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Taxonomic Status of Populations of the Light-vented Bulbul *Pycnonotus sinensis* (Gmelin, 1789) (Passeriformes: Pycnonotidae) in Taiwan and the Southern Ryukyus

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Takeshi Yamasaki (2006) Taxonomic status of populations of the light-vented Bulbul *Pycnonotus sinensis* (Gmelin, 1789) (Passeriformes: Pycnonotidae) in Taiwan and the southern Ryukyus. *Zoological Studies* **45**(2): 168-179. Populations of the Light-vented Bulbul *Pycnonotus sinensis* (Gmelin, 1789) from continental China, Taiwan, and the southern Ryukyus were compared on the basis of 3 color and 6 morphometric characters in 177 specimens. The Taiwanese sample markedly differed from the other samples. It showed less-distinct yellow streaks on the abdomen, a wider white nape patch, and longer hind claws. On the other hand, samples from continental China and the southern Ryukyus did not mutually differ in any examined characters. For that reason, I recognized *P. s. formosae* Hartert, 1910 from Taiwan as a valid subspecies, whereas *P. s. orii* Kuroda, 1923 from the southern Ryukyus was regarded as a junior synonym of the nominotypical subspecies from continental China. *Pycnonotus s. hainanus* (Swinhoe, 1870) from the southernmost part of continental China and Hainan I. was retained as a 3rd subspecies. It clearly differs from the others in having no white feathers on the nape. http://zoolstud.sinica.edu.tw/Journals/45.2/168.pdf

Key words: *Pycnonotus sinensis*, Subspecies classification, Plumage color, Morphometrics.

The Light-vented Bulbul *Pycnonotus sinensis* (Gmelin, 1789) (Passeriformes: Pycnonotidae) inhabits open woodlands, forest edges, and cultivated fields. It is distributed widely throughout East Asia (Fig. 1; Deignan 1960, Zheng 1985, Chen and Yu 1986, OSJ 2000). This bulbul was originally described from continental China (Gmelin 1789). Until the middle of the 19th century, this species was known to occur also in Taiwan (e.g., Swinhoe 1863). Later, populations from the southernmost part of continental China and Hainan I. were shown to be distinguishable from the other populations by their lack of white feathers on the nape (Swinhoe 1870, Sharpe 1881). Most subsequent authors (e.g., Hartert 1910, Deignan 1960, Cheng 1976, Zheng 1985) have recognized these southern Chinese populations as a distinct subspecies, *P. s. hainanus* (Swinhoe, 1870).

At the beginning of the 20th century, Hartert (1910) separated the Taiwanese population from the nominotypical subspecies as *P. s. formosae*. According to that description, this subspecies differs from *P. s. sinensis* in having shorter wings, a darker-brown chest band, and less-distinct yellow streaks on the abdomen. Subsequently, Kuroda (1923) described the population in the southern Ryukyus, Japan, an island group ~100 km east of Taiwan, as *P. s. orii*. He argued that the shorter wings and darker chest band also distinguish this subspecies from *P. s. sinensis*, and that it differs from *P. s. formosae* in having distinct abdominal streaks and a narrower white nape patch.

During the 20th century, many other subspecies have been proposed for *P. sinensis*, but all were later invalidated (Deignan 1960, Cheng 1976, Zheng 1985). In contrast, *P. s. formosae* and *P. s. orii* are recognized as valid in the con-

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temporary literature (e.g., Chen and Yu 1986, OSJ 2000).

Even so, Mauersberger and Fischer (1992) demonstrated that *P. s. sinensis* from Fujian Province, a maritime province of China closest to Taiwan, has shorter wings than those from more-northerly provinces. Moreover, Yamasaki (2002) clarified that, in *P. s. orii*, the chest band color becomes indistinct from autumn to the following summer by feather wear (Fig. 2A, B). Similarly, the nape patch width, the character used by Kuroda (1923) to discriminate *P. s. orii* and *P. s. formosae*, has proven to show a considerable seasonal variation within the former subspecies (Fig. 2C, D). These facts make it desirable to reevaluate the validity of *P. s. formosae* and *P. s. orii* by directly comparing specimens from relevant localities.

This study examines morphological variations within *P. sinensis* based on a series of specimens from various localities that cover almost the entire range of its distribution. Biogeographical implications of those results are also briefly discussed.

MATERIALS AND METHODS

Specimens from Taiwan and the southern Ryukyus were tentatively respectively assigned to *P. s. formosae* and *P. s. orii* following prevailing notions explained above. Reportedly, *P. s. sinensis* and *P. s. hainanus* coexist during the wintering season because of the partial migration of the former to southern China (Deignan 1960). Therefore, specimens from continental China and Hainan I. were identified to subspecies by the presence or absence of white feathers on the nape (present, but occasionally entirely concealed by long black feathers, in *P. s. sinensis*; absent in *P. s. hainanus*) irrespective of their localities within these regions. Specimens identified as *P. s. sinensis* were classified further into 2 geographic groups, the northern group (specimens from Jiangsu, Shanghai, Zhejiang, Chongqing, and Sichuan Provinces) and the southern group (those from Fujian and Guangdong Provinces, Xianggang, Hainan I., and Vietnam), taking the argument by Mauersberger and Fischer (1992) regarding their difference in wing length into con-

Fig. 1. Distribution of *Pycnonotus sinensis* (following Deignan 1960, Zheng 1985, Chen and Yu 1986, OSJ 2000). A recently established population on Okinawajima is not shown.

sideration. Although this last arrangement might be arbitrary because of considerable morphological overlap between the 2 groups, it was indispensable for minimizing noise from infrasubspecific variations in the results of the morphological analyses.

