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Letters

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Integrative taxonomy reveals Europe's rarest songbird species, the Gran Canaria blue chaffinch *Fringilla polatzeki*

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The conservation of endangered taxa often critically depends on accurate taxonomic designations. The status of the Gran Canaria population of the blue chaffinch *Fringilla teydea polatzeki* has not been reevaluated since the early 1900s when this taxon was described as a subspecies and combined with the much more common Tenerife blue chaffinch *F. t. teydea* in a single species. We show that multiple diagnostic differences in plumage, songs, calls and morphometrics distinguish *F. t. polatzeki* from *F. t. teydea*. Preliminary playback experiments suggest that *F. t. polatzeki* is able to discriminate between songs of both taxa. Along with previously reported differences in mitochondrial DNA, these findings show that the blue chaffinches on Gran Canaria and Tenerife represent two distinctive species: *F. polatzeki* and *F. teydea*. Gran Canaria blue chaffinch is Europe's rarest passerine species and should be classified as critically endangered. Its long-term survival in the wild currently depends on a very small (< 20 km^2) area in southwest Gran Canaria. Reclassification of Gran Canaria blue chaffinch as a species increases the urgency of ongoing conservation efforts. Our study underscores the critical importance of taxonomic clarification of threatened taxa that are currently classified as 'subspecies'.

Accurate taxonomic designations are of critical importance for the conservation of endangered taxa (May 1990). This is especially true for single-island endemics. In birds, many single-island endemics were combined into polytypic species in the early 20th century (Haffer 1992). As a consequence, the distinctiveness and conservation plight of many island taxa have been overlooked or underappreciated. In addition, taxa which are found on a single island tend to have a poorer conservation status than other taxa due to smaller population size and greater vulnerability to introduced predators, natural disasters and other stochastic factors (Pimm 1991). Re-assessments of the taxonomic status of single-island endemic subspecies are therefore of great importance for prioritising conservation efforts and may ultimately help avoiding extinctions.

The blue chaffinch *Fringilla teydea* is endemic to the Canary Islands where it is restricted to Gran Canaria and Tenerife. On both islands it is found in native Canary island pine *Pinus canariensis* forest (Martín and Lorenzo 2001). The Gran Canaria population was described by Hartert (1905) as a new subspecies, *F. t. polatzeki*, which he distinguished from the Tenerife population (*F. t. teydea*) on the basis of differences in plumage and size. All subsequent authors have treated *F. t. polatzeki* and *F. t. teydea* as subspecies of a single species (Bannerman 1912, Wolters 1975–1982, Sibley and Monroe 1990, Cramp and Perrins 1994, Dickinson and Christidis 2014). However, the taxonomic status of the two populations has not been re-evaluated since the original description of *F. t. polatzeki* (Hartert 1905). There have been detailed morphometric studies which found clear differences in size between *F. t. teydea* and *F. t. polatzeki* (Eck 1975, Grant 1979). A study based on mitochondrial control region sequences found that both taxa are reciprocally monophyletic (Pestano et al. 2000), and others using cytochrome *b* sequences found *F. t. teydea* and *F. t. polatzeki* to be distinct as well (Suárez et al. 2009, Rando et al. 2010). A study based on microsatellite data found significant differences between the two taxa in allele frequency distributions (Garcia-del-Rey et al. 2013). Based on these data, it has been suggested that both subspecies should be designated as evolutionarily significant units (Garcia-del-Rey et al. 2013). The limitations of using a single class of evidence (e.g. genetics) for taxonomic designations are well-known and ideally, species limits should be evaluated with several lines of evidence (Padial et al. 2010, Yeates et al. 2011).

Clarification of the taxonomic status of blue chaffinches is urgent because *F. t. polatzeki* is extremely rare and at risk due to small population size and stochastic events (Rodríguez

and Moreno 2004). The gravity of the conservation status of *F. t. polatzeki* is further underscored by the effects of a major forest fire in central Gran Canaria in 2007 which reduced the population size to only 122 birds in 2008, less than half the population size in 1991–2004 (Rodríguez and Moreno 2004, Carrascal and Seoane 2008). In this paper, we use an integrative approach to provide the first taxonomic re-assessment of *F. t. polatzeki* since its original description in 1905. Specifically, we use data on plumages, morphometrics, songs, calls and response to playback of songs to address species limits within *F. teydea*.

Methods

Plumage and morphometric data

We examined plumage characters of 52 adult-plumaged museum specimens of both taxa in the Naturalis Biodiversity Center (Leiden, Netherlands), The Natural History Museum (Tring, UK) and the Zoologisches Forschungsmuseum Alexander Koenig (Bonn, Germany). We compared five plumage characters which are listed in Table 1. We recorded wing length (chord of flattened wing from bend of wing to longest primary), tail length (longest rectrix measured from point of insertion of central rectrices to tip of longest rectrix), bill length (culmen from tip to base of skull), bill depth (both mandibles at limit of facial feathering) and bill width (at limit of facial feathering). We examined mensural characters with ruler for wing and tail (measured to nearest 0.5 mm) and with calipers for other measurements (to the nearest 0.1 mm). All mensural data were collected by CSR.

