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Morphological Differences Between Nearctic and Eastern Palearctic Gray-headed Chickadees (*Poecile cinctus*)

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ABSTRACT.—The geographic distribution of the non-migratory Gray-headed Chickadee (*Poecile cinctus*) straddles the continents of North America and Eurasia. Morphological variation in this species has been poorly studied, particularly regarding differences between Nearctic and adjacent Palearctic populations (subspecies *lathami* and *cinctus*, respectively). To evaluate geographic patterns of morphological variation between *lathami* and *cinctus*, we measured 24 variables related to coloration and structure on 24 museum specimens. We found statistically significant average differences between specimens of *lathami* and *cinctus* in three plumage areas and three measures of bill size. Genetic analysis is needed to further quantify divergence in *lathami*. *Received 17 December 2015. Accepted 11 March 2016.*

Key words: Beringia, Gray-headed Chickadee, morphological variation, plumage variation, *Poecile cinctus cinctus*, *Poecile cinctus lathami*, Siberian Tit.

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The Gray-headed Chickadee (*Poecile cinctus*) has the most extensive and northern distribution of all parid species. Their nearly circumboreal range extends from Scandinavia, across northern Eurasia to the Russian Far East, with a disjunct population in northern Alaska and adjacent Canada. As the only parid in both the Palearctic and Nearctic (Harrap and Quinn 1996), Gill et al. (2005) concluded that Gray-headed Chickadees spread across the Palearctic after speciation within the Nearctic. The small Nearctic population represents either the most basal population, from which the Palearctic populations dispersed, or a subsequent recolonization of the Nearctic from the Palearctic (Gill et al. 2005). Four subspecies of Gray-headed Chickadee are recognized (Hailman and Haftorn 1995, Clements 2007). We deal only with *P. c. cinctus* (Siberia to the Russian Far East; the most easterly Palearctic subspecies) and *P. c. lathami* (Alaska and northwestern Canada; the only Nearctic subspecies), hereafter referred to by their subspecies names alone.

The Nearctic Gray-headed Chickadee was first referred to as *Parus cinctus alascensis* (Pražák 1895) until the AOU (1952) submerged this name in *Parus cinctus lathami* (Stephens *in* Shaw, Gen. Zool., Vol. X, Pt. I: 44, 1817). No type exists for *alascensis* according to Hellmayr (1934:77) "The author [Pražák], who was insane, probably never examined a specimen himself. . .". Likewise, we have been unable to locate a type for *lathami*. Scant information has since been collected on the morphology of *lathami* and very little is known about its natural history.

In the Palearctic, morphological variation among Gray-headed Chickadee subspecies is slight and primarily clinal (Cramp et al. 1993, Harrap and Quinn 1996). Uimaniemi et al. (2003) found no significant genetic variation between two Palearctic subspecies of the Gray-headed Chickadee separated by more than 5,000 km. Snow (1954) found that within Palearctic populations of eight chickadee species, including the Gray-headed, wing and tail length were negatively correlated with minimum temperature and tail length increased from west to east. He also found that trends in plumage coloration included a tendency for chickadee species in colder climates to be lighter and greyer versus darker and more rufous in warmer climates.

Little information regarding geographic variation between *lathami* and *cinctus* has been published. Bent (1946) stated that *lathami* differed from *cinctus* in having a smaller bill and darker plumage. However, Harrap and Quinn (1996:288) suggested that *lathami* differs little from *cinctus* in plumage and that these differences fell within the variation observed in the latter taxon, and that bill measurements of *lathami* are "only marginally smaller". Phillips (1986:80) stated that *lathami* is "Smaller; bill small (Bl [bill length] 9–9.5 [mm], *fide* Ridgway). Pale like Siberian birds." All the above statements are based on unknown numbers and provenance of specimens.

To address the lack of published information on differences between *lathami* and *cinctus*, we measured color and structural characteristics on specimens of Gray-headed Chickadees deposited at major United States museums to quantify morphological differences between these two taxa.

METHODS

We examined 24 adult Gray-headed Chickadee specimens housed at the U.S. National Museum (USNM; $n = 14$), the Museum of Comparative Zoology (MCZ; $n = 8$), and the American Museum of Natural History (AMNH; $n = 2$); 8 were *cinctus* and 16 were *lathami* (Table 1). Subspecies were identified based on geographic provenance. With few exceptions, we obtained both structural and color measurements from all specimens. We used reflectance spectrophotometry to quantify plumage coloration (Hill 1998).