In all, 177 adult specimens were examined, of which 40 were *P. s. formosae* (19 males, 15 females, and 6 specimens of unknown sex), 26 were *P. s. orii* (12 males, 7 females, and 7 of unknown sex), 52 were the northern group of *P. s. sinensis* (22 males, 16 females, and 14 of unknown sex), 45 were the southern group of *P. s. sinensis* (18 males, 12 females, and 15 of unknown sex), and 14 were *P. s. hainanus* (7 males and females) (see Appendix for further details). Regarding analyses of infraspecific geographic variations, data from specimens from a population on Okinawajima, the central Ryukyus, were not included. This population was established in the mid 1970s, most likely through artificial introduction (OSJ 2000). Even so, 2 specimens from this island were used as yardsticks to categorize plumage color (see below).

Each specimen was examined for 2 color characters: darkness of the brown chest band (CB), and distinctness of the yellow abdominal streaks (AS). The width of the white nape patch (NP) was also examined in *P. s. formosae*, *P. s. orii*, and *P. s. sinensis* specimens. This character was not examined in specimens of *P. s. hainanus* because this subspecies lacks the nape patch. The CB was classified into 3 categories along a continuum from dark (I) to faint (III). To assign a CB score to each specimen, 2 specimens were first selected as yardsticks: the Kanagawa Prefectural Museum of Natural History specimen 14 (having a dark CB (I); collected on Yonagunijima, the southern Ryukyus in Dec.) and another Kyoto University Museum specimen 14 (having a faint CB (III); collected on Okinawajima in Mar.). All specimens were subsequently compared to these 2 reference skins. Specimens closely matching either of the 2 reference skins received the same score as the skin they matched, whereas specimens intermediate between the 2 reference skins received a score of II. The AS were classified as either distinct (I) or indistinct (II). As a yardstick for AS, I selected Kanagawa Prefectural Museum of Natural History specimen 7 (having indistinct AS (II); collected on Okinawajima in Dec.). Specimens with more-distinct AS than this reference skin received a score of I, and the other specimens received a score of II. The NP was classified into one of 5 categories ranging from seemingly absent to extremely wide: (I) entirely concealed by black feathers and apparently absent; (II) almost completely concealed by black feathers, resembling a white collar; (III) rather wide but partially concealed by black feathers; (IV) not concealed by black feathers, but including a few white feathers with black tips; and (V) not concealed by black feathers, invariably consisting of entirely white feathers.

Each specimen was also examined for the following 6 morphometric characters: wing length (WL; measured from the carpal joint to the tip of the flattened 4th outer primary), tail length (TLL; measured from the tip to the base of the central tail feather), upper bill length (BL; measured from the tip of the bill to the anterior end of the nostril), upper bill height (BH; measured at the anterior end of the nostril), tarsus length (TRL; measured from the notch on the back of the intertarsal joint to the lower edge of the last complete scale before the toes diverge), and hind claw length (HCL; measured on the dorsal side from the tip of the claw to the edge of the skin). The WL and TLL were measured to the nearest 0.5 mm. The others were measured to the nearest 0.05 mm.

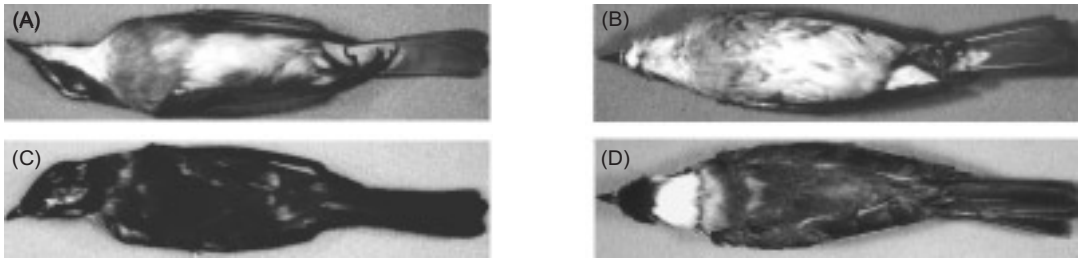

Fig. 2. Seasonal variation in plumage color of *Pycnonotus sinensis orii*. (A, C) Ventral and dorsal views of a specimen collected from Yonagunijima, the southern Ryukyus on 30 Dec. 1986 (Kanagawa Prefectural Museum of Natural History specimen 16); (B, D) ventral and dorsal views of a specimen collected from Yonagunijima on 2 June 1936 (Yamashina Institute for Ornithology specimen 24194).

Preliminary analyses for the largest sample (i.e., of the northern group of *P. s. sinensis*) revealed no significant sex-related variation in any of the 3 color characters ($p > 0.05$: Mann-Whitney U-tests). Therefore, data of these characters for males and females were pooled before the analyses. In contrast, preliminary analyses revealed significant sex-related variation in the 6 morphometric characters ($p < 0.05$: MANOVA, Wilks' lambda). For that reason, morphometric data for males and females were analyzed separately.