Bioacoustic data

Sound recordings were made in March–April 2001 (MSR, Gran Canaria and Tenerife), May 2004 (GS, JAL, Gran Canaria and Tenerife), June 2009, May 2010, June 2011, May–July 2012 (FR-G, Gran Canaria) and April 2014 (GS, JAL, Gran Canaria). To augment sample size, we included recordings archived in the British Library Sound Archive (London), the Xeno-Canto database (<www.xeno-canto.org/>), commercially available recordings (Moreno 2000, Bergmann et al. 2008) and unpublished recordings by T. Luijendijk. All unpublished sound recordings have been archived in the Macaulay Laboratory, Cornell Univ., Ithaca, NY, USA.

We examined song recordings of 64 blue chaffinches. All song recordings are assumed to have been from different individuals. This is based on colour ring data (which if present are unique for each individual), exact locality data (in combination with high territorial fidelity of birds during the breeding period, Rodríguez and Moreno 2008), and direct observations of the recordists. The songs of *F. t. teydea* and *F. t. polatzeki* consist of two phrases: a trill of short notes, followed by a phrase consisting of one to four much longer, broadband notes. Definition of first and second phrases is shown in Supplementary material Appendix 1, Fig. A1. Audiospectrograms and measurements were made using RAVEN PRO ver. 1.3 (Charif et al. 2007). To increase resolution, temporal characters were measured using a FFT size of 512, whereas frequencies were determined at a FFT size of 1024. The following measurements were recorded: 1) song duration, 2) duration of first phrase, 3) duration of second phrase, 4) lowest frequency of first note, 5) lowest frequency of the last three notes of first phrase, 6) maximum frequency, 7) minimum frequency, 8) frequency change from start to end of first phrase, 9) frequency range, 10) mean frequency, 11) number of notes in second phrase, 12) number of strongly ascending and descending, or strongly descending, notes in second phrase, 13) difference between the maximum amplitudes of first and second phrases (with amplitude adjusted so that maximum relative amplitude was –1 dB), 14) time to highest amplitude, measured from start of second phrase. We also examined 63 recordings of the calls of *F. t. teydea* and *F. t. polatzeki*. Song and call recordings are listed in Supplementary material Appendix 1, Table A1 and Table A2, respectively. In view of the extreme rarity of *F. t. polatzeki*, and to avoid harrassment, localities on Gran Canaria are withheld.

Song playback tests

Seven male *F. t. polatzeki* were subjected to playback experiments to assess whether these could discriminate between songs from their own taxon and those of *F. t. teydea*. We tested the null hypothesis that *F. t. polatzeki* responds equally often and equally strong to both taxa. For each trial, we played one minute of songs of *F. t. teydea*, followed by two minutes of silence (to identify any delayed response to song playback), and one minute of songs of *F. t. polatzeki* (as a control). This protocol is commonly used in studies of song recognition (Lynch and Baker 1990, Tietze et al. 2012). Recordings were of similar quality, which was judged both visually on sonagrams and by ear, obtained from Moreno (2000). Amplitude of sound files was normalized to the same level. Songs were played from a portable Leiker mp3 player with separate loudspeakers. Songs were played close to a known individual and inside a territory. Trials were performed between 9:00 am and 13:30 pm. Individuals were subjected to one trial only. We estimated the minimum distance to the speaker and classified responses as follows (scores used for statistical analysis between brackets): very strong (5), responded immediately by flying directly towards speaker, moving continuously around speaker, calling excitedly; strong (4), responded immediately by flying directly towards speaker, and singing in a nearby pine or branch; medium (3), responded not immediately by flying towards speaker, and continued singing in a nearby pine; light (2), responded after several seconds by flying towards speaker, and sang occasionally; very light (1), responded after several seconds by flying towards speaker, and continued foraging in a nearby pine; none (0), no change in behaviour, no approach to the speaker.

Data analyses

Plumage characters were considered diagnosable when they distinguished all individuals with certainty. For sound recordings, means were computed for each recording to give equal weight to individuals. Univariate comparisons were made using Mann–Whitney U-tests. Principal component analysis was used to reduce the dimensionality of the morphomet-

ric and bioacoustic datasets, and to determine whether *F. t. polatzeki* and *F. t. teydea* form separate clusters in multivariate character space. ANOVA and Mann–Whitney U-tests were used to test whether principal components differed significantly between *F. t. polatzeki* and *F. t. teydea*. We used the Wilcoxon signed ranks test to assess the effect size of the song playback results. We report effect size as a correlation efficient (r), which was calculated as $r = z/\sqrt{N}$, where N is the total sample size (Rosenthal 1994). For interpretation of effect size data, we followed Rosenthal (1996) who regards an effect size of $r > 0.7$ as 'very large'. All statistics were performed in PASW 18.0 (SPSS, IL, USA).