We took color measurements using a HR200 high-resolution spectrophotometer (Ocean Optics Inc., Dunedin, FL, USA) with an Analytical Instrument Systems Inc. (Ringoes, NJ, USA) model Mini – DT light source (powered by an Elpac Power Supplies unit, model W7212; Irvine, CA, USA). We analyzed data from the spectrophotometer in SpectraSuite (Ocean Optics Inc., Dunedin, FL, USA). For each plumage color measured, data were expressed in the *L. a. b*. color space (Graves 1997, Maley and Winker 2007) according to the following three values: *L* (dark to light), *a* (green to red), and *b* (blue to yellow).

We followed standard protocols for spectrophotometric measurement (Graves 1997, Hill 1998) while using a custom-made tip which kept the end

TABLE 1. The 24 Gray-headed Chickadee (*Poecile cinctus*) specimens used in this paper with assigned subspecies and geographic provenance.

Specimens	Subspecies	Location
AMNH 119527	*lathami*	Alaska, Hula-hula River; N 69.1°, W. 144.5°
AMNH 373211	*lathami*	Alaska, Golafnin Bay; N 64.6°, W. 163.1°
MCZ 256270	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
MCZ 256271	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
MCZ 256272	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
MCZ 64044	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
MCZ 64045	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
MCZ 64047	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
MCZ 64048	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
MCZ 64049	*cinctus*	Russia, Siberia, Nizhnekolymsk; N 68.3°, E. 161.2°
USNM 187731	*lathami*	Alaska, mountains near Eagle; N 64.7°, W. 141.2°
USNM 187732	*lathami*	Alaska, mountains near Eagle; N 64.7°, W. 141.2°
USNM 286599	*lathami*	Alaska, Twelvemile Creek; N 65.4°, W. 145.5°
USNM 286605	*lathami*	Alaska, McManus Creek; N 65.4°, W. 145.6°
USNM 287659	*lathami*	Alaska, Alatna River; N 67.6°, W. 154.3°
USNM 287660	*lathami*	Alaska, Alatna River; N 67.6°, W. 154.3°
USNM 298355	*lathami*	Alaska, Beaver Mountains; N 62.6°, W. 157.1°
USNM 299322	*lathami*	Canada, Old Crow River; N 68.2°, W. 139.6°
USNM 299323	*lathami*	Canada, Old Crow River; N 68.2°, W. 139.6°
USNM 299324	*lathami*	Canada, Old Crow River; N 68.2°, W. 140.5°
USNM 299325	*lathami*	Canada, Old Crow River; N 68.2°, W. 140.5
USNM 299326	*lathami*	Canada, Old Crow River; N 68.2°, W. 140.5
USNM 70828	*lathami*	Alaska, Nulato; N 64.7°, W. 158.0°
USNM 75431	*lathami*	Alaska, Nulato; N 64.7°, W. 158.0°

of the probe 9 mm from the plumage area being measured. We calibrated the spectrophotometer before each bird was scanned and collected data in the same order on each specimen (crown, mantle, flank, secondary, and tertial edges, and greater primary covert edges). We programmed SpectraSuite to average 20 scans and we measured all plumage areas three times in succession, with removal of the probe between each measurement.

We used metal calipers accurate to 0.01 mm to measure structural variables. We took all measurements (bill length [nares-tip], bill depth [at distal end of nares], bill width [at distal end of nares], wing length [relaxed], tail length, primary [p] 9 minus p10, p8–p9, p7–p8, and diagonal tarsus) from the USNM and AMNH specimens whereas we took all but tail and tarsal measurements from the MCZ specimens in compliance with the collection manager's wishes.

We analyzed differences in color and structural characters between *lathami* and *cinctus* using MiniTab15 statistical software (MiniTab Inc., State College, PA, USA). We used regression to test for effects of specimen age (years since collected) and day of the year on which specimen was obtained. For these tests we used adult specimens of *lathami* ($n = 9$ for color and $n = 12$ for structure) taken over a wide temporal distribution (specimens collected from 1876 to 1924, and in February, March, April, and August). We removed variables from subsequent analyses that had significant relationships with specimen age and date of collection. We also removed variables (three measures of wings) which we later learned can be affected by methods of specimen preparation.

We used ANOVAs to test for differences in color and structural variables of *lathami* and *cinctus*. We restricted our sample to specimens within 35° of longitude to the east and west of the Bering Strait to have equal geographic spread in both subspecies.