Univariate comparisons of color characters among samples were made using Kruskal-Wallis tests. When comparing CB, specimens collected in Jan. to Aug. were excluded because their chest bands become very faint through feather wear over time following the autumn molt (Yamasaki 2002). With respect to NP, specimens collected in Sept.-Mar. (the "winter plumage" group) and those collected in Apr.-Aug. (the "summer plumage" group) were analyzed separately because winter and summer plumages might differ in this aspect (Traylor 1967, Mauersberger and Fischer 1992, Yamasaki 2002).

Tukey's multiple comparison tests were used for univariate comparisons of morphometric characters among samples. Canonical discriminant analysis (CDA) based on the 6 log-transformed morphometric variables was also conducted with the CANDISC procedure of SAS (1990).

RESULTS

Univariate analyses of color characters

Table 1 shows the seasonal change in CB in the 5 examined samples. The chest band became significantly fainter from Sept. to Aug. in all samples ($p < 0.05$: Kendall's rank correlation tests). According to Yamasaki (2002), the seasonal change in CB is attributable to the wear of chest feathers after the autumn molt. A Kruskal-Wallis test based on specimens collected from Sept. to Dec., when chest feathers are not very worn, revealed no significant difference in CB among samples ($p > 0.05$).

The Kruskal-Wallis test revealed a significant difference in AS among the 5 samples ($p < 0.05$). Specimens of *P. s. formosae*, 90% of which (35 of 39 specimens) had indistinct AS (II), clearly differed from the others including *P. s. orii* , which invariably had distinct AS (I). Consequently, specimens of *P. s. orii* did not differ from those of *P. s. sinensis* or *P. s. hainanus* in this aspect.

Table 2 shows the seasonal change in NP in the 4 samples. In all samples, the nape patch was significantly narrower in Sept.-Mar. (the "winter plumage" period) than in Apr.-Aug. (the "summer plumage" period) ($p < 0.05$: Mann-Whitney U-tests). A comparison of the "winter plumage" by a Kruskal-Wallis test revealed a significant difference in NP among the samples ($p < 0.05$): 61% of specimens of *P. s. formosae* (14 of 23) had a wider NP (IV to V) than those of the other samples (I-III). The range of NP in *P. s. orii* (II to III) largely overlapped with those in the 2 local samples of *P. s. sinensis* (I-III in both).

A comparison of the "summer plumage" by a Kruskal-Wallis test also revealed a significant difference in NP among all samples ($p < 0.05$). In this plumage group, specimens of *P. s. formosae* had a markedly wider NP than those of the other subspecies (invariably V vs. I-V). On the other hand, the range of NP in *P. s. orii* (II-V) showed a broad overlap with those of the 2 samples of *P. s. sinensis* (I-V in the northern sample and II-V in the southern sample).

Univariate analyses of morphometric characters

Table 3 shows the measurements of the 5 samples, together with the results of Tukey's multiple comparison tests. Among males, *P. s. formosae* had a significantly shorter TRL and longer HCL than the 2 samples of *P. s. sinensis*. This subspecies also had a significantly shorter WL than did the northern sample. However, this character did not differ significantly between *P. s. formosae* and the southern sample of the nominotypical subspecies. Compared to *P. s. orii* and *P. s. hainanus*, *P. s. formosae* had a significantly longer HCL. The WL of *P. s. orii* was significantly shorter than that of the northern sample of *P. s. sinensis*. No significant differences were found in the morphometric characters between *P. s. orii* and the southern sample of *P. s. sinensis* or between the former and *P. s. hainanus*.

Among females, *P. s. formosae* had a significantly longer HCL than either sample of *P. s. sinensis*. *Pycnonotus s. formosae* also had a significantly shorter WL and TRL, and a lower BH compared to the northern sample. Importantly, none of these characters significantly differed between the former and the southern sample of the nominotypical subspecies. The HCL of *P. s. formosae* was significantly longer than those of *P.*

s. orii and *P. s. hainanus*. Additionally, *P. s. formosae* had a significantly longer BL than did *P. s. hainanus*. On the other hand, *P. s. orii* differed from the northern sample of *P. s. sinensis* in having a significantly shorter TRL. However, the former did not significantly differ from the southern sample in any morphometric characters. Likewise, no significant differences were evident in morphometric characters between *P. s. orii* and *P. s. hainanus*.

Multivariate analyses of morphometric characters

Among males, the CDA of the 6 morphometric characters revealed 97% of the total variation in the first 2 canonical axes (Table 4). Scores of the 1st canonical variable were smaller in *P. s. formosae* than in the other 4 samples. In the latter 4 samples, extensive overlap of the ranges of this variable existed. Scores of the 2nd canonical variable tended to be greater in the northern sample of

Table 1. Seasonal changes in the chest band (CB) intensity in *Pycnonotus sinensis*. Numerals indicate the numbers of specimens showing the given states

							P. s. sinensis								
	P. s. formosae			*P. s. orii*			Northern group			Southern group			*P. s. hainanus*		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Sept.	2			3											
Oct.	1	2						2			1				
Nov.	1	4					4	11		2	3			4	
Dec.	1			2	4		2	4		1	1			2	
Jan.	1	2						4			2				1
Feb.		5	1				1	7	1	1	2			2	1
Mar.		2			2		1	4		1	3				1
Apr.	2	1			4			3		1	6	1			
May		3	7						1		8	3			3
June	1		1		1	8			1						
July									1		2	4			
Aug.						2									

