 chromosomes include several east Asian

species allied to *R. chensinensis*, such as *R. ornativentris*, *R. dybowskii*, *R. pirica*. However, it has been known recently that *R. huanrenensis*, originally described from China (Fei *et al.*, 1990), is also a member of this group (Xie *et al.*, 1995) and co-occurs with *R. dybowskii* in South Korea (Yang *et al.*, 2000). Before this finding, *R. huanrenensis* has been known only from the type locality, Huanren County, Liaoning Province, China for nearly 10 years. The significant range extention to Korea was recorded from localities that were well-known for the presence of *R. dybowskii* (Yang *et al.*, 2000).

In South Korea, *R. huanrenensis* has been misidentified as *R. dybowskii* because of difficulties in identification. However, as shown in the present study, *R. huanrenensis* is actually well differentiated morphologically from *R. dybowskii* chiefly by the ventral color pattern. Moreover, males of these two species clearly different in the presence or absence of vocal sacs.

Since the separation of gene pools is the essence of species formation, a study of speciation must involve the examination of the level of reproductive isolation between the taxa compared. Allozymic analysis has been used extensively for such an examination at the zones of sympatry, and the contact zones of amphibian species that are problematic in taxonomic status (Wake et al, 1980; Yang and Park, 1988; Yang et al, 1988, 1997; Good, 1989). In our result, genetic divergence between R. huanrenensis and R. dybowskii included fixed allelic differences at Gp-4, Mdh, and Iddh loci, and these three loci are diagnostic genetic markers to identify them. No evidence of gene flow between these two species was found at the zone of sympatry. R. huanrenensis and R. dybowskii are completely isolated reproductively by their microhabitats, especially of the spawning site, and breeding habits. Particularly, the different condition of vocal sacs in males of the two species means the presence of clear differences of mating signals between them.

The east Asian brown frogs include two chromosomal groups (Kuramoto, 1979; Nishioka *et al.*, 1986; Matsui, 1991; Green and Borkin, 1993). *R. dybowskii*, *R. huanrenensis*, and *R. chensinensis* have 2n=24 chromosomes, while *R. amurensis* and *R. tsushimensis* have 2n=26 (Lee and Park, 1986; Nishioka *et al.*, 1986; Xie *et al.*, 1995; Yang *et al.*, 2000). It is generally believed that the fundamental chromosome number in *Rana* is 2n=26 (Morescalchi, 1973;

Wilson et al., 1974; Kuramoto, 1979, 1989; Schmid, 1980; Green, 1983; Park, 1990). From the study of R. dybowskii, Green (1983) proposed that the karyotypes with 24-chromosomes could have arisen in east Asia, based on the location of secondary constrictions and chromosome bands. Meanwhile, from the banding patterns of Eurasian and North American brown frogs, Nishioka et al. (1986, 1987) similarly suggested the chromosome number reduction from 2n=26 to 2n=24. Chromosome evolution through reduction in number resulted from inversion/fusion has also been reported in other anuran species (King, 1990; Bogart and Tandy, 1981; Blommers-Schlosser, 1978). Considering this pattern of chromosome evolution as a single event, it could be presumed that the species with putative derived chromosome number (2n=24) form a monophyletic group. However, our results indicate that R. dybowskii with 2n=24 is genetically closer to R. amurensis with 2n=26 (D=0.500) than to R. huanrenensis (D=0.584) or to R. chensinensis (D=0.584) both with 24 chromosomes. Reflecting this situation, R. amurensis did not form a cluster, but was included in a cluster containing other brown frogs with 24 chromosomes in all the three trees we obtained.

These results imply that the interspecies relationships incidental to the chromosomal evolution are not in accordance with relationship inferred from genetic analyses. In view of our results, two assumptions of chromosomal evolution in brown frogs around Korea would emerge. One possibility is that the chromosome number reduction has evolved independently at least two times (parallel reduction in chromosome number from 2n=26 to 24). Namely, R. tsushimensis first differentiated from the common stock of brown frogs around Korea with 2n=26 chromosomes. Subsequently, through a reduction of primary chromosome number, divergence of an ancestor of the R. huanrenensis and R. chensinensis lineage (2n=24) occured from an ancestral species (2n=26) common to the Korean R. amurensis and R. dybowdkii lineage. Finally, speciation of R. dybowskii (2n=24) and Korean R. amurensis (2n=26) occurred while also accompanying a secondary chromosome number reduction in the R. dybowskii lineage.

Another possibility is that the common ancestor of all these four species, after diverged from *R. tsushimensis*, reduced the chromosome number from 26 to 24 before the separation of the *R. huanrenensis* and *R. chensinensis* lineage and the Korean *R. amurensis* and *R. dybowskii* lineage. Subsequent speciation of the latter lineage would have included the reversal change in chromosome number from 24 to 26 in Korean *R. amurensis*.

It is yet to be surveyed which of these two assumptions is more probable, but the first assumption parallels with the idea proposed by Green and Borkin (1993) or Nishioka *et al.* (1992) that *R. arvalis* with 2n=24 chromosomes is paraphyletic with east Asian brown frogs having the same 2n=24 chromosomes. However, there are strong disagreements between Green and Borkin (1993) and Nishioka *et al.* (1992). Green and Borkin (1993) suggested parallel reduc-

tion to 2n=24 in European *R. arvalis* and all east Asian species including *R. dybowskii*, but according to Nishioka *et al.* (1992), all east Asian brown frogs with 26 chromosomes, excepting *R. tsushimensis* but including *R. amurensis* and even European *R. temporaria*, have that number as a result of reversal change in chromosome number from 24 to 26.

The second assumption more conforms to Green and Borkin (1993) or Tanaka-Ueno *et al.* (1998). These authors considered Japanese *R. ornativentris*, with 24 chromosomes, represents the sister group of other east Asian species having 24 chromosomes. Including *R. ornativentris*, "the parallel chromosome number reduction" hypothesis needs three steps (reductions in *R. ornativentris*, *R. dybowskii*, and the *R. huanrenensis* and *R. chensinensis* lineage), but "reversal change in Korean *R. amurensis*" requires only two steps (one reduction in the common ancestor of all species with 24 chromosomes and one reversal in Korean *R. amurensis*).

Moreover, later divergence of *R. amurensis* among east Asian brown frogs, suggested by our result and Nishioka et al. (1992), strongly contradicts to the idea proposed by Green and Borkin (1993) from allozyme analyses and by Tanaka-Ueno et al. (1998) from the analyses of mitochondrial DNA. Both of these reports suggested the earliest divergence of Russian R. amurensis among east Asian brown frogs. Interestingly, Korean and Russian R. amurensis exhibit different degree of genetic differentiation between R. dybowskii; The genetic differentiation between Korean R. dybowskii and R. amurensis we obtained in the present study (D=0.500) was intermediate between those reported between Korean R. dybowskii and Russian R. amurensis (D=0.874) by Green and Borkin (1993) and between R. dybowskii from Tsushima and R. amurensis from Mongolia, China, and Russia (D=0.304-0.311) reported by Nishioka et al. (1992).

These genetic inconsistencies of Korean and Russian *R. amurensis* suggest a distinct taxonomic status of each population. In order to clarify the problem of chromosome number change, as well as the relationships of local populations of *R. amurensis*, more extensive studies including many more taxa from regions surrounding Korea are strongly required.

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Appendix I. Buffer systems and enzymes for the analysis of horizontal starch gel electrophoresis

Buffer System	E. C. No.*	Enzyme	Condition
Continuous tris citrate II (pH 8.0)	2.7.3.2	Creatine kinase (<i>Ck-1,2</i>)	100V/3 hrs
	1.1.1.42	Isocitrate dehydrogenase (Idh)	
	5.4.2.2	Phosphoglucomutase (Pgm-1,2)	
	1.1.1.14	Iditol dehydrogenase (Iddh)	
	3.4.11.1	Leucine amino-peptidase (Lap)	
LiOH (pH 8.1)	N. S.**	General protein (Gp-3,4)	250V/3 hrs
	1.1.1.37	Malate dehydrogenase (Mdh)	
Discontinuous tris citrate (pH 8.2)	2.6.1.1	Aspartate aminotransferase (Aat-1)	200V/3 hrs
	4.2.1.3	Superoxide dismutase (Sod)	
	1.15.1.1	Aconitate hydratase (Acoh)	
	1.1.1.27	Lactate dehydrogenase (Ldh-1,2)	
	5.3.1.8	Mannose-6-phosphate isomerase (<i>Mpi</i>)	
Tris maleic EDTA (pH 7.4)	1.1.1.8	Glycerol-3-phosphate dehydrogenase (G3pdh)	100V/4 hrs
	2.6.1.1	Aspartate aminotransferase (Aat-2)	

^{*} E. C. No. : Enzyme commisson number

^{**} N. S.: Non specific

Appendix II. Allele frequencies of 41 populations in *Rana huanrenensis*, *R. dybowskii*, *R. chensinensis*, *R. amurensis* and *R. tsushimensis* from Korea, Japan, and China.

Loci					Rana hua	anrenensis	3				Ra	na dybow	rskii
LOCI	1	2	3	4	5	6	7	8	9	10	11	12	13
Acoh	b	a(0.02) b(0.98)	b	a(0.02) b(0.98)	b	b	b(0.96) c(0.02) d(0.02)	b	b	b	а	а	а
Ck-1	а	а	а	а	а	а	а	а	а	а	а	а	а
Ck-2	a(0.93) c(0.07)	а	а	а	а	а	а	а	а	а	а	а	а
Aat-1	h(0.91) j(0.09)	g(0.04) h(0.90) j(0.02) K(0.04)	h	h	h(0.81) j(0.06) K(0.13)	h	c(0.03) h(0.95) K(0.02)	h	h(0.94) j(0.06)	h(0.93) k(0.97)	b(0.03) c(0.03) h(0.59) i(0.03) j(0.06) k(0.26)	b(0.02) c(0.12) g(0.02) h(0.59) j(0.02) k(0.21) l(0.02)	c(0.12) h(0.57) j(0.02) k(0.29)
Aat-2	b	b	b	b	a(0.06) b(0.94)	a(0.03) b(0.97)	b	a(0.07) b(0.93)	b	b	b	b	b
Gp-3	С	С	С	С	С	С	b(0.02) c(0.98)	С	С	С	c(0.97) d(0.03)	c(0.98) d(0.02)	a(0.05) c(0.95)
Gp-4	d(0.07) e(0.93)	d(0.05) e(0.95)	d(0.03) e(0.95) f(0.02)	d(0.04) e(0.96)	е	d(0.02) e(0.96) f(0.02)	е	е	е	е	а	a(0.91) c(0.09)	a(0.95) c(0.05)
G3pdh	b	b	b	b	b	a(0.02) b(0.98)	a(0.03) b(0.97)	b	b	a(0.05) b(0.92) d(0.03)	b(0.47) d(0.53)	b(0.43) d(0.57)	b(0.55) d(0.45)
Idh	b	b	b(0.93) c(0.07)	b	b	b	b	b	b	b	b	b	b
Sod	С	С	С	С	С	С	С	С	c(0.97) d(0.03)	С	С	c(0.95) e(0.05)	c(0.95) e(0.05)
Lap	а	а	а	а	а	а	а	а	а	а	а	а	а
Ldh-1	е	d(0.02) e(0.98)	е	d(0.02) e(0.98)	е	d(0.03) e(0.95) f(0.02)	d(0.02) e(0.98)	е	d(0.06) e(0.94)	d(0.03) e(0.97)	b	b	b(0.98) c(0.02)
Ldh-2	d	d	a(0.03) d(0.97)	a(0.08) d(0.92)	d	d	d	d	a(0.03) d(0.97)	a(0.02) d(0.98)	d	d	d
Mdh	d(0.46) f(0.48) g(0.06)	d(0.32) f(0.59) g(0.09)	d(0.32) f(0.56) g(0.12)	d(0.44) f(0.50) g(0.06)	d(0.19) f(0.62) g(0.19)	d(0.22) f(0.62) g(0.16)	d(0.12) f(0.60) g(0.28)	d(0.36) f(0.50) g(0.14)	d(0.25) f(0.69) g(0.06)	a(0.02) d(0.22) f(0.56) g(0.20)	a(0.06) c(0.94)	С	С
Мрі	d(0.70) e(0.30)	b(0.04) d(0.94) g(0.02)	b(0.02) d(0.98)	b(0.06) d(0.94)	b(0.06) d(0.94)	d(0.97) e(0.03)	d(0.97) e(0.03)	d	b(0.09) d(0.91)	d	b(0.06) d(0.19) e(0.53) f(0.06) g(0.16)	b(0.12) d(0.07) e(0.58) g(0.21) h(0.02)	b(0.05) d(0.09) e(0.50) g(0.31) h(0.05)
Pgm-1	b	b(0.96) c(0.04)	b(0.87) c(0.13)	b(0.94) c(0.06)	a(0.06) b(0.94)	b	b	b(0.93) c(0.07)	b	a(0.02) b(0.98)	С	С	b(0.09) c(0.91)
Pgm-2	b	b	b	b	b	b	b	b(0.43) c(0.57)	b	b(0.98) c(0.02)	С	С	b(0.02) c(0.98)
lddh	е	е	d(0.02) e(0.98)	е	е	d(0.09) e(0.91)	d(0.15) e(0.85)	е	d(0.09) e(0.91)	е	b	b(0.98) c(0.02)	a(0.02) b(0.98)

Appendix II. (Continued)