RESULTS

We found no significant relationships between coloration and age of specimens; however, five color variables had significant correlations with day of the year on which specimens were collected

TABLE 2. Comparison of color and structural variables of the Gray-headed Chickadee (*Poecile cinctus*) subspecies *cinctus* and *lathami*. Statistically significant differences in bold.

	P. c. cinctus			*P. c. lathami*				
Variable	*n*	Mean	SD	*n*	Mean	SD	*F*	*P*
Mantle *L*	**7**	**44.1**	**2.2**	**15**	**40.5**	**2.5**	**9.6**	**0.006**
Mantle a	7	4.3	0.6	15	3.9	1.0	0.6	0.44
Mantle b	7	9.1	0.8	15	7.9	2.8	1.2	0.29
Remiges *a*	**7**	**1.3**	**0.2**	**15**	**1.8**	**0.6**	**5.0**	**0.04**
Crown *L*	7	39.2	1.7	15	37.2	3.0	2.4	0.13
Crown *b*	7	7.1	0.9	15	7.2	0.8	0.2	0.70
Flank *L*	**7**	**65.1**	**1.7**	**15**	**60.9**	**4.4**	**5.5**	**0.03**
Flank *a*	7	4.1	1.3	15	5.6	1.7	4.0	0.06
Flank *b*	7	11.5	2.6	15	12.6	3.9	0.7	0.42
Greater covert *L*	7	47.4	5.8	15	44.2	2.4	3.0	0.10
Bill length (mm)	**10**	**6.9**	**0.5**	**15**	**7.8**	**0.3**	**50.6**	**<0.001**
Bill width (mm)	**10**	**3.0**	**0.4**	**12**	**3.7**	**0.3**	**43.5**	**<0.001**
Bill depth (mm)	**10**	**3.5**	**0.5**	**13**	**3.9**	**0.3**	**16.7**	**<0.001**
Wing length (mm)	10	66.9	1.8	16	67.4	2.0	<0.1	0.90

(crown *a*, edging of remiges *L* and *b*, and greater covert edging *a* and *b*). These variables were removed from subsequent analyses. No significant correlations were found between structural variables and specimen age or day of the year of collection.

For the remaining 14 variables, *lathami* differed significantly from *cinctus* in 3 of 10 color variables and 3 of 4 structural variables (Table 2; note that only 0.05×14 tests $= \sim 1$ significant comparison would be expected by chance). We found, when comparing *lathami* to *cinctus*, the following significant color differences: mantle coloration was darker (lower *L* value), flank coloration was darker (lower *L* value), and edging of remiges was redder (higher *a* value). All three bill measurements (length, width, and depth) were significantly larger in *lathami* than in *cinctus*. All other traits did not differ significantly (Table 2).

DISCUSSION

The first published account of morphological differences between *lathami* and *cinctus* Gray-headed Chickadees was that of Bent (1946) who stated that *lathami* have darker plumage and a smaller bill length; this was reiterated by Harrap and Quinn (1996). Neither the number nor location of specimens for these observations was provided. Our findings support the "darker plumage" claim but contradict the "smaller bill length" claim. Our results suggest divergence in bill dimensions and coloration between *lathami* and *cinctus*. These findings support the status of *lathami* as being different from *cinctus*; however, our data analyses and project design were insufficient to determine if *lathami* forms a robust subspecies differing from *cinctus* based on definitions and discussion within Remsen (2010). Future genetic research may illuminate the historical geographic patterns of isolation in this species and help determine if *cinctus* and *lathami* shared ancestors within the Beringian refugium (Hopkins 1959), or if these two subspecies existed in disparate refugia during the last glacial maximum.

Properly defined taxonomic delineations are one of the basic necessities for focusing conservation efforts most effectively. In light of the scarcity of *lathami*, it is imperative that taxonomic standing of this subspecies be investigated further. Given their propensity for using transitional habitat at the northern fringe of the boreal forest (Murie 1928), *lathami* is likely particularly susceptible to effects of climate change (e.g., rapidly changing tree line; Grace et al. 2002) and expanding distribution of competing congeneric parids (T. Booms, pers. comm.). Due to perceived declines in the *lathami* (H. Korth, pers. comm.) and the apparent rarity of this taxon (<5 individuals seen annually over the past decade [T. Booms, pers. comm.]), it is important to understand aspects of its natural

history, population dynamics, and taxonomic status. Our findings support the distinctness of *lathami* and we hope this information can be used to bolster conservation action for this rare and sparsely distributed taxon.

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