Table 2. Seasonal changes in the nape patch (NP) width in *Pycnonotus sinensis*. Numerals indicate the numbers of specimens showing the given states

											P. s. sinensis									
	P. s. formosae					*P. s. orii*					Northern group					Southern group				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Sept.			1	1			1	2										1		
Oct.			2	1									1							
Nov.		1	1	3							2	2	9				2	3		
Dec.		1	1					6				3	3			1				
Jan.				2	1						1	1	2				1	1		
Feb.			1	4							1	4	4				2	2		
Mar.			1	2			1	1				2	3			1	1	2		
Apr.					4			2	2		1			1	1			5	2	
May					10										1		2	4	3	2
June					2		1	1	5	2					1					
July															1				2	4
Aug.									1	1										

P. s. sinensis and smaller in *P. s. hainanus*. Ranges of this variable in *P. s. formosae*, *P. s. orii*, and the southern sample of *P. s. sinensis* greatly overlapped. Two-dimensional plots of the scores of the first 2 canonical variables (Fig. 3A) showed that the range in *P. s. hainanus* was completely

Table 3. Measurements (mm) of *Pycnonotus sinensis*. The upper columns show the mean ± SD, followed by the sample sizes in parentheses. Ranges are given in the lower columns. Differences among samples were tested using Tukey's multiple comparisons. F, *P. s. formosae*; O, *P. s. orii*; N, the northern group of *P. s. sinensis*; S, the southern group of *P. s. sinensis*; H, *P. s. hainanus*; ns, not significant ($p > 0.05$)

Sex		WL	TLL	BL
Male	*P. s. formosae*	86.47 ± 2.27(19)	79.60 ± 3.09(15)	9.26 ± 0.36(18)
		81.0 - 89.0	73.0 - 84.0	8.60 - 10.05
	P. s. orii	86.96 ± 1.78(12)	78.25 ± 2.95(10)	8.80 ± 0.31(10)
		84.5 - 89.5	74.0 - 81.5	8.40 - 9.35
	P. s. sinensis	90.02 ± 3.36(22)	79.89 ± 4.16(22)	9.22 ± 0.45(21)
	(Northern group)	82.0 - 97.0	71.0 - 87.5	8.55 - 10.00
	P. s. sinensis	86.89 ± 2.17(18)	79.28 ± 3.21(16)	9.14 ± 0.62(16)
	(Southern group)	81.5 - 90.0	72.0 - 83.5	8.25 - 10.45
	P. s. hainanus	86.07 ± 1.90(7)	80.92 ± 2.67(6)	8.83 ± 0.48(7)
		84.0 - 89.0	78.5 - 86.0	8.35 - 9.55
	Differences among samples	N > FOSH	ns	ns
Female	*P. s. formosae*	83.10 ± 2.32(15)	75.90 ± 2.78(15)	9.13 ± 0.26(14)
		80.5 - 87.5	72.0 - 82.5	8.60 - 9.55
	P. s. orii	85.43 ± 2.19(7)	77.57 ± 2.64(7)	8.88 ± 0.53(6)
		83.0 - 89.5	75.0 - 82.0	8.25 - 9.45
	P. s. sinensis	86.50 ± 3.48(15)	78.14 ± 3.63(14)	8.80 ± 0.29(15)
	(Northern group)	81.0 - 93.5	71.0 - 84.5	8.40 - 9.40
	P. s. sinensis	84.77 ± 2.25(11)	77.04 ± 1.92(12)	8.98 ± 0.44(12)
	(Southern group)	81.5 - 88.5	75.0 - 81.0	8.30 - 9.80
	P. s. hainanus	82.50 ± 3.07(7)	77.21 ± 3.43(7)	8.63 ± 0.27(6)
		77.0 - 85.5	70.5 - 80.5	8.35 - 8.95
	Differences among samples	N > FH	ns	F > H

Sex		BH	TRL	HCL
Male	*P. s. formosae*	3.73 ± 0.15(19)	20.77 ± 0.74(18)	7.27 ± 0.39(16)
		3.45 - 4.05	19.25 - 22.45	6.50 - 8.00
	P. s. orii	3.80 ± 0.20(10)	21.10 ± 0.51(11)	6.63 ± 0.20(9)
		3.50 - 4.10	20.25 - 21.90	6.30 - 6.90
	P. s. sinensis	3.78 ± 0.16(20)	21.89 ± 0.69(22)	6.82 ± 0.34(22)
	(Northern group)	3.55 - 4.10	20.55 - 23.00	6.20 - 7.40
	P. s. sinensis	3.77 ± 0.14(16)	21.55 ± 0.80(17)	6.81 ± 0.29(18)
	(Southern group)	3.50 - 3.95	19.70 - 22.75	6.20 - 7.30
	P. s. hainanus	3.70 ± 0.24(6)	20.71 ± 0.67(7)	6.18 ± 0.16(7)
		3.45 - 4.15	19.80 - 21.95	6.00 - 6.40
	Differences among samples	ns	N > FH, S > F	F > ONSH, N > H, S > H
Female	*P. s. formosae*	3.60 ± 0.14(14)	20.37 ± 0.84(15)	7.07 ± 0.19(15)
		3.40 - 3.85	18.90 - 21.50	6.70 - 7.30
	P. s. orii	3.73 ± 0.07(6)	20.97 ± 0.46(7)	6.39 ± 0.22(6)
		3.65 - 3.80	20.55 - 21.85	6.20 - 6.70
	P. s. sinensis	3.70 ± 0.17(16)	21.82 ± 0.55(15)	6.68 ± 0.40(16)
	(Northern group)	3.25 - 4.00	21.05 - 22.80	6.05 - 7.50
	P. s. sinensis	3.71 ± 0.12(11)	21.07 ± 0.38(11)	6.53 ± 0.24(12)
	(Southern group)	3.55 - 3.90	20.35 - 21.50	6.15 - 6.90
	P. s. hainanus	3.70 ± 0.14(6)	20.34 ± 0.54(7)	6.34 ± 0.17(7)
		3.55 - 3.95	19.60 - 21.05	6.05 - 6.50
	Differences among samples	N > F	N > FOSH	F > ONSH