Losi							Rana d	ybowskii						
Loci	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Acoh	a(0.92) b(0.08)	а	a(0.89) b(0.11)	а	а	a(0.94) b(0.06)	a(0.98) b(0.02)	a(0.98) b(0.02)	а	а	a(0.98) b(0.02)	а	а	a(0.50) b(0.50)
Ck-1	а	а	а	а	а	а	а	а	а	а	а	а	а	а
Ck-2	a(0.97) b(0.03)	a	а	а	а	а	а	а	а	а	а	а	а	а
Aat-1	c(0.11) h(0.41) j(0.08) k(0.38) l(0.02)	c(0.14) h(0.61) j(0.07) k(0.18)	h(0.54) j(0.07) k(0.39)	b(0.08) d(0.25) h(0.57) k(0.10)	h(0.46) k(0.46) l(0.08)	c(0.26) h(0.48) k(0.26)	b(0.02) c(0.21) h(0.45) k(0.32)	c(0.02) f(0.02) g(0.02) h(0.31) i(0.02) k(0.60) I(0.01)	c(0.04) f(0.04) h(0.28) j(0.14) k(0.50)	f(0.21) h(0.36) k(0.43)	c(0.09) f(0.05) h(0.48) j(0.07) k(0.27) l(0.04)	c(0.08) f(0.04) h(0.39) j(0.08) k(0.41)	c(0.10) h(0.55) k(0.35)	c(0.50) h(0.50)
Aat-2	b	a(0.04) b(0.96)	b	b	b	b	b	a(0.02) b(0.98)	b	b	b	b	b	b
Gp-3	С	С	С	c(0.98) d(0.02)	С	С	С	С	С	С	С	С	С	С
Gp-4	a(0.97) c(0.03)	а	а	a(0.85) c(0.15)	a	а	а	a(0.88) c(0.12)	a(0.79) c(0.21)	a(0.71) c(0.29)	a(0.84) c(0.14)	a(0.96) c(0.04)	a(0.95) c(0.05)	а
G3pdh	b(0.42) d(0.58)	b(0.64) d(0.36)	b(0.54) d(0.46)	b(0.02) d(0.93) e(0.05)	b(0.83) d(0.17)	b(0.40) d(0.60)	b(0.43) d(0.57)	b(0.41) d(0.55) e(0.04)	b(0.46) d(0.54)	b(0.57) d(0.43)	b(0.39) d(0.59) e(0.02)	b(0.42) d(0.58)	b(0.40) d(0.60)	b(0.50) d(0.50)
ldh	b	a(0.07) b(0.93)	b	b	a(0.02) b(0.98)	b	b	b	b	b	b	b	b	b
Sod	c(0.97) e(0.03)	С	b(0.14) c(0.86)	С	a(0.02) c(0.98)	c(0.98) e(0.02)	a(0.02) c(0.96) e(0.02)	c(0.97) e(0.03)	С	С	c(0.98) e(0.02)	c(0.96) e(0.04)	c(0.95) e(0.05)	С
Lap	a(0.99) b(0.01)	а	а	а	а	а	а	а	а	а	а	а	а	а
Ldh-1	b(0.99) e(0.01)	b	b	b	a(0.02) b(0.98)	b(0.98) e(0.02)	b(0.98) e(0.02)	b	b	b	b	b	b	b
Ldh-2	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Mdh	С	С	С	С	С	С	С	С	С	С	c(0.98) e(0.02)	С	С	С
Мрі	a(0.02) b(0.06) d(0.11) e(0.55) g(0.20) h(0.06)	b(0.14) d(0.07) e(0.50) g(0.25) h(0.04)	b(0.04) d(0.04) e(0.39) g(0.54)	е	d(0.02) e(0.46) g(0.45) h(0.07)	b(0.06) d(0.10) e(0.66) g(0.12) h(0.06)	b(0.03) d(0.07) e(0.54) g(0.29) h(0.07)	b(0.02) d(0.10) e(0.66) g(0.17) h(0.05)	b(0.04) d(0.18) e(0.64) g(0.14)	b(0.07) d(0.14) e(0.51) g(0.21) h(0.07)	b(0.11) d(0.09) e(0.61) g(0.19)	d(0.08) e(0.62) g(0.27) h(0.04)	a(0.05) d(0.10) e(0.45) g(0.35) h(0.05)	d
Pgm-1	С	С	С	С	b(0.39) c(0.61)	b(0.16) c(0.84)	b(0.10) c(0.90)	С	b(0.04) c(0.96)	С	b(0.07) c(0.93)	b(0.08) c(0.92)	С	С
Pgm-2	a(0.03) c(0.97)	С	С	С	С	С	С	С	С	С	С	С	С	С
lddh	a(0.04) b(0.96)	a(0.07) b(0.93)	b	a(0.25) b(0.75)	b(0.93) c(0.07)	a(0.02) b(0.96) c(0.02)	a(0.03) b(0.94) c(0.03)	b	b	b(0.79) c(0.21)	b(0.93) c(0.07)	b(0.92) c(0.08)	b(0.85) c(0.15)	b

Appendix II. (Continued)

Loci	R. chen	sinensis					Rana ar	murensis					F	?. t
LOCI	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Acoh	а	a	a(0.83) b(0.17)	a(0.63) b(0.37)	а	a(0.40) b(0.60)	a(0.53) b(0.47)	a(0.40) b(0.58) c(0.02)	a(0.17) b(0.45) c(0.38)	a(0.58) b(0.42)	a(0.78) b(0.19) c(0.02) d(0.01)	a(0.93) b(0.07)	a	a(0.65) b(0.35)
Ck-1	а	а	а	а	а	а	а	а	а	а	а	а	а	а
Ck-2	а	а	а	а	а	а	а	а	а	а	а	а	а	а
Aat-1	g	b(0.10) g(0.90)	h(0.08) j(0.92)	g(0.04) h(0.04) j(0.90) l(0.02)	h(0.30) j(0.70)	h(0.15) j(0.85)	g(0.02) h(0.25) j(0.73)	j(0.92) I(0.08)	h(0.10) j(0.88) l(0.02)	g(0.08) j(0.84) l(0.02)	h(0.01) j(0.89) l(0.10)	j	j	a(0.35) e(0.65)
Aat-2	b	b	b	b(0.93) c(0.07)	b	b	a(0.05) b(0.95)	b	b	a(0.25) b(0.75)	b	b	b	a(0.15) b(0.85)
Gp-3	С	С	С	С	С	С	С	С	С	С	c(0.97) d(0.03)	С	С	С
Gp-4	е	е	d(0.98) e(0.02)	d	d	d	d	d	d	d	d	d	d	b
G3pdh	b	a(0.80) b(0.20)	С	c(0.97) d(0.33)	a(0.10) c(0.90)	b(0.05) c(0.88) d(0.07)	a(0.05) c(0.93) d(0.02)	С	a(0.05) c(0.95)	С	С	С	С	c(0.05) d(0.95)
ldh	b	b	b	b	b	b	b	b	b	a(0.08) b(0.92)	b	b	b	С
Sod	С	a(0.10) c(0.90)	d	d(0.96) f(0.02) g(0.02)	d	b(0.05) c(0.88) d(0.07)	d	d	d	d	d	d	d	е
Lap	а	а	а	а	а	а	а	а	а	а	а	а	а	а
Ldh-1	f	f	С	С	С	С	С	С	С	С	С	С	С	е
Ldh-2	a(0.10) d(0.50) e(0.40)	d(0.90) e(0.10)	d	d(0.97) e(0.33)	d	d(0.95) e(0.05)	d(0.97) e(0.03)	b(0.02) d(0.96) e(0.02)	d	d	d	d	d	С
Mdh	f	f	е	b(0.02) e(0.95) g(0.02) h(0.01)	е	e(0.90) h(0.10)	b(0.02) e(0.98)	е	b(0.02) e(0.98)	e(0.92) g(0.08)	b(0.03) e(0.94) g(0.03)	e(0.90) g(0.10)	е	b
Мрі	d(0.80) e(0.20)	b(0.20) d(0.80)	e(0.13) g(0.37) h(0.06) i(0.13) j(0.21) k(0.10)	e(0.18) g(0.07) i(0.30) j(0.42) k(0.03)	i(0.80) j(0.20)	e(0.05) g(0.07) i(0.68) j(0.15) l(0.05)	e(0.13) g(0.07) i(0.55) j(0.25)	e(0.40) g(0.48) i(0.05) j(0.07)	e(0.13) g(0.15) i(0.32) j(0.38) k(0.02)	e(0.08) g(0.08) i(0.25) j(0.59)	d(0.01) e(0.27) g(0.37) i(0.20) j(0.15)	e(0.22) g(0.38) i(0.15) j(0.25)	g(0.20) i(0.06) j(0.56) k(0.18)	a(0.20) c(0.75) g(0.05)
Pgm-1	b(0.90) c(0.10)	b	С	b(0.08) c(0.88) d(0.04)	С	С	С	С	b(0.02) c(0.98)	С	С	С	С	b
Pgm-2	С	С	С	c(0.98) d(0.02)	С	С	С	c(0.95) d(0.05)	С	С	С	С	С	d
lddh	d	d	d	b(0.02) d(0.98)	d	d	d	d(0.98) e(0.02)	d(0.88) e(0.12)	d	d(0.99) e(0.01)	d	d	d

Appendix III. Nei's (1978) genetic distance coefficients (above diagonal) and Rogers' (1972) genetic similarity coefficients (below diagonal) among 41 populations of *Rana huanrenensis*, *R. dybowskii*, *R. chensinensis*, *R. amurensis* and *R. tsushimensis* from Korea, Japan and China