separated from those in the other samples. Likewise, the range in *P. s. formosae* was mostly distinct from those in the other samples. On the other hand, the range in *P. s. orii* broadly overlapped that in the southern sample of *P. s. sinensis*. The 2 *P. s. sinensis* samples were mutually discernible, but exhibited a slight range overlap.

Values of standardized coefficients indicated that the greatest contributions to variance on the 1st canonical axis were made by differences in HCL (negative) and TRL (positive) (Table 4). Meanwhile, the greatest contributions to variance on the 2nd canonical axis were made by differences in TLL (negative) and WL (positive). These results showed that, in males, *P. s. formosae* differed considerably from the other samples in having a longer HCL. Furthermore, the results showed that the northern sample of *P. s. sinensis* differed from the southern sample in having a longer WL relative to the TLL. Moreover, *P. s. hainanus* differed from the others in having a shorter WL relative to the TLL.

Among females, the first 2 canonical variables accounted for 96% of the total variation (Table 4). Scores of the 1st variable were largest in *P. s. formosae*. Ranges of this variable in the other 4 samples showed a broad mutual overlap. Scores of the 2nd canonical variable were large in the northern sample of *P. s. sinensis* and small in *P. s. hainanus*. In the other samples, ranges of this variable broadly overlapped with each other. Two-dimensional plots of the scores of the first 2 canonical variables (Fig. 3B) showed that *P. s. formosae* had little or no range overlap with that of the other samples. On the other hand, *P. s. orii* showed an extensive range overlap with that of the southern sample of *P. s. sinensis*. Furthermore, the 2 *P. s. sinensis* samples had completely separate ranges; *P. s. hainanus* was largely discriminated from the others but showed a slight range overlap.

Table 4 indicates that the greatest contributions to variance on the 1st canonical axis were made by differences in HCL (positive) and TRL (negative). The greatest contributions to variance on the 2nd canonical axis were made by differences in WL (positive) and TRL (positive). These results showed that, in females, *P. s. formosae* differed from the other samples in having a relatively longer HCL. Results also showed that the northern sample of *P. s. sinensis* differed from the southern sample in having a longer WL and TRL; *P. s. hainanus* differed from the others in having a shorter WL and TRL.

DISCUSSION

The results of this examination indicate that the Taiwanese and southern Ryukyus populations are not differentiable from *P. s. sinensis* by either wing length or chest band color. With respect to wing length, Hartert (1910) and Kuroda (1923), who inferred shorter wings in those 2 populations than in the nominotypical subspecies on the continent (see "Introduction"), might not have considered the geographic variation within the latter. The present results show that the northern population of *P. s. sinensis* tends to have longer wings than the southern population. All specimens with wings longer than 90 mm (10 males and 2 females) belonged to the northern population (Table 3). Considering that both Hartert (1910) and Kuroda

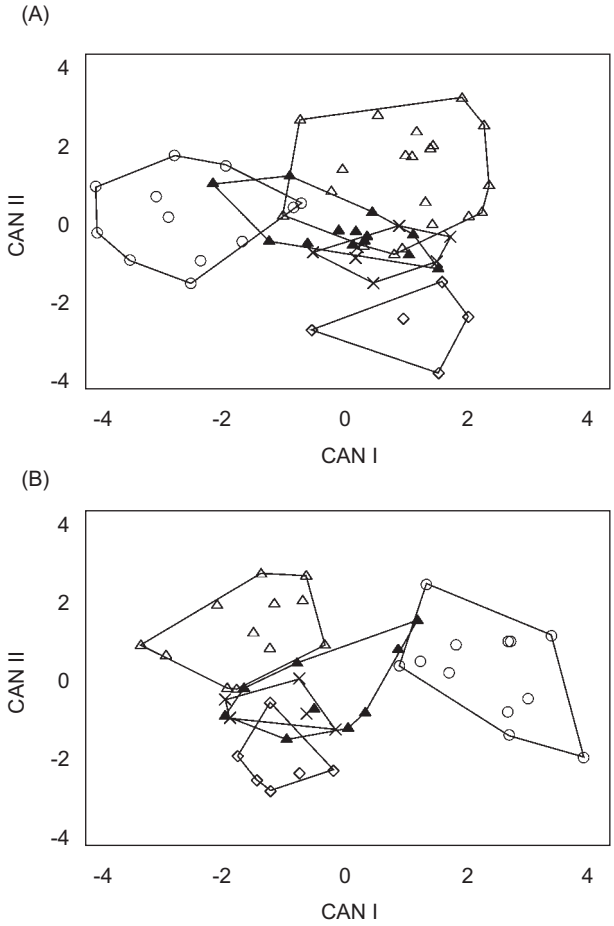

Fig. 3. Two-dimensional plots of the 1st against the 2nd canonical variables of 6 morphometric characters in male (A) and female (B) *Pycnonotus sinensis*. Open circles represent *P. s. formosae*; crosses, *P. s. orii*; open triangles, the northern group of *P. s. sinensis*; closed triangles, the southern group of *P. s. sinensis*; and open diamonds, *P. s. hainanus*.