China																					
population	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
R. huanrenesis		005	007	004	007	007	011	004	000	000	F70	Eno	FE^	E0.4	FOO	FOO	C40	E4.4	FFO	E77	
1 Jangseong 2 Pohang	.965	.005	.007 .000	.004	.007 .000	.007 .000	.011	.024 .017	.006 .000	.008 .000	.573 .581	.588 .599	.556 .565	.584 .594	.566 .575	.582 .589	.640 .670	.514 .525	.558 .574	.577 .588	
3 Cheongsong	.952	.978	_	.000	.001	.001	.004	.017	.002	.001	.576	.594	.563	.591	.570	.585	.664	.531	.573	.587	
4 Yeongdeog	.963	.982	.977	_	.002	.002	.006	.017	.002	.002	.582	.600	.568	.598	.576	.592	.671	.531	.577	.591	
5 Pyeongchang 6 Hanso-ri	.950 .952	.975 .975	.963 .971	.963 .968	.971	.000	.001	.018 .018	.000	.000	.592 .586	.610 .605	.575 .570	.601 .601	.586 .581	.598 .596	.683 .672	.532 .530	.582 .578	.596 .594	
7 Oban-ri	.942	.967	.957	.956	.964	.979	.000	.021	.002	.001	.583	.601	.567	.597	.578	.594	.669	.527	.573	.589	
8 Inje	.925	.946	.948	.947	.943	.943	.930	_	.019	.017	.510	.528	.499	.526	.504	.519	.595	.463	.505	.519	
9 Kapyeong 10 Donghae	.952 .950	.972 .977	.963 .968	.966 .967	.966 .974	.978 .976	.968 .973	.930 .945	.969	.001	.590 .587	.607 .606	.574 .573	.604 .600	.583 .585	.598 .597	.679 .672	.532 .534	.581 .578	.597 .594	
R. dybowskii	.930	.977	.900	.967	.974	.976	.973	.943	.909	_	.367	.606	.573	.600	.565	.597	.072	.554	.576	.594	
11 Yangpyeong	.547	.541	.538	.538	.539	.535	.541	.563	.538	.541	_	.000	.000	.001	.000	.005	.026	.022	.002	.002	
12 Cheongyang	.538	.532	.529	.528	.530	.527	.532	.555	.531	.532	.973	_	.000	.000	.001	.005	.022	.024	.001	.000	
13 Muju 14 Jangseong	.550 .539	.545 .531	.539 .525	.538 .524	.543 .530	.540 .526	.545 .530	.567 .553	.541 .527	.544 .530	.961 .960	.969 .968	.961	.001	.000	.002 .004	.033 .026	.011 .022	.002 .001	.000	
15 Kurye	.550	.545	.543	.538	.547	.543	.544	.571	.539	.543	.961	.961	.961	.952	.005	.004	.037	.015	.005	.003	
16 Haenam	.534	.532	.526	.525	.530	.526	.530	.554	.528	.530	.952	.948	.955	.954	.947	_	.045	.015	.011	.004	
17 Jeju 18 Keoje	.515 .571	.508 .568	.503 .564	.502 .561	.504 .566	.504 .563	.509 .567	.531 .591	.502 .563	.506 .566	.915 .919	.926 .917	.904 .937	.911 .921	.906 .933	.888 .931	.864	.075	.022 .022	.027 .016	
19 Hadong	.546	.540	.535	.534	.538	.535	.540	.563	.535	.538	.955	.962	.958	.967	.933	.939	.913	.925	.022	.000	
20 Yangsan	.540	.535	.530	.529	.533	.530	.535	.558	.531	.534	.960	.968	.972	.973	.957	.951	.910	.939	.978	-	
21 Donghae	.525	.519	.513	.512	.519	.515	.518	.543	.514	.518	.955	.966	.950	.965	.940	.944	.918	.917	.954	.958	
22 Inje 23 Kanseong	.538 .550	.531 .545	.525 .540	.524 .539	.529 .543	.525 .540	.529 .544	.553 .567	.525 .539	.529 .543	.958 .940	.959 .945	.949 .943	.958 .943	.938 .942	.938 .931	.917 .906	.916 .916	.950 .927	.954 .940	
24 Keojin	.546	.540	.534	.533	.538	.534	.538	.562	.535	.538	.959	.974	.960	.964	.949	.939	.927	.922	.966	.970	
25 Kapyeong	.534	.528	.522	.521	.527	.523	.527	.551	.524	.527	.959	.969	.967	.974	.949	.949	.916	.938	.966	.979	
26 Wonju 27 Tsushima Isl.	.538	.534	.528	.527	.532	.528	.533	.556	.530	.532	.959 .903	.971 .895	.967 .891	.966 .898	.952 .895	.955 .897	.918 .845	.930 .852	.955 .899	.970 .896	
R. chensinensis	_	_	_	_	_	_	_	_	_	_	.903	.033	.031	.030	.095	.037	.043	.032	.099	.090	
28 Ninxia	.653	.664	.659	.660	.665	.666	.671	.687	.674	.660	.599	.592	.599	.586	.599	.578	.566	.631	.596	.597	
29 Quing	.611	.629	.616	.624	.631	.634	.641	.647	.648	.634	.589	.588	.589	.581	.580	.572	.572	.600	.590	.592	
R. amurensis	400	405	400	400	404	400	407		400	400	000	000	000	000	000	C1=	F07	F00	F0.	000	
30 Haenam 31 Kangwha	.439 .452	.435 .448	.430 .444	.429 .443	.431 .447	.432 .446	.437 .449	.457 .473	.436 .450	.430 .444	.600 .580	.603 .581	.600 .584	.608 .586	.600 .578	.617 .586	.587 .569	.582 .563	.594 .584	.602 .586	
32 Sorae	.433	.432	.427	.425	.427	.428	.433	.454	.433	.427	.606	.608	.601	.602	.604	.602	.597	.579	.593	.601	
33 Yangpyeong	.509	.507	.504	.504	.503	.503	.509	.529	.510	.503	.619	.620	.613	.623	.615	.624	.608	.592	.611	.615	
34 Cheongju 35 Yeongdong	.459 .460	.455 .453	.452 .450	.451 .449	.456 .449	.456 .449	.457 .455	.483 .474	.458 .455	.452 .449	.585 .579	.587 .584	.579 .581	.589 .589	.585 .578	.592 .600	.574 .566	.557 .565	.577 .572	.581 .582	
35 Yeongdong 36 Cheongyang	.460	.463	.458	.456	.458	.459	.465	.484	.464	.458	.571	.573	.569	.577	.569	.580	.560	.549	.566	.572	
37 Yangsan	.431	.429	.428	.422	.432	.429	.431	.458	.429	.424	.561	.564	.557	.568	.571	.571	.552	.539	.556	.561	
38 Kyeongju	.441	.436	.431	.429	.432	.432	.439	.458	.437	.431	.605	.608	.604	.610	.602	.618	.591	.584	.596	.604	
39 Kangnung 40 Koseong	.431 .419	.427 .417	.421 .412	.420 .411	.422 .413	.423 .414	.429 .419	.448 .439	.427 .418	.422 .412	.606 .595	.609 .597	.605 .592	.613 .594	.606 .594	.618 .596	.593 .584	.587 .573	.600 .583	.608 .593	
R. tsushimensis					0						.000	.007	.002	.00 .	.00.	.000	.00.	.0.0	.000	.000	
44 Tauchine Let													075		~~~	075		075		005	
41 Tsushima Isl.	.430	.426	.422	.424	.429	.429	.433	.430	.429	.426	.372	.378	.375	.382	.367	.375	.390	.375	.389	.385	
																					41
Population R. huanrenensis	.430	.426	23	.424	.429	.429	.433	.430	.429	.426	.372	32	33	.382	35	36	.390	38	39	40	41
Population R. huanrenensis 1 Jangseong	.610	.586	23	.570	.588	.587	27	.385	29	30 .813	.769	32 .827	.638	.751	35 .756	36 .738	.810	38	39 .841	40 .872	.834
Population R. huanrenensis 1 Jangseong 2 Pohang	.610 .623	.586 .598	23 .561 .568	.570 .584	.588 .602	.587 .593	27 - -	.385 .364	29 .445 .417	30 .813 .824	31 .769 .784	32 .827 .830	.638 .648	.751 .762	35 .756 .779	.738 .752	.810 .819	.809 .825	39 .841 .855	.872 .878	.834 .841
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong	.610 .623 .621	.586 .598 .597	.561 .568 .565	.570 .584 .581	.588 .602 .602	.587 .593 .589	27	.385 .364 .377	29 .445 .417 .434	30 .813 .824 .826	.769 .784 .787	.827 .830 .828	.638 .648 .646	.751 .762 .759	.756 .779 .780	.738 .752 .751	.810 .819 .819	.809 .825 .827	.841 .855 .858	.872 .878 .882	.834 .841 .839
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang	.610 .623	.586 .598	.561 .568 .565 .572 .574	.570 .584 .581 .586 .593	.588 .602 .602 .607 .609	.587 .593 .589 .596 .603	27 - - -	.385 .364 .377 .378 .363	29 .445 .417	.813 .824 .826 .835 .836	.769 .784 .787 .796 .793	.827 .830 .828 .837 .846	.638 .648 .646 .656	.751 .762 .759 .769 .774	35 .756 .779	.738 .752 .751 .762 .760	.810 .819 .819 .832 .824	.809 .825 .827 .837 .836	.841 .855 .858 .868 .865	.872 .878 .882 .890 .890	.834 .841 .839 .844 .843
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri	.610 .623 .621 .628 .627 .631	.586 .598 .597 .604 .602	23 .561 .568 .565 .572 .574	.570 .584 .581 .586 .593 .589	.588 .602 .602 .607 .609	.587 .593 .589 .596 .603 .599	27 - - - - - -	28 .385 .364 .377 .378 .363 .356	29 .445 .417 .434 .433 .415	30 .813 .824 .826 .835 .836 .830	31 .769 .784 .787 .796 .793 .788	.827 .830 .828 .837 .846	.638 .648 .646 .656 .656	.751 .762 .759 .769 .774	35 .756 .779 .780 .791 .788 .784	36 .738 .752 .751 .762 .760 .757	.810 .819 .819 .832 .824 .822	.809 .825 .827 .837 .836 .831	.841 .855 .858 .868 .865 .862	.872 .878 .882 .890 .890	.834 .841 .839 .844 .843
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri	.610 .623 .621 .628 .627 .631	.586 .598 .597 .604 .602 .606	23 .561 .568 .565 .572 .574 .576	.570 .584 .581 .586 .593 .589	.588 .602 .602 .607 .609 .609	.587 .593 .589 .596 .603 .599 .596	27 - - - - - - -	28 .385 .364 .377 .378 .363 .356 .346	29 .445 .417 .434 .433 .415 .406 .393	30 .813 .824 .826 .835 .836 .830 .818	31 .769 .784 .787 .796 .793 .788 .777	.827 .830 .828 .837 .846 .834	.638 .648 .646 .656 .656 .651	.751 .762 .759 .769 .774 .763	35 .756 .779 .780 .791 .788 .784 .773	36 .738 .752 .751 .762 .760 .757 .748	.810 .819 .819 .832 .824 .822 .811	.809 .825 .827 .837 .836 .831	.841 .855 .858 .868 .865 .862 .847	.872 .878 .882 .890 .890 .887	.834 .841 .839 .844 .843 .834
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri	.610 .623 .621 .628 .627 .631	.586 .598 .597 .604 .602	23 .561 .568 .565 .572 .574	.570 .584 .581 .586 .593 .589	.588 .602 .602 .607 .609	.587 .593 .589 .596 .603 .599	27 - - - - - -	28 .385 .364 .377 .378 .363 .356	29 .445 .417 .434 .433 .415	30 .813 .824 .826 .835 .836 .830	31 .769 .784 .787 .796 .793 .788	.827 .830 .828 .837 .846	.638 .648 .646 .656 .656	.751 .762 .759 .769 .774	35 .756 .779 .780 .791 .788 .784	36 .738 .752 .751 .762 .760 .757	.810 .819 .819 .832 .824 .822	.809 .825 .827 .837 .836 .831	.841 .855 .858 .868 .865 .862	.872 .878 .882 .890 .890	.834 .841 .839 .844 .843
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae	.610 .623 .621 .628 .627 .631 .626	.586 .598 .597 .604 .602 .606 .601	.561 .568 .565 .572 .574 .576 .572 .499	.570 .584 .581 .586 .593 .589 .586 .514	.588 .602 .602 .607 .609 .609 .605	.587 .593 .589 .596 .603 .599 .596	27 - - - - - - -	.385 .364 .377 .378 .363 .356 .346	29 .445 .417 .434 .433 .415 .406 .393 .369	.813 .824 .826 .835 .836 .830 .818	.769 .784 .787 .796 .793 .788 .777 .714	.827 .830 .828 .837 .846 .834 .822	.638 .648 .646 .656 .656 .651 .642	.751 .762 .759 .769 .774 .763 .754 .688	35 .756 .779 .780 .791 .788 .784 .773 .712	.738 .752 .751 .762 .760 .757 .748	.810 .819 .819 .832 .824 .822 .811 .740	.809 .825 .827 .837 .836 .831 .818	39 .841 .855 .858 .868 .865 .862 .847 .783	.872 .878 .882 .890 .890 .887 .873	.834 .841 .839 .844 .843 .834 .816
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii	.610 .623 .621 .628 .627 .631 .626 .553 .634	.586 .598 .597 .604 .602 .606 .601 .530 .608	23 .561 .568 .565 .572 .574 .576 .572 .499 .578	.570 .584 .581 .586 .593 .589 .586 .514 .592	.588 .602 .602 .607 .609 .605 .533 .612	.587 .593 .589 .596 .603 .599 .596 .522 .603	27 - - - - - - - - -	28 .385 .364 .377 .378 .363 .356 .346 .317 .348 .368	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411	.813 .824 .826 .835 .836 .830 .818 .752 .816	31 .769 .784 .787 .796 .793 .788 .777 .714 .775	32 .827 .830 .828 .837 .846 .834 .822 .756 .823 .845	.638 .648 .646 .656 .656 .651 .642 .582 .645	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .775	35 .756 .779 .780 .791 .788 .784 .773 .712 .770	36 .738 .752 .751 .762 .760 .757 .748 .680 .744	.810 .819 .819 .832 .824 .822 .811 .740 .811	.809 .825 .827 .837 .836 .831 .818 .753 .818	39 .841 .855 .858 .868 .865 .862 .847 .783 .848	.872 .878 .882 .890 .890 .887 .873 .806 .870	.834 .841 .839 .844 .843 .834 .816 .840 .827