(1923) mentioned that wing lengths of *P. s. sinensis* often exceed 90 mm, the *P. s. sinensis* representatives they examined might have come from the northern part of the range. With respect to chest band color, both Hartert (1910) and Kuroda (1923) apparently ignored the seasonal variation within single local populations: all populations of *P. sinensis* examined here showed the darkest chest band immediately after the autumn molt. Holotypes of both *P. s. formosae* and *P. s. orii* were collected in autumn (Oct. for *P. s. formosae*: Hartert 1910; Sept. for *P. s. orii*: Kuroda 1923), which might have engendered an overemphasis of the distinctively dark chest bands in these subspecies as compared to chest bands of other subspecies.

As stated above, neither the wing length nor the chest band color of the Taiwanese population was distinct from that of *P. s. sinensis*. However, this study revealed that the former clearly differs from the latter and other populations in several other characters: more-indistinct yellow abdominal streaks, a wider white nape patch, and longer hind claws, the latter two of which were not mentioned by Hartert (1910). In contrast, the present study found no morphological differences between the southern Ryukyus population and *P. s. sinensis*. The author therefore concludes that *P. s. formosae* Hartert, 1910 from Taiwan is valid, whereas *P. s. orii* Kuroda, 1923 from the southern Ryukyus is synonymous with *P. s. sinensis*.

The geographic pattern of morphological variation detected herein is interesting from a biogeographical viewpoint. According to the biogeographical history inferred from studies of herpetofaunas (Ota 1998 2000), the southern Ryukyus were already separated from continental Asia in the Middle Pleistocene, whereas a land bridge connected Taiwan to the Asian continent until the Late Pleistocene glacial maxima (ca. 20,000-15,000 yrs ago). Nevertheless, the present results indicate that the southern Ryukyus population closely resembles the continental Chinese population in plumage and mensural characters, whereas the Taiwanese population is highly distinct from the latter in those characters. A possible reason for this discrepancy is that morphological evolution in the Taiwanese population has been extremely rapid and recent. Other studies of passerine birds (e.g., Greenberg et al. 1998, Joseph et al. 2004) noted similarly rapid morphological evolution. Analyses of biochemical or molecular data will be particularly effective in providing an adequate explanation for the geographic deployment of morphological variation within *P. sinensis*.

Table 4. Standardized coefficients for the first 2 canonical axes of variation in morphometric characters

	Male		Female	
Characters	CA I	CA II	CA I	CA II
WL	0.83	1.22	0.61	1.01
TLL	-0.38	-1.38	-0.60	-0.76
BL	-0.88	0.44	0.69	-0.06
BH	0.50	-0.54	-0.73	-0.32
TRL	0.90	0.50	-0.92	0.95
HCL	-1.04	0.82	1.14	0.72
Eigenvalue	2.01	1.57	3.28	1.26
Difference	0.44	1.48	2.02	1.11
Proportion	0.54	0.42	0.69	0.26
Cum. Propotion	0.54	0.97	0.69	0.96

Taxonomic conclusions

Pycnonotus sinensis sinensis
(Gmelin, 1789)

Muscicapa sinensis Gmelin, 1789, Syst. Nat. 1(2): 942 (type locality: China [restricted to Guangdong Prov. by Deignan 1960]).

Pycnonotus sinensis orii Kuroda, 1923, Bull. Br. Ornithol. Cl. 43: 105. syn. nov. (type locality: Yonagunijima, the southern Ryukyus, Japan).

Pycnonotus sinensis septentrionalis Stresemann, 1923, J. Ornithol. 71: 363 (type locality: Wusong, Shanghai, China).

Pycnonotus sinensis stresemanni La Touche, 1925, Handb. Birds Eastern China 1(1): 94 (type locality: northwestern Fujian Prov., China).

Pycnonotus sinensis meridionalis Delacour, 1927, Bull. Br. Ornithol. Cl. 47: 157 (type locality: Lang Son, northern Vietnam).

Pycnonotus sinensis kobayashii Kuroda, 1930, Tori 6: 270. syn. nov. (type locality: Ishigakijima, the southern Ryukyus, Japan).

Pycnonotus sinensis brevirostris Hachisuka, 1939, Ornithol. Soc. Jpn. Suppl. Publ. 15: 76 (type locality: Hainan I., China).

Type specimens: Unknown whereabouts (see Dickinson et al. 2002).

Diagnosis: This subspecies is characterized by the following combination of characteristics: white feathers on the nape; white nape patch concealed by black feathers to varying degrees in winter plumage; white nape patch often concealed by black feathers to varying degrees in summer plumage; distinct yellow streaks on abdomen; relatively short hind claws (HCL/TRL: 0.284-0.344 in

males, 0.265-0.336 in females).