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong	.610 .623 .621 .628 .627 .631 .626 .553 .634 .628	.586 .598 .597 .604 .602 .606 .601 .530 .608	.561 .568 .565 .572 .574 .576 .576 .578 .578	.570 .584 .581 .586 .593 .589 .589 .514 .592 .590	.588 .602 .602 .607 .609 .605 .533 .612 .608	.587 .593 .589 .596 .603 .599 .596 .522 .603 .599	27 	28 .385 .364 .377 .378 .363 .356 .346 .317 .348 .368	29 .445 .417 .434 .433 .415 .406 .393 .369 .411	.813 .824 .826 .835 .836 .830 .818 .752 .816 .841	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .799	.827 .830 .828 .837 .846 .834 .822 .756 .823 .845	.638 .648 .646 .656 .656 .651 .642 .582 .645 .660	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .775	35 .756 .779 .780 .791 .788 .784 .773 .712 .770 .794	.738 .752 .751 .762 .760 .757 .748 .680 .744 .765	.810 .819 .819 .832 .824 .822 .811 .740 .811 .834	.809 .825 .827 .837 .836 .831 .818 .753 .818 .841	39 .841 .855 .858 .868 .865 .862 .847 .783 .848 .872	.872 .878 .882 .890 .890 .887 .873 .806 .870 .897	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii	.610 .623 .621 .628 .627 .631 .626 .553 .634	.586 .598 .597 .604 .602 .606 .601 .530 .608	23 .561 .568 .565 .572 .574 .576 .572 .499 .578	.570 .584 .581 .586 .593 .589 .586 .514 .592	.588 .602 .602 .607 .609 .605 .533 .612	.587 .593 .589 .596 .603 .599 .596 .522 .603	27 - - - - - - - - -	28 .385 .364 .377 .378 .363 .356 .346 .317 .348 .368	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411	.813 .824 .826 .835 .836 .830 .818 .752 .816	31 .769 .784 .787 .796 .793 .788 .777 .714 .775	32 .827 .830 .828 .837 .846 .834 .822 .756 .823 .845	.638 .648 .646 .656 .656 .651 .642 .582 .645	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .775	35 .756 .779 .780 .791 .788 .784 .773 .712 .770	36 .738 .752 .751 .762 .760 .757 .748 .680 .744	.810 .819 .819 .832 .824 .822 .811 .740 .811	.809 .825 .827 .837 .836 .831 .818 .753 .818	39 .841 .855 .858 .868 .865 .862 .847 .783 .848	.872 .878 .882 .890 .890 .887 .873 .806 .870	.834 .841 .839 .844 .843 .834 .816 .840 .827
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong	.610 .623 .621 .627 .631 .626 .553 .634 .628	.586 .598 .597 .604 .602 .606 .601 .530 .608 .604	.561 .568 .568 .572 .574 .576 .572 .499 .578 .575 .006 .003 .004	.570 .584 .581 .586 .593 .589 .586 .514 .592 .590	.588 .602 .602 .607 .609 .609 .605 .533 .612 .608	.587 .593 .589 .596 .603 .599 .596 .522 .603 .599	27 	28 .385 .364 .377 .378 .363 .356 .346 .317 .348 .368 .466 .475 .456 .480	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411 .504 .509 .498	.813 .824 .826 .835 .836 .830 .818 .752 .816 .841 .492 .487 .488	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512	.827 .830 .828 .837 .846 .834 .822 .756 .823 .845 .483 .481 .484	.638 .648 .646 .656 .651 .642 .582 .645 .660	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .507 .503 .508	35 .756 .779 .780 .791 .784 .773 .712 .770 .794 .526 .519 .522	.738 .752 .751 .762 .757 .748 .680 .744 .765 .544 .540 .544	.810 .819 .819 .832 .824 .822 .811 .740 .811 .834 .535 .531 .536	.809 .825 .827 .837 .836 .831 .818 .753 .818 .841 .489 .483 .486 .481	.841 .855 .858 .868 .865 .862 .847 .783 .848 .872 .487 .488	.872 .878 .882 .890 .890 .887 .873 .806 .870 .897	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpoong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye	.610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .005 .006	.586 .598 .597 .604 .602 .606 .601 .530 .608 .604	.561 .568 .568 .565 .572 .574 .576 .572 .499 .578 .575 .006 .003 .004	.570 .584 .581 .586 .593 .589 .586 .514 .592 .590 .001 .000 .001	.588 .602 .602 .607 .609 .605 .533 .612 .608	.587 .593 .589 .596 .603 .599 .596 .522 .603 .599 .000 .000	27 	.385 .364 .377 .378 .363 .356 .346 .317 .348 .368 .466 .475 .456 .480 .462	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .509 .498 .514 .515	.813 .824 .826 .835 .836 .830 .818 .752 .816 .841 .492 .487 .488 .486 .490	.769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512 .504	.827 .830 .828 .837 .846 .834 .822 .756 .823 .845 .483 .481 .484	.638 .648 .646 .656 .656 .651 .642 .582 .645 .660 .442 .443 .446 .435	.751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .507 .503 .508	.756 .779 .780 .791 .788 .784 .773 .712 .770 .794 .526 .519 .522 .511	.738 .752 .751 .762 .760 .757 .748 .680 .744 .765 .544 .540 .544 .532	.810 .819 .819 .832 .824 .822 .811 .740 .811 .834 .535 .531 .536 .525 .533	.809 .825 .827 .837 .836 .831 .818 .753 .818 .841 .489 .483 .486	.841 .855 .858 .868 .865 .862 .847 .783 .848 .872 .487 .482 .484 .481	.872 .878 .882 .890 .890 .887 .873 .806 .870 .507 .504 .506 .503	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971 .971
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam	.610 .623 .621 .628 .627 .631 .626 .553 .634 .628	.586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005	.561 .568 .565 .572 .574 .576 .578 .578 .575 .006 .003 .004 .006 .008	.570 .584 .581 .586 .593 .589 .586 .514 .592 .590 .001 .000 .001	.588 .602 .607 .609 .609 .605 .533 .612 .608	.587 .593 .596 .603 .599 .596 .522 .603 .599 .000 .000	27 	28 .385 .364 .377 .378 .363 .356 .346 .317 .348 .368 .466 .475 .456 .480 .462 .491	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411 .504 .509 .498 .514 .515 .533	.813 .824 .826 .835 .836 .830 .818 .752 .816 .841 .492 .487 .488 .486 .490 .478	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512 .508	827 830 828 837 846 834 822 756 823 845 481 484 486	.638 .648 .646 .656 .656 .651 .642 .582 .645 .660 .442 .443 .446 .435	.751 .769 .769 .774 .763 .754 .688 .753 .775 .507 .508 .508 .508 .499	.756 .776 .780 .791 .788 .784 .773 .712 .770 .794 .526 .519 .522 .511	.738 .752 .751 .762 .760 .757 .748 .680 .744 .765 .544 .540 .544 .532	.810 .819 .832 .824 .822 .811 .740 .811 .834 .535 .531 .536 .525 .533	.809 .825 .827 .837 .836 .831 .818 .753 .818 .841 .489 .483 .486 .481 .488	.841 .855 .858 .868 .865 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475	.872 .878 .882 .890 .890 .887 .873 .806 .870 .507 .504 .506 .503 .507	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971 .971 .971
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje		.586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005 .002 .010 .011	.561 .568 .565 .572 .574 .576 .572 .499 .578 .575 .006 .003 .004 .006 .008	.570 .584 .581 .586 .593 .589 .514 .592 .590 .001 .001 .001 .004 .008	.588 .602 .602 .607 .609 .605 .533 .612 .608	.587 .593 .589 .596 .603 .599 .596 .522 .603 .599 .000 .000 .000 .000 .002	27 	28 .385 .364 .377 .378 .363 .346 .317 .348 .368 .466 .475 .456 .480 .462 .491 .533 .410	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411 .504 .509 .498 .514 .515 .533 .535 .473	.813 .824 .826 .835 .836 .836 .818 .752 .816 .841 .492 .487 .488 .486 .490 .478 .512 .519	.769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512 .504 .514 .505 .523 .542	827 830 828 837 846 834 822 756 823 845 .483 481 486 484 486 502 521	.638 .648 .646 .656 .656 .651 .642 .582 .645 .660 .442 .443 .443 .443 .444 .441 .478	.751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .507 .508 .502 .508 .499 .520 .546	.756 .779 .780 .791 .788 .784 .773 .712 .770 .794 .526 .511 .524 .501 .524 .501	.738 .752 .751 .762 .760 .757 .748 .680 .744 .765 .544 .532 .544 .532 .544 .527 .560 .579	.810 .819 .819 .832 .824 .824 .824 .811 .740 .811 .535 .531 .535 .531 .525 .533 .525 .533	.809 .825 .827 .837 .836 .831 .818 .753 .818 .441 .489 .483 .486 .481 .488 .475 .502 .516	39 .841 .855 .858 .868 .865 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475 .504	.872 .878 .882 .890 .887 .873 .806 .870 .897 .507 .504 .503 .507 .503 .531 .538	.834 .841 .839 .844 .843 .834 .816 .827 .838 .991 .971 .971 .971 .975 .996 .947
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .029	.586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005 .002 .011 .028 .028	.561 .568 .565 .572 .574 .576 .572 .499 .575 .006 .003 .004 .006 .008 .034 .010	.570 .584 .581 .586 .593 .589 .586 .514 .592 .590 .001 .001 .004 .008 .020 .023	.588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .000 .000 .004 .010 .024	.587 .593 .589 .596 .603 .599 .596 .522 .603 .000 .000 .000 .000 .001 .026 .019	27 -	28 .385 .364 .377 .378 .363 .346 .317 .348 .368 .466 .475 .456 .480 .462 .491 .533 .410 .462	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411 .504 .509 .498 .514 .515 .533 .535 .473 .491	.813 .824 .826 .835 .836 .830 .818 .752 .816 .841 .492 .487 .488 .486 .490 .478 .512 .519 .505	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512 .508 .512 .505 .523 .544 .555	.827 .830 .828 .837 .846 .834 .822 .756 .823 .845 .483 .484 .486 .502 .521 .500	.638 .648 .646 .656 .656 .651 .642 .582 .645 .660 .442 .443 .446 .435 .440 .441 .471 .471	.751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .507 .503 .508 .499 .526 .517	35 .756 .779 .780 .791 .784 .773 .712 .770 .526 .519 .522 .511 .535 .551 .531	.738 .752 .751 .762 .760 .757 .748 .680 .744 .765 .544 .532 .544 .532 .544 .527 .560 .579	.810 .819 .819 .832 .824 .822 .811 .740 .535 .531 .536 .525 .533 .524 .552 .572	.809 .825 .827 .837 .836 .831 .818 .753 .818 .449 .483 .486 .481 .488 .475 .502 .516 .500	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .504 .511	.872 .878 .882 .890 .897 .873 .806 .870 .507 .504 .506 .503 .507 .500 .531 .531 .532	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971 .971 .971 .996 .947 .947
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan		.586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005 .002 .010 .011 .028 .023 .005	.561 .568 .565 .572 .574 .576 .572 .499 .578 .575 .006 .003 .004 .004 .008 .034 .018 .018	.570 .584 .581 .586 .593 .586 .514 .590 .001 .001 .001 .008 .020 .023 .001	.588 .602 .602 .607 .609 .609 .605 .533 .612 .608 .001 .000 .000 .000 .004 .016 .000	.587 .593 .589 .599 .599 .599 .599 .000 .000 .000 .00	27 	28 .385 .364 .377 .378 .363 .356 .346 .317 .348 .368 .466 .475 .480 .466 .480 .491 .533 .410 .462 .464	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .509 .498 .514 .515 .533 .535 .473 .491 .496	.813 .824 .826 .835 .836 .830 .818 .752 .816 .841 .492 .487 .488 .486 .490 .478 .512 .519 .505	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512 .504 .512 .504 .512 .505 .523 .548 .513	32 .827 .830 .828 .837 .846 .822 .756 .823 .845 .483 .481 .484 .486 .484 .486 .502 .521 .500 .491	.638 .648 .646 .656 .656 .651 .642 .582 .645 .660 .442 .443 .446 .435 .446 .440 .461 .478 .448	34 .751 .762 .759 .769 .774 .688 .753 .775 .507 .508 .502 .508 .499 .520 .546 .517 .512	35 .756 .779 .780 .791 .784 .773 .712 .770 .794 .526 .511 .522 .511 .535 .551 .531	.738 .752 .751 .762 .760 .757 .748 .680 .744 .765 .544 .532 .544 .532 .545 .527 .560 .579 .559	.810 .819 .819 .832 .824 .811 .740 .811 .834 .535 .531 .536 .525 .533 .524 .552 .570 .545 .537	.809 .825 .827 .837 .836 .831 .818 .753 .818 .841 .489 .483 .486 .481 .489 .502 .516 .500 .488	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475 .504 .5101 .487	.872 .878 .882 .890 .887 .873 .873 .806 .870 .507 .504 .503 .503 .507 .503 .503 .538 .524 .510	.834 .841 .839 .844 .843 .816 .840 .827 .838 .991 .971 .971 .971 .971 .996 .947 .971
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .024 .005	.586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005 .002 .011 .028 .028	.561 .568 .565 .572 .574 .576 .572 .499 .575 .006 .003 .004 .006 .008 .034 .010	.570 .584 .581 .586 .593 .589 .586 .514 .592 .590 .001 .001 .004 .008 .020 .023	.588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .000 .000 .004 .010 .024	.587 .593 .589 .596 .603 .599 .596 .522 .603 .000 .000 .000 .000 .001 .026 .019	27 -	28 .385 .364 .377 .378 .363 .346 .317 .348 .368 .466 .475 .456 .480 .462 .491 .533 .410 .462	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411 .504 .509 .498 .514 .515 .533 .535 .473 .491	.813 .824 .826 .835 .836 .830 .818 .752 .816 .841 .492 .487 .488 .486 .490 .478 .512 .519 .505	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512 .508 .512 .505 .523 .544 .555	.827 .830 .828 .837 .846 .834 .822 .756 .823 .845 .483 .484 .486 .502 .521 .500	.638 .648 .646 .656 .656 .651 .642 .582 .645 .660 .442 .443 .446 .435 .440 .441 .471 .471	.751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .507 .503 .508 .499 .526 .517	35 .756 .779 .780 .791 .784 .773 .712 .770 .526 .519 .522 .511 .535 .551 .531	.738 .752 .751 .762 .760 .757 .748 .680 .744 .765 .544 .532 .544 .532 .544 .527 .560 .579	.810 .819 .819 .832 .824 .822 .811 .740 .535 .531 .536 .525 .533 .524 .552 .572 .572	.809 .825 .827 .837 .836 .831 .818 .753 .818 .449 .483 .486 .481 .488 .475 .502 .516 .500	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .504 .511	.872 .878 .882 .890 .897 .873 .806 .870 .507 .504 .506 .503 .507 .500 .531 .531 .532	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971 .971 .971 .996 .947 .947
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong	21 .610 .623 .621 .628 .626 .553 .634 .005 .006 .002 .012 .010 .029 .024 .007 .005 .950	.586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005 .002 .010 .011 .023 .006 .005 .000	23 .561 .568 .565 .572 .574 .576 .575 .575 .006 .003 .004 .004 .004 .004 .004 .005 .002 .002	.570 .584 .581 .586 .593 .589 .589 .584 .592 .590 .001 .000 .001 .004 .008 .023 .001 .004	.588 .602 .607 .609 .609 .605 .533 .612 .608 .001 .000 .000 .004 .003 .024 .016 .000 .000 .000	.587 .593 .589 .596 .603 .596 .522 .603 .599 .000 .000 .000 .000 .001 .026 .019 .003 .004 .004	27 	28 .385 .364 .377 .378 .363 .356 .346 .475 .480 .462 .491 .491 .491 .494 .494 .494 .494 .494	29 .445 .417 .434 .433 .415 .406 .393 .369 .399 .411 .504 .513 .535 .473 .496 .513 .492 .479	30 .813 .824 .826 .835 .836 .830 .818 .841 .492 .487 .498 .498 .512 .519 .512 .497 .494 .4	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .799 .512 .504 .514 .512 .504 .514 .512 .523 .542 .513 .544 .544 .544 .544 .544 .544 .544 .54	32 .827 .830 .828 .837 .846 .834 .822 .845 .483 .481 .484 .486 .502 .521 .521 .495 .480 .481 .494 .495 .4	33 .638 .648 .646 .656 .651 .642 .645 .660 .442 .443 .446 .435 .442 .443 .444 .451 .478 .448 .452 .448 .454 .448	34 .751 .762 .759 .769 .774 .763 .754 .753 .775 .507 .503 .508 .502 .508 .502 .546 .517 .512 .511 .500 .488	35 .756 .779 .780 .791 .788 .784 .773 .770 .794 .526 .511 .521 .521 .521 .535 .551 .531 .535 .535 .531 .532 .532 .533 .533 .533 .533 .533 .533	36 .738 .752 .751 .760 .760 .757 .748 .744 .765 .544 .540 .574 .544 .542 .544 .552 .554 .552 .554 .552 .554 .552 .554 .552	37 .810 .819 .819 .832 .824 .822 .811 .834 .535 .531 .536 .525 .533 .552 .570 .545 .545 .545 .545 .545 .545	38 .809 .825 .827 .837 .836 .831 .818 .841 .489 .483 .484 .485 .485 .486 .481 .488 .481 .488 .483 .484 .484 .485 .486 .487 .486 .487 .487 .488 .4	39 .841 .855 .858 .868 .865 .862 .847 .783 .848 .872 .487 .482 .484 .481 .484 .481 .484 .481 .484 .484 .494 .4	.872 .878 .882 .890 .890 .887 .873 .806 .870 .504 .504 .503 .507 .503 .538 .524 .510 .512 .493 .483	.834 .841 .839 .844 .843 .834 .816 .840 .971 .971 .971 1.015 .994 .947 .950 .981 .979
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin		22 .586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005 .002 .004 .005 .002 .006 .006 .007 .007 .008 .009 .0	23 .561 .568 .565 .572 .574 .576 .578 .578 .578 .578 .006 .003 .004 .004 .004 .004 .008 .010 .005 .000 .0	24 .570 .584 .581 .586 .593 .589 .586 .514 .592 .590 .001 .001 .000 .001 .000 .001 .0	25 .588 .602 .602 .607 .609 .609 .609 .609 .600 .0	26 .587 .593 .589 .603 .599 .603 .599 .000 .000 .000 .000 .000 .000 .001 .026 .019 .003 .000 .000 .000 .000 .000 .000 .00	27 	28 .385 .364 .377 .378 .363 .356 .317 .348 .363 .364 .466 .475 .456 .480 .491 .462 .491 .462 .464 .443 .454 .464 .464 .464 .464 .464 .464 .464	29 .445 .417 .434 .406 .399 .411 .504 .515 .533 .535 .535 .533 .491 .496 .498 .4	30 .813 .824 .826 .836 .836 .836 .818 .752 .816 .841 .492 .487 .488 .486 .490 .478 .519 .505 .492 .492 .494 .4	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .793 .512 .504 .505 .523 .514 .505 .523 .514 .515 .514 .514 .514 .515 .514 .514 .514 .514 .514 .515 .514 .514 .514 .515 .514 .514 .515 .514 .514 .515 .514 .514 .514 .515 .514 .514 .515 .514 .514 .515 .514 .515 .514 .515 .514 .515 .514 .515 .514 .515 .514 .516 .516 .517 .5	32 827 830 828 837 846 834 822 756 823 845 483 484 486 502 491 500 491 504 495 480 495 496 497 497 497 497 497 497 497 497	33 638 648 646 656 656 651 642 582 645 642 443 444 443 444 445 445 442 444 443 445 444 443 443 444 443 443 444 443 443	34 .751 .762 .759 .774 .763 .774 .763 .775 .507 .503 .508 .508 .509 .520 .546 .517 .512 .514 .500 .488	35 .756 .779 .780 .781 .773 .712 .770 .794 .526 .519 .522 .511 .531 .555 .551 .551 .553 .553 .553	36 .738 .752 .761 .762 .762 .762 .748 .680 .744 .765 .544 .532 .544 .527 .559 .552 .545 .545 .579 .552 .546 .579 .552 .546 .579 .579 .579 .579 .579 .579 .579 .579	37 .810 .819 .819 .832 .824 .824 .811 .740 .811 .535 .525 .533 .524 .553 .524 .553 .524 .553 .525 .525 .527 .545 .537 .545 .536 .525 .525 .526 .527 .537 .537 .538 .528 .538 .529 .5	38 .809 .825 .827 .836 .831 .753 .818 .841 .489 .483 .486 .481 .502 .483 .486 .481 .5500 .488 .475 .500 .488 .475 .489 .475 .489	39 841 .855 .858 .868 .865 .862 .847 .783 .848 .872 .484 .481 .481 .501 .487 .487 .484 .884 .88	.872 .878 .882 .890 .890 .887 .873 .806 .870 .507 .504 .503 .507 .500 .531 .538 .524 .512 .493 .483	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971 .971 .996 .947 .940 .950
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .024 .007 .005 .975 .950	22 .586 .598 .597 .604 .602 .606 .601 .530 .004 .005 .002 .010 .011 .011 .028 .023 .006 .005 .000 .005 .967 .967	23 .561 .568 .565 .572 .574 .576 .572 .499 .004 .006 .003 .004 .006 .003 .004 .005 .002 .002 .002 .002	24 .570 .584 .581 .586 .593 .586 .514 .592 .590 .001 .001 .004 .008 .020 .020 .023 .001 .001 .001 .001 .001	25 .588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .000 .004 .016 .004 .016 .000 .0	.587 .593 .589 .596 .603 .596 .522 .603 .599 .000 .000 .000 .000 .001 .026 .019 .003 .004 .004	27 	28 385 364 377 378 363 363 346 317 348 368 466 475 480 462 491 491 491 494 494 494 494 494	29 .445 .417 .434 .433 .415 .406 .399 .411 .504 .498 .514 .513 .535 .473 .491 .496 .498 .499	30 813 824 826 835 836 830 818 8752 487 488 490 478 492 496 496 497 468 477 488	31 .769 .784 .796 .793 .788 .777 .714 .775 .799 .512 .508 .512 .504 .514 .514 .513 .514 .490 .495 .503	32 827 830 828 837 846 834 832 756 483 481 484 484 486 484 486 491 495 495 495 495 495 495 495 495	33 638 648 646 656 656 656 651 642 582 443 446 443 444 444 443 444 445 444 445 446 448 452 448 453 441 443	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .507 .503 .508 .502 .548 .499 .520 .546 .517 .512 .517 .512 .500 .488 .494 .494 .505	35 .7566 .779 .7800 .791 .7884 .773 .712 .770 .794 .526 .511 .524 .5515 .5511 .5315 .5511 .5315 .5515 .5515 .5515 .5515 .5515 .5515 .5515 .5515 .5515 .5515 .5515 .5516	36 .738 .752 .751 .762 .762 .760 .757 .748 .680 .744 .765 .544 .540 .532 .544 .532 .544 .532 .546 .579 .552 .546 .571 .552 .552 .537	37 810 819 819 882 8824 8821 811 740 535 535 525 533 524 552 570 535 552 557 535 555 555 557 555 557 558 559 559 559 559 559 559 559	38 809 825 827 837 836 831 848 841 489 483 484 481 481 482 483 484 484 484 484 484 484 484	39 .841 .855 .858 .868 .865 .862 .847 .783 .848 .848 .847 .481 .4	.872 .878 .882 .890 .890 .897 .873 .806 .870 .504 .503 .507 .503 .531 .538 .524 .510 .512 .493 .494 .499	.834 .841 .839 .844 .816 .840 .827 .838 .991 .971 .971 .971 .947 .950 .950 .981 .975
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin		22 .586 .598 .597 .604 .602 .606 .601 .530 .608 .604 .005 .004 .005 .002 .004 .005 .002 .006 .006 .007 .007 .008 .009 .0	23 .561 .568 .565 .572 .574 .576 .578 .578 .578 .578 .006 .003 .004 .004 .004 .004 .008 .001 .005 .000 .0	24 .570 .584 .581 .586 .593 .589 .586 .514 .592 .590 .001 .001 .000 .001 .000 .001 .0	25 .588 .602 .602 .607 .609 .609 .609 .609 .600 .0	26 .587 .593 .589 .596 .603 .599 .522 .603 .603 .600 .000 .000 .000 .000 .000 .001 .001 .002 .001 .004 .000 .0	27 	28 .385 .364 .377 .378 .363 .356 .317 .348 .363 .364 .466 .475 .456 .480 .491 .462 .491 .462 .464 .443 .454 .464 .464 .464 .464 .464 .464 .464	29 .445 .417 .434 .406 .399 .411 .504 .515 .533 .535 .535 .533 .491 .496 .498 .4	30 .813 .824 .826 .836 .836 .836 .818 .752 .816 .841 .492 .487 .488 .486 .490 .478 .519 .505 .492 .492 .494 .4	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .793 .512 .504 .505 .523 .514 .505 .523 .514 .515 .514 .514 .514 .515 .514 .514 .514 .514 .514 .515 .514 .514 .514 .515 .514 .514 .515 .514 .514 .515 .514 .514 .514 .515 .514 .514 .515 .514 .514 .515 .514 .515 .514 .515 .514 .515 .514 .515 .514 .515 .514 .516 .516 .517 .5	32 827 830 828 837 846 834 822 756 823 845 483 484 486 502 491 500 491 504 495 480 495 496 497 497 497 497 497 497 497 497	33 638 648 646 656 656 651 642 582 645 642 443 444 443 444 445 445 442 444 443 445 444 443 443 444 443 443 444 443 443	34 .751 .762 .759 .774 .763 .774 .763 .775 .507 .503 .508 .508 .509 .520 .546 .517 .512 .514 .500 .488	35 .756 .779 .780 .781 .773 .712 .770 .794 .526 .519 .522 .511 .531 .555 .551 .551 .553 .553 .553	36 .738 .752 .761 .762 .762 .762 .748 .680 .744 .765 .544 .532 .544 .527 .559 .552 .545 .545 .579 .552 .546 .579 .552 .546 .579 .579 .579 .579 .579 .579 .579 .579	37 .810 .819 .819 .832 .824 .824 .811 .740 .811 .535 .525 .531 .533 .524 .553 .524 .553 .525 .525 .520 .510	38 .809 .825 .827 .836 .831 .753 .818 .841 .489 .483 .486 .481 .502 .483 .486 .481 .5500 .488 .475 .500 .488 .475 .489 .475 .489	39 841 .855 .858 .868 .865 .862 .847 .783 .848 .872 .484 .481 .481 .501 .487 .487 .484 .884 .88	.872 .878 .882 .890 .890 .887 .873 .806 .870 .507 .504 .506 .503 .507 .500 .531 .538 .524 .512 .493 .483	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971 .971 .996 .947 .940 .950
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .024 .007 .005 .975 .950 .965 .970 .958	22 .586 .598 .597 .604 .602 .606 .601 .530 .604 .005 .002 .010 .011 .011 .028 .023 .006 .005 .000 .009 .967 .949 .886	23 .561 .568 .565 .572 .574 .576 .572 .574 .499 .004 .006 .003 .004 .006 .008 .001 .005 .002 .002 .949 .952 .873	24 .570 .584 .581 .586 .593 .586 .514 .592 .590 .001 .001 .004 .008 .020 .020 .023 .001 .001 .001 .001 .001 .001 .001 .000 .001 .002 .003 .003 .003 .004 .005 .0	25 -588 -602 -607 -609 -605 -605 -608 -605 -533 -612 -608 -001 -000 -000 -000 -000 -000 -000 -0	26 -587 -593 -596 -603 -599 -600 -000 -000 -002 -000 -000 -000 -000	27 	28 385 364 377 378 363 363 346 317 348 368 466 475 480 462 491 491 491 494 494 494 494 494	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .515 .535 .473 .531 .496 .513 .496 .513 .496 .510 .510 .510 .510 .510 .510 .510 .510	30 813 824 826 835 836 830 818 8752 487 488 490 478 492 496 497 498 497 498 497 498 497 498 497 498 497 498 497 498 497 498 498 498 498 498 498 498 498	31 .769 .784 .796 .793 .783 .777 .714 .775 .799 .512 .508 .512 .504 .514 .514 .514 .513 .514 .513 .514 .513 .514 .514 .513 .514 .515 .516 .517 .518 .518 .519 .5	32 827 830 828 837 846 834 832 756 483 481 484 486 484 486 494 495 495 495 495 475 475 475	33 638 648 646 656 656 656 651 642 582 443 446 443 444 443 444 444 445 444 445 446 447 448 452 448 449 440 441 441 442 443 444 443 444 444 445 446 447 448 447 448 448 449 449 449 449 449 449 449 449	34 .751 .762 .759 .769 .774 .763 .775 .503 .775 .503 .508 .499 .516 .517 .512 .514 .505 .499 .	35 .756 .779 .780 .791 .788 .784 .773 .712 .770 .794 .526 .511 .524 .531 .531 .531 .531 .531 .531 .531 .531	36 .738 .752 .751 .762 .762 .760 .757 .748 .680 .744 .765 .544 .540 .544 .545 .544 .552 .544 .552 .546 .573 .534 .532	37 810 819 819 882 8824 8824 8811 .740 .535 .531 .536 .525 .570 .510 .510 .510	38 809 825 827 837 836 831 848 841 489 483 484 485 516 502 516 500 488 489 447 478 476	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475 .447 .463 .471 .476 .474	.872 .878 .8890 .890 .897 .873 .806 .870 .504 .507 .503 .507 .503 .531 .531 .538 .524 .510 .512 .493 .494 .499	.834 .841 .839 .844 .843 .816 .840 .827 .838 .991 .971 .971 .971 .971 .975 .996 .995 .995 .995 .995 .995 .995 .99