Distribution: Breeds in continental China ranging from eastern Sichuan, northeastern Yunnan and Guizhou Provs. eastward to the maritime provinces of China, Jiangsu, Zhejiang, Fujian, and Guangdong Provs., and in the Yaeyama Group, the southern Ryukyus, Japan. Partially migrates in winter southward to Hainan I. and northeastern Vietnam.

Remarks: Specimens of this subspecies from Jiangsu, Shanghai, Zhejiang, Chongqing, and Sichuan Provs. tend to have longer wings and tarsi than those from more-southerly areas, but variations in these measurements are more or less clinal (Fig. 4). Therefore, recognition of a taxonomic border between northern and southern populations based on these characters would be meaningless.

Pycnonotus hoyi Riley, 1923 was described originally as a full species on the basis of an immature bird from Yueyang, Hunan Prov., China. The type specimen was often considered to belong to *P. s. sinensis* (e.g., Deignan 1960). However, Cheng (1976) placed *P. hoyi* in synonymy with Anderson's bulbul *P. xanthorrhous andersoni*.

Pycnonotus s. kobayashii has been regarded as a junior synonym of *P. s. orii* (e.g., OSJ 1942 1974 2000, Deignan 1960, see also Yamasaki 2002). Thus, synonymization of the latter with *P. s. sinensis* in the present study has engendered the addition of *P. s. kobayashii* to the synonym list of *P. s. sinensis*.

Deignan (1960) synonymized *P. s. brevirostris* Hachisuka, 1939 with *P. s. sinensis*, but Cheng (1976) and Zheng (1985) placed it in synonymy with *P. s. hainanus*. The holotype of *P. s. brevirostris* (Yamashina Institute for Ornithology 27189), while clearly differing from *P. s. hainanus* in having white feathers on the nape on the one hand, had no differences from *P. s. sinensis* on the other hand. Thus, *P. s. brevirostris* should not be regarded as a junior synonym of *P. s. hainanus*.

Pycnonotus sinensis hainanus
(Swinhoe, 1870)

Ixus hainanus Swinhoe, 1870, Ibis 12: 253 (type locality: Hainan I. and its adjacent island, Naochow).

Pycnonotus hainanus indochinensis Delacour, 1927, Bull. Br. Ornithol. Cl. 47: 156 (type locality: Lang Son, northern

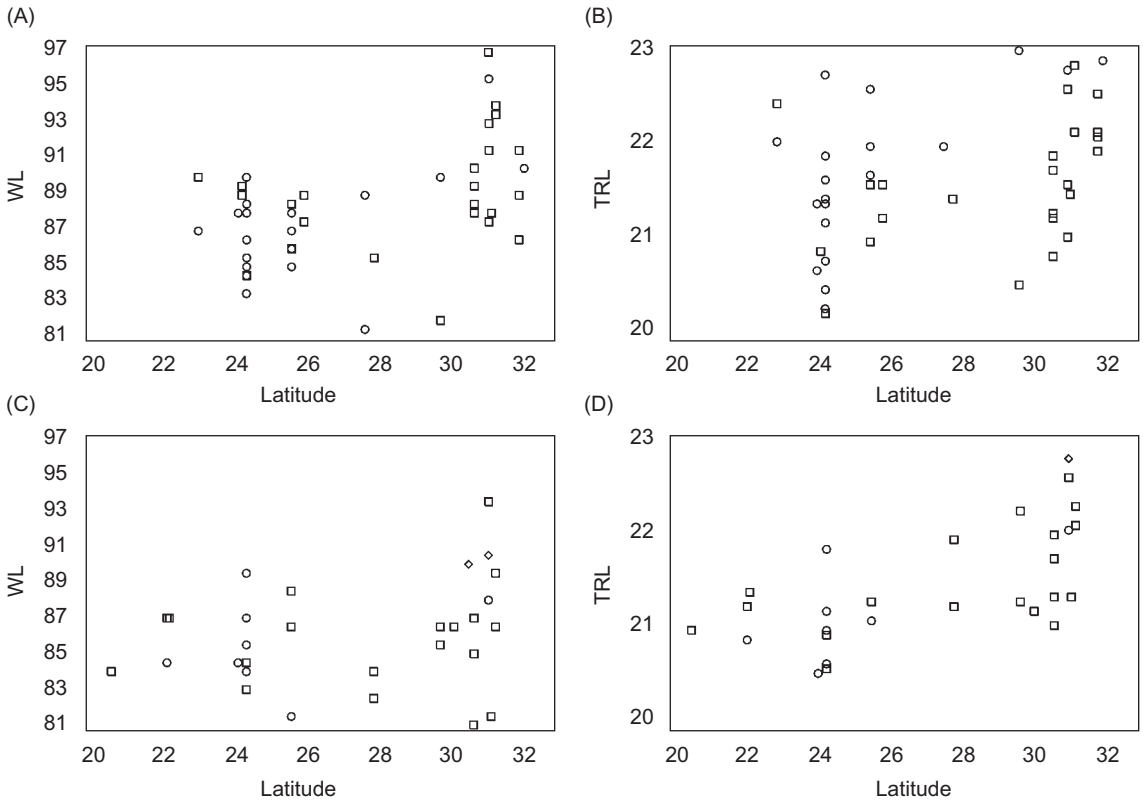

Fig. 4. Scatterplots of wing-length (WL) or tarsus-length (TRL) on latitude in male (A and B) and female (C and D) *Pycnonotus sinensis sinensis* (including *P. s. orii*). Circles, squares, and diamonds respectively represent specimens collected during Apr.-Aug., Sept.-Mar., and at an unknown time.