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 21 Inje 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia	21 610 623 621 628 627 631 626 553 634 628 006 005 006 002 012 010 029 024 007 005 965 9760 985 884	22 -586 -598 -597 -604 -602 -606 -606 -603 -608 -005 -002 -001 -011 -023 -006 -005 -009 -0	23 .561 .568 .565 .572 .572 .574 .576 .003 .004 .006 .008 .010 .000 .002 .000 .002 .949 .952 .873	24 .570 .584 .581 .586 .593 .589 .590 .001 .000 .001 .004 .001 .004 .001 .000 .001 .001 .001 .002 .001 .001 .001 .004 .004 .885 .8	25 .588 .602 .602 .607 .609 .609 .533 .612 .608 .000 .0	26 .587 .593 .589 .596 .603 .599 .500 .000 .000 .000 .000 .000 .001 .026 .001 .000 .000 .000 .000 .000 .000 .00	27 	28 .385 .364 .377 .378 .363 .356 .317 .348 .466 .475 .456 .480 .491 .491 .491 .494 .4	29 .445 .417 .434 .433 .415 .406 .393 .369 .393 .491 .514 .515 .533 .513 .473 .491 .498 .479 .489 .504 .	30 813 824 826 835 836 830 818 8752 816 487 488 487 490 478 490 479 479 479 479 479 479 479 479	31 .769 .784 .787 .796 .793 .788 .797 .714 .775 .508 .512 .508 .512 .504 .514 .505 .514 .505 .514 .505 .514 .505 .514 .505 .514 .505 .514 .505 .514 .505 .514 .505 .514 .505 .514 .505 .506 .514 .505 .506 .506 .506 .507 .508 .5	32 827 830 828 837 846 833 848 822 756 823 481 484 486 484 486 502 521 500 491 495 474 484 484 485 502 502 503 503 503 503 503 503 503 503	33 .638 .648 .646 .656 .656 .642 .582 .645 .443 .444 .443 .444 .440 .478 .450 .433 .444 .445 .435 .435 .433 .442 .443 .445 .437 .437 .4	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .503 .508 .502 .508 .499 .591 .514 .500 .546 .517 .512 .514 .500 .548 .494 .505 .508 .508 .509 .508 .509 .508 .509 .508 .509 .508 .509 .508 .509 .508 .509 .508 .509 .508 .509 .508 .509 .509 .509 .509 .509 .509 .509 .509	35 .756 .779 .780 .791 .788 .784 .773 .712 .770 .526 .519 .522 .511 .531 .532 .508 .501 .506 .512 .506 .512 .616	36 .738 .752 .761 .762 .762 .760 .7748 .680 .744 .540 .544 .532 .544 .532 .544 .522 .528 .537 .531 .522 .528 .537 .534 .637	37 810 819 889 8824 8824 8811 .740 .811 .535 .525 .533 .524 .535 .525	38 809 825 827 836 831 818 753 818 841 483 486 487 489 472 478 476 476 -	39 .841 .855 .858 .868 .868 .867 .783 .848 .872 .487 .482 .484 .481 .494 .501 .494 .4	.872 .878 .889 .890 .887 .873 .806 .870 .507 .504 .506 .503 .507 .503 .521 .538 .524 .512 .493 .494 .499 .496	.834 .841 .839 .844 .843 .834 .816 .840 .827 .838 .991 .971 .971 .940 .950 .950 .953 .956 .953
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .024 .007 .005 .975 .950 .965 .970 .958	22 .586 .598 .597 .604 .602 .606 .601 .530 .604 .005 .002 .010 .011 .011 .028 .023 .006 .005 .000 .009 .967 .949 .886	23 .561 .568 .565 .572 .574 .576 .578 .578 .578 .578 .004 .004 .004 .004 .005 .002 .002 .002 .002 .003 .004 .005 .009 .0	24 .570 .584 .581 .586 .593 .586 .514 .592 .590 .001 .001 .004 .008 .020 .020 .023 .001 .001 .001 .001 .001 .001 .000 .001 .002 .003 .003 .003 .004 .005 .0	25 -588 -602 -607 -609 -605 -605 -608 -605 -533 -612 -608 -001 -000 -000 -000 -000 -000 -000 -0	26 -587 -593 -596 -603 -599 -600 -000 -000 -002 -000 -000 -000 -000	27 	28 385 364 377 363 363 356 346 475 456 480 462 491 453 464 478 448 464 478 449 464 478 478 478 478 478 478 478 47	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .515 .535 .473 .531 .496 .513 .496 .513 .496 .510 .510 .510 .510 .510 .510 .510 .510	30 813 824 826 835 836 830 818 8752 487 488 490 478 492 496 497 498 497 498 497 498 497 498 497 498 497 498 497 498 497 498 497 498 497 498 498 498 498 498 498 498 498	31 .769 .784 .796 .793 .783 .777 .714 .775 .799 .512 .508 .512 .504 .514 .514 .514 .513 .514 .513 .514 .513 .514 .514 .513 .514 .515 .516 .517 .518 .518 .519 .5	32 827 830 828 837 846 834 832 756 483 481 484 486 484 486 494 495 495 495 495 475 475 475	33 638 648 646 656 656 656 651 642 582 443 446 443 444 443 444 444 445 444 445 446 447 448 452 448 449 440 441 441 442 443 444 443 444 444 444 445 446 447 447 447 447 447 447 447 447 447	34 .751 .762 .759 .769 .774 .763 .775 .503 .775 .503 .508 .499 .516 .517 .512 .514 .505 .499 .	35 .756 .779 .780 .791 .788 .784 .773 .712 .770 .794 .526 .511 .524 .531 .531 .531 .531 .531 .531 .531 .531	36 .738 .752 .751 .762 .762 .760 .757 .748 .680 .744 .765 .544 .540 .544 .545 .544 .552 .544 .552 .546 .573 .534 .532	37 810 819 819 882 8824 8824 8811 .740 .535 .531 .536 .525 .570 .510 .510 .510	38 809 825 827 837 836 831 848 841 489 483 484 485 516 502 516 500 488 489 447 478 476	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475 .447 .463 .471 .476 .474	.872 .878 .8890 .890 .897 .873 .806 .870 .504 .507 .503 .507 .503 .531 .531 .538 .524 .510 .512 .493 .494 .499	.834 .841 .843 .844 .843 .816 .840 .971 .971 .971 .971 .971 .975 .996 .981 .975 .979 .950 .985 .975 .979 .955
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .024 .007 .005 .975 .950 .965 .970 .958 .884	22 .586 .598 .597 .604 .602 .606 .601 .530 .604 .005 .002 .010 .011 .011 .028 .023 .006 .005 .009 .0	23 .561 .568 .565 .572 .574 .576 .572 .574 .499 .004 .006 .003 .004 .006 .008 .018 .010 .005 .002 .002 .949 .952 .873 .614 .598	24 .570 .584 .581 .586 .593 .586 .514 .001 .001 .001 .004 .008 .020 .023 .001 .001 .001 .001 .001 .001 .001 .001 .001 .000 .001 .002 .003 .003 .003 .003 .004 .005 .0	25 .588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .000 .000 .004 .016 .000 .0	26	27 	28 385 364 377 378 363 363 346 317 348 368 466 475 480 462 491 478 448 448 448 448 475 464 475 476 477 476 477 477 477 477 477	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .515 .535 .473 .531 .496 .513 .496 .513 .496 .513 .497 .653 .653 .653 .653 .653 .653 .653 .653	30 813 824 826 835 836 830 818 8752 816 487 488 487 490 478 490 479 479 479 479 479 479 479 479	31 .769 .784 .787 .796 .793 .788 .777 .714 .512 .508 .512 .504 .514 .514 .514 .514 .514 .514 .514 .514 .513 .514 .514 .515 .523 .544 .516 .516 .517 .518 .518 .519 .519 .519 .510 .5	32 827 830 828 837 846 834 832 756 823 845 483 484 486 484 486 487 495 495 495 495 475 500 497 500 500 500 500 500 500 500 50	33 638 648 646 656 656 656 651 642 582 443 446 443 444 440 435 442 443 442 443 443 444 443 443 444 443 443	34 .751 .762 .759 .769 .774 .763 .775 .503 .775 .503 .508 .499 .514 .505 .499 .591 .541	35 .7566 .7799 .7800 .7911 .7888 .7844 .7733 .712 .5216 .5511 .5224 .5513 .5521 .5036 .5511 .5016 .512 .512 .512 .512 .512	36 .738 .752 .751 .762 .762 .760 .757 .748 .680 .544 .765 .544 .540 .544 .552 .544 .552 .546 .573 .534 .537 .534 .582	37 810 819 819 882 8824 8821 811 740 535 535 525 570 510 510 510 525 552 570 510 510 525 525 535 536 545 552 552 552 552 552 552 552	38 809 825 827 837 836 831 848 841 489 483 486 481 488 487 502 516 500 488 489 476 572 572 527	39 .841 .855 .858 .868 .868 .865 .847 .783 .848 .872 .487 .482 .481 .486 .475 .504 .487 .489 .471 .463 .471 .567 .521	.872 .878 .8890 .890 .897 .873 .806 .870 .507 .504 .503 .507 .503 .531 .531 .538 .524 .494 .499 .496	.834 .841 .839 .844 .816 .827 .838 .991 .971 .971 .971 .940 .981 .950 .981 .955 .956 .958 .780
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .002 .012 .010 .029 .024 .007 .005 .975 .950 .965 .970 .958 .884 .589 .584	22 .586 .598 .604 .602 .606 .601 .530 .604 .005 .004 .005 .002 .010 .011 .028 .023 .005 .009 .009 .009 .010 .009 .0	23 .561 .568 .565 .572 .572 .574 .576 .003 .004 .006 .008 .010 .000 .002 .000 .002 .949 .952 .873	24 .570 .584 .581 .586 .593 .589 .592 .590 .001 .000 .001 .000 .001 .001 .001 .001 .001 .001 .001 .001 .003 .001 .0	25 .588 .602 .602 .607 .609 .605 .533 .608 .001 .000 .0	26 .587 .593 .599 .596 .603 .599 .522 .600 .000 .000 .000 .000 .000 .000 .0	27	28 .385 .364 .377 .363 .363 .346 .317 .348 .368 .466 .475 .456 .480 .462 .491 .491 .491 .491 .494 .474 .474 .474 .474 .474 .474 .474 .474 .475 .476 .476 .476 .477 .476 .477 .476 .477 .477 .477 .477 .477 .477 .478 .4	29 .445 .417 .434 .433 .415 .369 .491 .504 .509 .411 .504 .515 .533 .535 .473 .491 .496 .514 .496 .514 .496 .503 .535 .473 .547 .555 .535 .547 .555 .535 .535 .535 .535 .535 .535 .53	30 .813 .824 .826 .835 .836 .836 .830 .841 .492 .487 .488 .490 .492 .497 .492 .497 .492 .497 .492 .497 .498 .497 .498 .498 .499 .4	31 .769 .784 .787 .796 .793 .775 .777 .714 .508 .512 .504 .513 .542 .503 .544 .490 .503 .504 .503 .504 .503 .504 .503 .504 .503 .504 .503 .504 .503 .504 .503 .504 .505 .505 .506 .506 .507 .508 .508 .509 .5	32 827 830 828 837 846 833 848 822 756 823 481 484 486 484 486 502 521 500 491 495 474 484 484 485 502 502 503 503 503 503 503 503 503 503	33 .638 .648 .646 .656 .656 .651 .642 .582 .443 .444 .443 .444 .443 .444 .444 .444 .452 .448 .452 .448 .453 .442 .448 .453 .441 .453 .442 .443 .445 .445 .445 .446 .456 .447 .456 .448 .456 .448 .456 .456 .448 .456 .448 .456 .456 .456 .456 .456 .456 .456 .456 .456 .447 .456 .4	34 .751 .762 .759 .769 .774 .688 .502 .503 .755 .507 .503 .502 .508 .502 .540 .517 .512 .510 .488 .499 .540 .5505 .499 .5506 .499 .505 .499 .505 .499 .505 .499 .506 .490 .507 .500 .488 .500 .488 .500 .488 .500 .490 .500 .488 .500 .490 .500 .490 .500 .488 .494 .500 .490 .500 .591 .591 .591 .591	35 .7566 .7797 .7801 .7818 .7844 .773 .712 .7794 .5266 .5119 .5252 .5213 .522 .523 .523 .5212 .616 .616 .574 .014	36 .738 .752 .751 .762 .762 .762 .762 .763 .744 .765 .544 .765 .544 .540 .540 .545 .544 .540 .540 .579 .582 .544 .540 .579 .582 .544 .540 .579 .582 .544 .547 .582 .548 .537 .534 .637 .532 .637 .582 .023 .012	37 .810 .819 .819 .832 .824 .822 .811 .740 .834 .535 .531 .525 .525 .525 .525 .545 .545 .535 .545 .5	38 .809 .825 .827 .837 .836 .831 .848 .841 .489 .483 .486 .481 .489 .483 .486 .481 .489 .483 .486 .487 .472 .478 .479 .478 .479 .478 .4	39 .841 .855 .858 .868 .865 .868 .865 .847 .783 .838 .885 .847 .487 .481 .481 .486 .475 .504 .514 .476 .474 .567 .521 .001 .010	.872 .878 .882 .890 .890 .897 .873 .806 .897 .504 .503 .507 .503 .507 .531 .532 .493 .483 .499 .496 .505 .507 .507 .507 .507 .507 .507 .507	.834 .841 .843 .844 .843 .816 .840 .827 .838 .991 .971 .971 .971 .971 .996 .947 .950 .953 .953 .953 .953 .780
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Niinxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .024 .007 .05 .955 .970 .958 .884 .589 .584 .601 .589 .601	22 -586 -598 -597 -604 -602 -606 -601 -530 -604 -005 -002 -010 -011 -005 -000 -005 -000 -005 -000 -005 -006 -006 -006 -006 -007 -0	23 .561 .568 .565 .572 .574 .576 .572 .499 .004 .000 .003 .004 .004 .005 .002 .002 .002 .002 .003 .004 .565 .6	24 .570 .584 .581 .586 .593 .586 .514 .590 .001 .000 .001 .004 .008 .001 .001 .004 .000 .001 .0	25 .588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .000 .000 .004 .016 .000 .0	26	27	28 .385 .364 .377 .378 .363 .346 .346 .348 .456 .475 .456 .491 .462 .491 .462 .491 .4	29 .445 .417 .434 .443 .415 .406 .393 .369 .411 .504 .515 .533 .514 .513 .491 .498 .513 .491 .513 .491 .513 .513 .513 .513 .513 .513 .513 .51	30 .813 .824 .826 .835 .836 .830 .818 .752 .487 .488 .490 .478 .492 .496 .490 .478 .492 .496 .497 .498 .478 .492 .496 .497 .498 .497 .498 .497 .498 .598 .5	31 .769 .784 .787 .796 .793 .788 .777 .714 .508 .512 .504 .514 .503 .544 .503 .544 .503 .544 .503 .544 .503 .544 .503 .549 .504 .504 .504 .505 .504 .506 .504 .506 .504 .506 .506 .506 .507 .508 .509 .5	32 827 830 828 837 846 834 832 756 483 481 484 486 484 486 521 591 495 591 495 500 491 495 500 500 500 500 500 500 500 5	33 638 648 646 656 656 656 651 642 582 443 446 443 444 443 444 443 444 443 444 443 444 443 444 443 444 443 443 445 443 446 443 446 447 448 449 449 449 449 449 449 449 449 449	34 .751 .762 .759 .774 .763 .774 .763 .775 .503 .775 .503 .508 .499 .502 .546 .517 .512 .514 .514 .514 .505 .499 .591 .541 .014	35 .7566 .7799 .7800 .7911 .7888 .7844 .7733 .7122 .5216 .5511 .5224 .5011 .5355 .5511 .5312 .5016 .5026 .5016 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5027 .5037 .5	36 .738 .752 .761 .762 .762 .760 .757 .748 .680 .544 .765 .544 .532 .544 .532 .544 .527 .560 .579 .552 .528 .537 .534 .537 .582 .023 .041	37 810 819 889 8824 8824 8811 .740 .535 .525 .525 .570 .545 .552 .577 .545 .552 .570 .545 .552 .570 .545 .552 .570 .545 .552 .570 .545 .552 .570 .545	38 .809 .825 .827 .837 .836 .831 .818 .753 .818 .483 .486 .475 .502 .516 .500 .488 .489 .481 .489 .481 .489 .481 .481 .482 .481 .483 .486 .475 .502 .516 .500 .481 .481 .482 .483 .486 .481 .481 .482 .483 .486 .481 .485 .486 .487 .486 .487 .488 .588 .5	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475 .501 .487 .489 .471 .463 .471 .567 .521 .0010 .002	.872 .878 .882 .890 .890 .887 .873 .806 .870 .507 .504 .503 .507 .503 .531 .538 .521 .510 .512 .493 .494 .496 .577 .527	.834 .841 .843 .844 .843 .834 .816 .827 .838 .991 .971 .971 .940 .947 .950 .953 .956 .953 .780
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae 33 Yangpyeong		22 -586 -598 -597 -604 -602 -606 -603 -604 -005 -002 -004 -005 -002 -006 -005 -007 -0	23 .5611 .568 .5655 .572 .574 .576 .572 .499 .578 .006 .003 .004 .006 .008 .010 .009	24 .570 .584 .581 .586 .593 .589 .590 .001 .001 .001 .004 .008 .004 .001 .004 .001 .004 .001 .004 .001 .001 .004 .001 .005 .885 .885 .896 .996 .8	25 .588 .602 .602 .602 .603 .609 .609 .609 .609 .609 .609 .609 .608 .608 .001 .000 .000 .000 .000 .000 .000 .0	26 .587 .593 .589 .596 .603 .599 .500 .000 .000 .000 .000 .000 .001 .026 .001 .004 .004 .004 .004 .004 .006 .000 .000	27	28 .385 .364 .377 .378 .363 .356 .346 .317 .348 .466 .475 .456 .480 .462 .491 .462 .491 .462 .491 .543 .460 .465 .544 .554 .554	29 .445 .417 .434 .443 .415 .406 .399 .411 .504 .514 .515 .533 .491 .498 .498 .499 .053053574 .564 .598	30 813 824 826 835 836 830 818 752 816 841 487 488 486 490 478 496 479 479 479 479 479 479 479 479	31 .769 .784 .787 .796 .793 .788 .797 .714 .775 .508 .512 .508 .512 .504 .514 .505 .514 .496 .503 .514 .496 .504 .505 .504 .506 .506 .507 .507 .508 .508 .508 .519 .508 .519 .508 .519 .508 .519 .508 .509 .5	32 827 830 828 837 846 833 848 822 756 823 481 484 486 485 485 487 487 495 487 495 487 487 487 487 487 487 487 487	33 638 648 646 656 656 661 642 582 645 543 444 443 444 441 443 442 440 441 443 445 442 440 441 441 442 443 445 446 447 448 449 449 440 440 440 441 441 441 442 443 446 446 447 447 448 449 449 449 440 440 440 440 440	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .503 .508 .499 .502 .514 .500 .514 .500 .514 .500 .514 .500 .514 .500 .514 .500 .514 .500 .514 .500 .514 .500 .514 .500 .516 .500 .516 .500 .517 .501 .501 .501 .501 .501 .501	35 .7566 .779 .780 .781 .788 .784 .773 .712 .770 .526 .519 .522 .511 .535 .508 .512 .523 .508 .512 .523 .508 .512 .524 .501 .506 .512 .616 .574	36 .738 .752 .761 .762 .762 .760 .757 .748 .680 .744 .544 .540 .544 .532 .544 .522 .524 .537 .531 .522 .528 .537 .532 .534 .637 .582	37 810 819 819 832 824 821 740 811 740 811 536 525 533 524 552 553 552 553 552 553 552 553 554 555 555 555 555 555 555	38 809 825 827 836 831 818 753 818 841 489 483 484 475 502 516 500 478 478 478 476 476 572 572 572 572 572 572 572 572	39 841 855 858 868 865 862 847 783 848 847 487 487 487 487 487 487 487 487	.872 .878 .889 .890 .887 .873 .806 .870 .507 .504 .503 .507 .503 .507 .503 .512 .493 .494 .499 .496 .577 .527	.834 .841 .843 .843 .834 .816 .827 .838 .991 .971 .971 .940 .950 .953 .953 .953 .953 .780
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jejiu 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae 33 Yangpyeong 34 Cheongju	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .006 .002 .012 .010 .029 .024 .007 .005 .975 .950 .965 .970 .958 .884 .698 .691 .589 .601 .616 .583	22 .586 .598 .597 .604 .602 .606 .601 .530 .002 .010 .005 .002 .010 .005 .006 .005 .967 .949 .886 .603 .592 .605 .588 .608 .608	23 .5611 .568 .5655 .572 .574 .576 .572 .499 .004 .006 .003 .004 .006 .008 .009	24 .570 .584 .581 .586 .593 .592 .590 .001 .004 .004 .002 .023 .001 .001 .001 .001 .001 .001 .001 .001 .003 .001 .002 .003 .003 .004 .005 .0	25 .588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .0	26	27	28 385 364 377 363 363 366 346 317 368 466 475 456 480 462 491 478 443 464 478 474 	29 .445 .417 .434 .433 .415 .369 .411 .504 .514 .513 .496 .513 .491 .513 .496 .513 .535 .473 .496 .513 .656 .556	30 813 824 826 835 836 838 838 830 841 492 487 488 490 491 492 497 498 497 498 497 498 497 498 497 488 497 488 497 488 498 498 498 498 498 498 498	31 .769 .784 .787 .796 .793 .777 .714 .502 .504 .512 .504 .512 .504 .513 .514 .513 .514 .495 .504 .503 .504 .504 .504 .505 .504 .506 .504 .506 .507 .508 .509 .5	32 827 830 828 837 846 834 822 756 823 845 483 481 484 484 486 487 487 500 491 495 474 475 565 500 020 0019 888 888	33 638 648 646 656 656 651 642 582 443 446 443 443 444 443 443 444 443 444 443 444 443 444 443 444 443 444 443 444 443 444 443 444 443 444 443 446 447 448 449 449 449 449 449 449 449 449 449	34 .751 .762 .759 .769 .774 .688 .753 .775 .503 .502 .502 .508 .499 .517 .512 .514 .505 .499 .591 .514 .505 .499 .501 .501 .502 .503 .502 .503 .503 .503 .503 .503 .503 .503 .503	35 .7566 .7799 .7800 .7911 .7888 .7844 .7733 .7122 .5216 .5511 .5224 .5011 .5355 .5511 .5312 .5016 .5026 .5016 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5017 .5026 .5027 .5037 .5	36 .738 .752 .751 .762 .762 .760 .762 .760 .757 .748 .680 .544 .765 .544 .540 .544 .540 .544 .552 .546 .532 .544 .552 .552 .554 .552 .553 .553 .553 .637 .5534 .637 .582 .023 .012 .041 .065 .012	37 .810 .819 .819 .832 .824 .822 .811 .740 .834 .535 .535 .525 .525 .525 .525 .545 .5	38 809 825 827 837 836 831 838 841 489 483 486 481 487 502 516 488 489 487 472 472 478 476 572 527 001 007 001 072 073 073	39 .841 .855 .858 .868 .868 .867 .783 .8868 .847 .783 .8872 .487 .481 .481 .481 .475 .504 .514 .477 .501 .001 .0020 .082 .082	.872 .878 .882 .890 .897 .873 .806 .897 .504 .503 .507 .503 .507 .531 .532 .532 .494 .499 .496 .577 .527	.834 .841 .843 .844 .843 .844 .827 .838 .991 .971 .971 .971 .971 .940 .950 .953 .953 .953 .953 .780
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 21 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae 33 Yangpyeong 34 Cheongju 35 Yeongdong 36 Cheongyang	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .000 .012 .010 .029 .012 .010 .029 .029 .029 .030 .050 .066 .055 .975 .950 .965 .976 .958 .884 .589 .584 .601 .580 .601 .616 .583 .580 .571	22 .586 .598 .604 .602 .606 .601 .530 .604 .005 .004 .005 .002 .010 .002 .010 .005 .005 .007 .949 .949 .949 .603 .603 .604 .603 .604 .605 .604 .605 .606 .606 .607 .607 .608 .609 .6	23 .561 .568 .568 .565 .572 .574 .499 .576 .006 .003 .004 .006 .003 .004 .010 .005 .002 .000 .000 .002 .949 .952 .873 .614 .598 .614 .598 .615 .593 .591 .593	24 .570 .584 .581 .586 .593 .586 .592 .590 .001 .000 .001 .000 .001 .000 .001 .001 .000 .001 .0	25 .588 .602 .607 .609 .605 .533 .605 .500 .0	26 .587 .593 .598 .596 .603 .599 .599 .000 .000 .000 .000 .002 .019 .000 .0	27	28 .385 .364 .378 .363 .363 .346 .317 .378 .368 .466 .475 .454 .454 .454 .454 .478 .454 .478 .4	29 .445 .417 .434 .433 .415 .369 .369 .316 .514 .515 .513 .535 .473 .491 .496 .499 .504 .514 .515 .513 .535 .535 .473 .516 .517 .584 .598 .560 .544 .598 .560 .544 .558	30 813 824 826 835 836 838 838 830 818 841 492 487 488 490 492 487 488 492 497 488 492 497 488 492 497 488 492 497 498 498 499 497 498 499 499 499 499 499 499 499	311 .769 .784 .787 .796 .793 .796 .793 .7714 .777 .714 .508 .512 .504 .514 .515 .512 .504 .514 .505 .523 .542 .508 .512 .508 .512 .508 .512 .509 .518 .510 .509 .510 .510 .510 .510 .510 .510 .510 .510	32 827 830 828 837 846 822 756 823 845 483 481 486 502 521 500 491 495 500 491 500 600 600 600 600 600 600 600	33 .638 .648 .646 .656 .656 .656 .651 .642 .562 .443 .443 .444 .435 .442 .444 .437 .433 .421 .437 .430 .442 .437 .430 .442 .437 .430 .442 .437 .430 .442 .437 .430 .430 .442 .437 .448 .430 .449 .4	34 .751 .762 .759 .769 .774 .688 .507 .503 .507 .503 .502 .508 .502 .546 .517 .512 .514 .505 .499 .520 .488 .494 .505 .499 .517 .512 .505 .499 .505 .499 .501 .501 .501 .501 .501 .501 .501 .501	35 -756 -779 -780 -7791 -788 -773 -712 -7794 -526 -511 -521 -521 -523 -523 -523 -523 -523 -523 -523 -524 -511 -512 -512 -512 -512 -512 -512 -512	36 .738 .752 .751 .762 .762 .762 .762 .763 .744 .765 .544 .540 .544 .545 .547 .552 .546 .579 .552 .546 .579 .552 .546 .579 .552 .546 .579 .552 .546 .579 .552 .546 .579 .552 .546 .579 .552 .546 .579 .552 .546 .579 .570 .570 .570 .570 .570 .570 .570 .570	37 810 819 819 832 824 822 821 740 535 531 536 552 552 552 554 555 554 555 555	38 .809 .825 .827 .837 .836 .831 .818 .841 .489 .483 .486 .481 .484 .487 .502 .516 .500 .488 .473 .474 .472 .478 .476 .752 .001 .007 .001 .013 .002	39 .8411 .8555 .858 .868 .8658 .8682 .847 .783 .848 .872 .487 .482 .484 .475 .504 .501 .471 .476 .474 .701 .0022 .011 .010 .0022 .021 .019 .0031	.872 .878 .882 .890 .890 .897 .873 .806 .870 .507 .504 .503 .507 .503 .507 .531 .531 .531 .534 .510 .524 .510 .524 .510 .524 .510 .524 .510 .524 .510 .524 .510 .524 .510 .527 .527	.834 .841 .839 .844 .816 .827 .838 .991 .971 .971 .971 .971 .971 .940 .950 .953 .953 .953 .953 .953 .953 .953 .953