Vietnam).

Holotype : The Natural History Museum, Tring 1898.10.2.161, an adult collected at Naochow I., 40 mi (64 km) from Hainan I. in Feb. 1868 by R. Swinhoe.

Diagnosis : This subspecies is characterized by the following combination of characteristics: no white feathers on nape; distinct yellow streaks on abdomen; relatively short hind claws (HCL/TRL: 0.286-0.312 in males, 0.295-0.325 in females).

Distribution: Hainan I., southwestern Guangdong and southern Guangxi Provs., China; northern Vietnam.

Remarks: The parapatric distribution with *P. s. sinensis* deserves particular attention. It might suggest the presence of reproductive isolation between them. These taxa should be regarded as full species if this is actually the case.

Pycnonotus sinensis formosae
(Hartert, 1910)

Pycnonotus sinensis formosae Hartert, 1910, Novit. Zool. 17: 230 (type locality: Taipei, Taiwan).

Holotype: American Museum of Natural History 568353, an adult male collected at Taipei, Taiwan in October 1896 by collectors for A. Owston.

Diagnosis: This subspecies is characterized by the following combination of characteristics: white feathers on nape; white nape patch often not concealed by black feathers in winter plumage; white nape patch not concealed by black feathers in summer plumage; indistinct yellow streaks on abdomen; relatively long hind claws (HCL/TRL: 0.314-0.409 in males, 0.325-0.386 in females).

Distribution: The western plain of Taiwan.

Remarks: By taking a conservative stance, I tentatively retained this taxon at subspecific rank. Further studies examining aspects other than morphological differentiation of the Taiwanese population (e.g., retrospective monophyly and ecological segregation: see de Queiroz 1998 for a review of species criteria) are desired to verify this account.

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APPENDIX : Specimens examined.

Pycnonotus sinensis formosae

Taiwan: National Science Museum, Tokyo (NSMT) 6257, Natural History Museum, Tring (NHM) 98.10.2.149, Osaka Museum of Natural History (OMNH) 806-809, Yamashina Institute for Ornithology (YIO) 121, 584, 585, 1921, 1922, 2671, 7002, 7003, 13287, 14961, 14962, 15024, 16030, 16031, 16098-16100, 22559, 27436-27441, 27962, 27963, 29560-29564, 7(3), 7(5), 87-0430, NG305.

Pycnonotus sinensis orii

Yonagunijima: Kanagawa Prefectural Museum of Natural History (KMNH) 11-16, Kyoto University Museum (KUM) 18, 25, YIO 24181, 24193, 24194, 24203, 24214, 24217, 24219, 24224, 24225; Kuroshima: NSMT A15067-A15069; Ishigakijima: YIO 12740; Iriomotejima: NSMT 9046, 9058, YIO 88-0343; Haterumajima: 2 uncataloged Okinawa Prefectural Museum (OPM) specimens.

Pycnonotus sinensis sinensis

Jiangsu: NHM 1905.12.24.533,1914.5.6.633, 1914.5.6.634, 1914.5.6.652, 1914.5.6.655, YIO 27323, 33552-33555; Shanghai: American Museum of Natural History (AMNH) 568334-568340, NHM 1914.5.6.635, 1914.5.6.637-1914.5.6.639, 1914.5.6.642, 1914.5.6.643, 1914.5.6.656, 81.5.1.250, 98.10.2.136, 98.10.2.137, YIO 28217, 28218; Zhejiang: NHM 1914.5.6.630-1914.5.6.632, 1914.5.6.641, 1914.5.6.651, 88.4.1.633, 98.10.2.150-98.10.2.152, YIO 27324, 27326; Chongqing: AMNH 204743-204751; Sichuan: AMNH 423763; Fujian: AMNH 143058, 143059, 143061-143066, 261460, 261461, 418095, 568352, NHM 1903.7.3.134, 1914.5.6.644, 79.4.5.1628, 79.4.5.1643, 86.9.1.2170(1), 86.9.1.2170(3), 86.9.1.2172, 86.9.1.2173, 88.4.1.634, 88.4.1.635, 98.10.2.131, 98.10.2.141, 98.10.2.143, 98.10.2.144, NSMT 452, 454; Guangdong: NHM 1910.5.2.356, 1935.10.23.449-1935.10.23.452, 98.10.2.134, 98.10.2.135, 98.10.2.148; Xianggang: NHM 1914.5.6.627, 1981.1.64, 60.4.16.219, 86.7.3.10, 98.10.2.138; Vietnam: NHM 1927.6.5.856; Hainan: NHM 1909.8.30.57, YIO 27189, 02.0008.

Pycnonotus sinensis hainanus

Guangdong: NHM 1935.10.23.445, 1935.10.23.447, 1935.10.23.448; Hainan: NSMT 450, 451, NHM 1909.8.30.58, 1914.5.6.658, YIO 27186-27188, 05.0027; Vietnam: NHM 1925.1.14.112, 1926.9.8.760, 1927.6.5.854