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae 33 Yangsyong 34 Cheongju 35 Yeongdong 36 Cheongyang 37 Yangsan	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .001 .029 .024 .005 .975 .950 .965 .970 .958 .884 .698 .589 .584 .601 .583 .580 .571 .564	22 .586 .598 .597 .604 .602 .606 .601 .530 .002 .010 .011 .011 .028 .023 .006 .005 .000 .010 .011 .018 .886 .603 .592 .605 .588 .603 .592	23 .561 .568 .565 .572 .574 .576 .572 .574 .499 .004 .006 .003 .004 .006 .003 .018 .010 .005 .002 .002 .949 .952 .873 .614 .598 .614 .598 .615 .628 .590 .615 .628 .593 .591 .583	24 .570 .584 .581 .583 .589 .592 .590 .001 .004 .008 .009 .001 .002 .003 .003 .003 .003 .004 .005 .0	25 .588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .000 .000 .004 .016 .000 .0	26 .587 .593 .599 .596 .603 .599 .000 .000 .000 .002 .001 .002 .000 .004 .000 .000 .000 .000 .000	27	28 385 364 377 378 363 363 346 317 348 368 466 475 480 462 491 478 448 478 449 478 474 474 475 548 554 554 574 574 575 575 575 575	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .514 .515 .535 .473 .535 .473 .496 .513 .496 .514 .515 .535 .473 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .545 .545 .545 .546 .546 .546 .546 .546	30 813 824 826 835 836 837 836 841 492 487 488 490 478 491 492 496 497 498 497 498 497 498 498 497 498 497 498 498 498 499 499 499 499 499	31 .769 .784 .787 .796 .793 .788 .777 .714 .512 .508 .512 .504 .514 .514 .514 .513 .514 .514 .513 .514 .513 .514 .503 .504 .503 .504 .504 .504 .504 .504 .504 .504 .505 .504 .504 .504 .504 .504 .505 .504 .504 .504 .505 .504 .504 .504 .505 .504 .506 .507 .508 .509 .5	32 827 830 828 837 846 834 832 756 483 481 484 486 484 486 484 486 487 502 521 495 500 491 495 500 900 900 900 900 900 900 9	33 638 648 646 656 656 656 651 665 642 443 446 443 444 440 435 442 448 450 442 448 450 442 448 450 656 656 657 660 670 670 670 670 670 670 67	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .503 .508 .499 .501 .514 .505 .499 .591 .541 .014 .005 .012 .053 .940 .947 .943	35 .7566 .7799 .7800 .7911 .7888 .7884 .7773 .712 .5216 .5511 .522 .5513 .5521 .506 .5512 .512 .512 .516 .516 .574 .015 .015 .015 .015 .015 .015 .015 .015	36 .738 .752 .751 .762 .762 .760 .757 .748 .680 .744 .765 .544 .540 .544 .545 .544 .552 .544 .552 .546 .573 .534637 .582 .023 .012 .041 .065 .012 .017 .930	37 810 819 819 882 8824 8824 8811 .740 .535 .525 .533 .524 .552 .570 .510 .510 .510 .525 .545 .545 .545 .546 .546 .548 .648	38 809 825 827 837 836 831 838 848 488 488 488 481 488 481 488 481 481	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475 .487 .489 .471 .463 .471 .501 .0010 .0022 .082 .082 .0019 .031 .011	40 .872 .878 .882 .890 .897 .873 .806 .870 .504 .506 .503 .507 .503 .531 .538 .524 .510 .512 .493 .483 .494 .499 .496 .577 .527 .006 .012 .025 .092 .036 .036 .036 .036	.834 .841 .843 .844 .816 .827 .838 .991 .971 .971 .947 .947 .950 .981 .975 .979 .950 .981 .975 .979 .950 .981 .979 .950 .993 .993 .993 .993 .993 .993 .993 .99
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae 33 Yangpyeong 34 Cheongju 35 Yeongdong 36 Cheongyang 37 Yangsan 38 Kyeongju	21 610 623 621 628 628 627 631 626 553 634 628 006 002 012 010 029 024 007 005 955 970 958 884 589 584 601 580 601 616 583 571 564 603	22 -586 -598 -597 -604 -602 -606 -601 -530 -604 -005 -002 -010 -011 -023 -006 -000 -009 -000 -0	23 .561 .568 .565 .572 .574 .576 .003 .004 .006 .008 .000 .008 .000 .0	24 .570 .584 .581 .586 .593 .586 .514 .590 .001 .004 .008 .001 .004 .001 .004 .001 .004 .001 .004 .001 .004 .001 .005 .885 .885 .886 .593 .690 .6	25 .588 .602 .607 .609 .609 .605 .533 .612 .000 .0	26	27	28 .385 .364 .377 .378 .363 .356 .317 .348 .466 .475 .456 .480 .462 .491 .478 .454 .474 .905 .548 .547 .533 .5574 .533 .554 .554 .554 .554 .554 .554 .55	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .515 .533 .514 .515 .533 .473 .491 .515 .533 .514 .515 .533 .516 .515 .533 .517 .517 .518 .518 .519 .519 .519 .519 .519 .519 .519 .519	30 .813 .824 .826 .835 .836 .836 .838 .818 .752 .816 .492 .487 .488 .490 .478 .492 .496 .479 .492 .496 .479 .496 .479 .496 .479 .496 .479 .496 .996 .496 .9	31 .769 .784 .787 .796 .793 .788 .777 .714 .775 .508 .512 .504 .514 .505 .553 .542 .518 .513 .514 .496 .495 .503 .504568 .522 .007922 .896 .955 .951	32 827 830 828 837 846 834 848 481 488 488 488 484 486 495 491 495 495 490 000 019 000 019 000 019 000 019 019	33 .638 .648 .646 .656 .656 .651 .642 .582 .645 .582 .443 .446 .443 .444 .435 .442 .447 .437 .73 .74 .060 .72 .74 .060 .772 .774 .060 .772 .774 .060 .772 .774 .060 .772 .774 .888 .888	34 .751 .762 .759 .7769 .7774 .688 .753 .503 .508 .499 .502 .504 .517 .512 .514 .505 .499549511 .014 .005 .499 .591 .541 .014 .005 .499 .591 .541 .014 .005 .499 .591 .541 .943	35 .7566 .779 .780 .791 .788 .784 .773 .712 .770 .526 .519 .522 .523 .501 .502 .551 .501 .502 .501 .502 .501 .502 .501 .502 .502 .501 .502 .502 .503 .503 .503 .503 .503 .503 .503 .503	36 .738 .752 .761 .762 .762 .763 .768 .744 .680 .744 .540 .544 .540 .544 .522 .524 .544 .527 .552 .528 .537 .532 .528 .012 .023 .012 .041 .065 .012 .017 .0930 .938	37 810 819 889 882 8824 8811 740 8811 536 5535 525 525 525 557 535 558 558 558 558 558 558 558	38 .809 .825 .827 .837 .836 .831 .818 .753 .818 .841 .489 .483 .484 .485 .551 .500 .516 .500 .601 .6	39 8411 8555 8568 8688 865 8692 8477 7833 8488 8488 8472 4887 4894 4811 4864 4754 4874 4874 4874 4874 4874 4874 487	.872 .878 .882 .890 .890 .887 .873 .806 .870 .504 .506 .503 .507 .503 .538 .524 .512 .493 .494 .496 .577 .527 .006 .012	.834 .841 .843 .843 .843 .834 .816 .827 .838 .991 .971 .971 .940 .950 .950 .950 .955 .956 .956 .957 .959 .959 .959 .959 .959 .959 .959
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae 33 Yangsyong 34 Cheongju 35 Yeongdong 36 Cheongyang 37 Yangsan	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .001 .029 .024 .005 .975 .950 .965 .970 .958 .884 .698 .589 .584 .601 .583 .580 .571 .564	22 .586 .598 .597 .604 .602 .606 .601 .530 .002 .010 .011 .011 .028 .023 .006 .005 .000 .010 .011 .018 .886 .603 .592 .605 .588 .603 .592	23 .561 .568 .565 .572 .574 .576 .572 .574 .499 .004 .006 .003 .004 .006 .003 .018 .010 .005 .002 .002 .949 .952 .873 .614 .598 .614 .598 .615 .628 .590 .615 .628 .593 .591 .583	24 .570 .584 .581 .583 .589 .592 .590 .001 .004 .008 .009 .001 .002 .003 .003 .003 .003 .004 .005 .0	25 .588 .602 .602 .607 .609 .605 .533 .612 .608 .001 .000 .000 .000 .004 .016 .000 .0	26 .587 .593 .599 .596 .603 .599 .000 .000 .000 .002 .001 .002 .000 .004 .000 .000 .000 .000 .000	27	28 385 364 377 378 363 363 346 317 348 368 466 475 480 462 491 478 448 478 449 478 474 474 475 548 554 554 574 574 575 575 575 575	29 .445 .417 .434 .433 .415 .406 .393 .369 .411 .504 .514 .515 .535 .473 .535 .473 .496 .513 .496 .514 .515 .535 .473 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .535 .535 .473 .545 .545 .545 .546 .546 .546 .546 .546	30 813 824 826 835 836 837 836 841 492 487 488 490 478 491 492 496 497 498 497 498 497 498 498 497 498 497 498 498 498 499 499 499 499 499	31 .769 .784 .787 .796 .793 .788 .777 .714 .512 .508 .512 .504 .514 .514 .514 .513 .514 .514 .513 .514 .513 .514 .503 .504 .503 .504 .504 .504 .504 .504 .504 .504 .505 .504 .504 .504 .504 .504 .505 .504 .504 .504 .505 .504 .504 .504 .505 .504 .506 .507 .508 .509 .5	32 827 830 828 837 846 834 832 756 823 845 481 484 484 486 484 486 487 487 502 521 495 495 475 475 500 491 495 500 495 600 495 600 495 600 600 600 600 600 600 600 60	33 638 648 646 656 656 656 651 665 642 443 446 443 444 440 435 442 448 450 442 448 450 442 448 450 656 656 657 660 672 673 674 675 675 675 675 675 675 675 675	34 .751 .762 .759 .769 .774 .763 .754 .688 .753 .775 .503 .508 .499 .501 .514 .505 .499 .591 .541 .014 .005 .012 .053 .940 .947 .943	35 .7566 .7799 .7800 .7911 .7888 .7884 .7773 .712 .5216 .5511 .522 .5513 .5521 .506 .5512 .512 .512 .516 .516 .574 .015 .015 .015 .015 .015 .015 .015 .015	36 .738 .752 .751 .762 .762 .760 .757 .748 .680 .744 .765 .544 .540 .544 .545 .544 .552 .544 .552 .546 .573 .534637 .582 .023 .012 .041 .065 .012 .017 .930	37 810 819 819 882 8824 8824 8811 .740 .535 .525 .533 .524 .552 .570 .510 .510 .510 .525 .545 .545 .545 .546 .546 .548 .648	38 809 825 827 837 836 831 838 848 488 488 488 481 488 481 488 481 481	39 .841 .855 .858 .868 .862 .847 .783 .848 .872 .487 .482 .484 .481 .486 .475 .487 .489 .471 .463 .471 .501 .0010 .0022 .082 .082 .0019 .031 .011	40 .872 .878 .882 .890 .897 .873 .806 .870 .504 .506 .503 .507 .503 .531 .538 .524 .510 .512 .493 .483 .494 .499 .496 .577 .527 .006 .012 .025 .092 .036 .036 .036 .036	.834 .841 .843 .844 .816 .827 .838 .991 .971 .971 .971 .947 .950 .981 .975 .979 .950 .981 .780 .979 .950 .979 .950 .979 .950 .979 .979 .979 .979 .979 .979 .979 .97
Population R. huanrenensis 1 Jangseong 2 Pohang 3 Cheongsong 4 Yeongdeok 5 Pyeongchang 6 Hanso-ri 7 Oban-ri 8 Inje 9 Kapyeong 10 Donghae R. dybowskii 11 Yangpyeong 12 Cheongyang 13 Muju 14 Jangseong 15 Kurye 16 Haenam 17 Jeju 18 Keoje 19 Hadong 20 Yangsan 21 Donghae 22 Inje 23 Kanseong 24 Keojin 25 Kapyeong 26 Wonju 27 Tsushima Isl. R. chensinensis 28 Ninxia 29 Quing R. amurensis 30 Haenam 31 Kangwha 32 Sorae 33 Yangpyeong 34 Cheongju 35 Yeongdong 36 Cheongyang 37 Yangsan 38 Kyeongju 39 Kangnung	21 .610 .623 .621 .628 .627 .631 .626 .553 .634 .628 .006 .005 .002 .012 .010 .029 .024 .007 .005 .975 .950 .965 .970 .958 .884 .698 .601 .589 .589 .584 .601 .616 .616 .583 .580 .601 .616 .6583 .580 .601 .571 .564	22 .586 .598 .604 .602 .606 .601 .530 .604 .005 .004 .005 .002 .010 .011 .028 .023 .005 .009 .019 .05 .05 .06 .06 .07 .07 .08 .09 .09 .09 .09 .09 .09 .09 .09	23 .561 .568 .565 .572 .574 .576 .576 .006 .003 .004 .006 .003 .004 .018 .005 .002 .949 .952 .949 .952 .873 .614 .598 .591 .591 .591 .615 .628 .593 .591 .616 .618	24 .570 .584 .581 .586 .593 .592 .590 .001 .000 .001 .000 .001 .001 .001 .001 .001 .001 .001 .001 .001 .003 .001 .002 .003 .004 .005 .0	25 .588 .602 .602 .607 .609 .605 .533 .608 .001 .000 .0	26	27	28 385 364 377 363 363 363 346 346 475 456 480 462 474 474 474 474 474 475 474 474	29 .445 .417 .434 .433 .415 .369 .491 .504 .514 .515 .533 .535 .473 .491 .496 .514 .496 .514 .515 .533 .535 .473 .516 .574 .585 .677 .584 .598 .598 .594 .594 .594 .594 .594 .596 .578	30 813 824 826 835 836 838 838 830 841 492 487 488 490 491 492 497 483 478 - 571 571 571 571 571 571 571 888 993 994 994 994 997 977	31 .769 .784 .787 .796 .793 .775 .779 .512 .508 .577 .504 .512 .504 .513 .542 .503 .544 .490 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .503 .504 .505 .505 .505 .505 .505 .506 .507 .508 .509 .5	32 827 830 828 837 846 822 756 823 845 483 481 484 486 484 486 487 486 487 487 500 491 495 500 491 600 600 600 600 600 600 600 60	33 .638 .648 .646 .656 .656 .656 .651 .642 .443 .446 .443 .444 .443 .444 .443 .444 .452 .448 .452 .448 .453 .447 .477 .600 .742 .774 .774 .774 .774 .774 .774 .774 .774 .774 .774 .774 .774 .774 .774 .774 .774 .775 .774 .774 .777 .774 .774 .777 .774 .775 .7	34 .751 .762 .759 .769 .774 .688 .502 .503 .755 .507 .503 .502 .508 .502 .540 .517 .512 .510 .541 .505 .499 .541 .505 .499 .591 .591 .591 .591 .591 .591 .591 .5	35 .7566 .7799 .7801 .7818 .7844 .773 .712 .7794 .5266 .5119 .5252 .5213 .5213 .5212 .5216 .5316 .506 .512 .512 .512 .516 .516 .574 .015 .053 .073 .019 .928 .959 .944	36 .738 .752 .761 .762 .762 .762 .763 .744 .765 .544 .765 .544 .540 .540 .540 .541 .552 .544 .540 .579 .552 .544 .540 .579 .552 .544 .540 .579 .532 .544 .540 .579 .532 .544 .540 .579 .552 .546 .547 .552 .546 .547 .552 .548 .547 .552 .548 .549 .637 .534 .637 .582 .041 .041 .041 .930 .938 .938 .939 .939	37 810 819 819 819 832 824 822 811 740 834 535 531 536 525 570 510 525 570 510 510 525 525 570 500 500 500 500 500 600 600 60	38 .809 .825 .827 .837 .836 .831 .848 .841 .489 .483 .486 .481 .481 .482 .483 .484 .483 .486 .481 .487 .502 .516 .600 .488 .487 .472 .478 .478 .470 .001 .010 .011 .011 .011 .022 .033 .034 .035 .0	39 .8411 .8555 .858 .868 .8658 .8682 .847 .783 .8882 .4844 .481 .4816 .487 .4817 .4613 .471 .476 .504 .5101 .010 .022 .011 .010 .022 .021 .019 .0013 .001	.872 .878 .889 .890 .890 .897 .504 .503 .507 .503 .507 .531 .531 .534 .510 .512 .493 .483 .499 .496 .503 .507 .510 .510 .524 .510 .524 .510 .524 .510 .524 .510 .524 .510 .524 .510 .524 .510 .524 .524 .524 .532 .532 .532 .532 .532 .532 .532 .532	.834 .841 .839 .844 .843 .834 .816 .827 .838 .991 .971 .971 .971 .971 .940 .950 .981 .975 .975 .976 .950 .953 .956 .979 .979 .979 .979 .979 .979 .979 .97