Results

Plumage

Differences in male plumage characters are listed in Table 1. Male plumages of *polatzeki* differed from *teydea* by five diagnostic character states. These included 1) the presence of a velvet-black band on the forehead, 2) the extent of grey colouration on the underparts, 3) the colouration of the belly and flanks, 4) the colour and demarcation of the tips of the greater upperwing-coverts, and 5) the breadth, colouration and demarcation of the pale fringes of the upperwing-coverts and tertials. Some of these character differences are easily discernable in the field, including the smaller extent of grey colouration on the chest, the paler underparts and clearly demarcated white wingbars of *polatzeki* (Fig. 1a, b). In both *polatzeki* and *teydea* the median upperwing-coverts may show white tips but only in *polatzeki* do the greater upperwing-coverts show extensive white tips. The female of *polatzeki* is on average paler than the female of *teydea*, with less extensive brown-grey on upper belly and flanks and with more extensive white on the belly, and the size is generally smaller, but the overlap in both colour and size is considerable.

Morphometrics

Summary statistics of morphometric characters are presented in Table 1. Although no morphometric character was diagnostic, male *polatzeki* and *teydea* differed significantly in all five characters ($p < 0.001$; Mann–Whitney U-test). Female *polatzeki* and *teydea* differed significantly in wing length ($p < 0.001$), tail length ($p < 0.005$) and bill length ($p < 0.005$; Mann–Whitney U-test). For bill depth and bill width, sample size was insufficient for statistical testing.

One principal component with an eigenvalue > 1 was extracted from five morphometric variables (Fig. 2a). The morphometrics of *polatzeki* and *teydea* differed significantly for the first principal component ($p < 0.001$; one-way ANOVA), which was determined mostly by wing length. Factor loadings and eigenvalues are presented in Table 2.

Song

Summary statistics of song characters are given in Table 3. Recordings of the songs of *polatzeki* differed markedly from those of *teydea* (Fig. 1c–f), with four characters showing no overlap (Table 3). These were: 1) lowest frequency of the first note, 2) frequency change from start to end of the first phrase, 3) frequency range, and 4) number of strongly ascending and descending, or strongly descending, notes in the second phrase. The first phrase of the song of *polatzeki*

Table 1. Plumage and morphometric differences between Gran Canaria and Tenerife blue chaffinches. Measurements are mean ± standard deviation (range; sample size).

Character	Gran Canaria blue chaffinch (*Fringilla t. polatzeki*)	Tenerife blue chaffinch (*Fringilla t. teydea*)
Plumage: males		
Velvet-black band on forehead	Pronounced	Absent, or restricted to a trace of a narrow sooty bar
Chin to chest	Darker slate-grey, not extending to lower chest and belly	Dull slate-grey, extending onto belly and flanks
Belly and flanks	Extensively greyish-white, clearly paler than upperparts; upper and central belly pure white	Upper belly and flanks medium to pale grey, similar to upperparts; only central belly greyish-white
Tips of greater upperwing-coverts	Pale greyish-white, forming white wing bar strongly contrasting with blackish feather centers	Medium to pale grey, poorly demarcated from blackish feather centers
Fringes of upperwing-coverts and tertials	Narrow slate-blue fringes; upper wing appears blacker	Broad, ash-grey, poorly demarcated from blackish feather centers
Morphometrics: males		
Wing length	95.4 ± 0.9 (93.0–97.0; 27)	101.6 ± 2.2 (97.0–105.0; 37)
Tail length	71.3 ± 2.9 (66.0–76.5; 27)	79.8 ± 3.9 (71.0–86.5; 37)
Bill length	18.4 ± 0.6 (17.6–19.4; 27)	19.7 ± 0.6 (18.4–21.5; 36)
Bill depth	10.3 ± 0.3 (9.8–10.9; 23)	11.0 ± 0.5 (10.2–11.9; 15)
Bill width	9.7 ± 0.5 (8.6–10.3; 23)	10.7 ± 0.4 (10.0–11.2; 15)
Morphometrics: females		
Wing length	88.9 ± 1.0 (87.0–90.5; 12)	93.8 ± 2.4 (88.0–98.0; 25)
Tail length	70.3 ± 1.0 (69.0–71.0; 4)	74.6 ± 2.1 (71.0–79.0; 25)
Bill length	18.2 ± 0.7 (17.5–19.7; 11)	19.4 ± 1.0 (17.8–21.1; 23)
Bill depth	11.1 ± 0.0 (11.1–11.1; 1)	11.8 ± 0.6 (11.2–12.4; 3)
Bill width	9.5 ± 0.0 (9.5–9.5; 1)	10.5 ± 0.1 (10.4–10.6; 3)

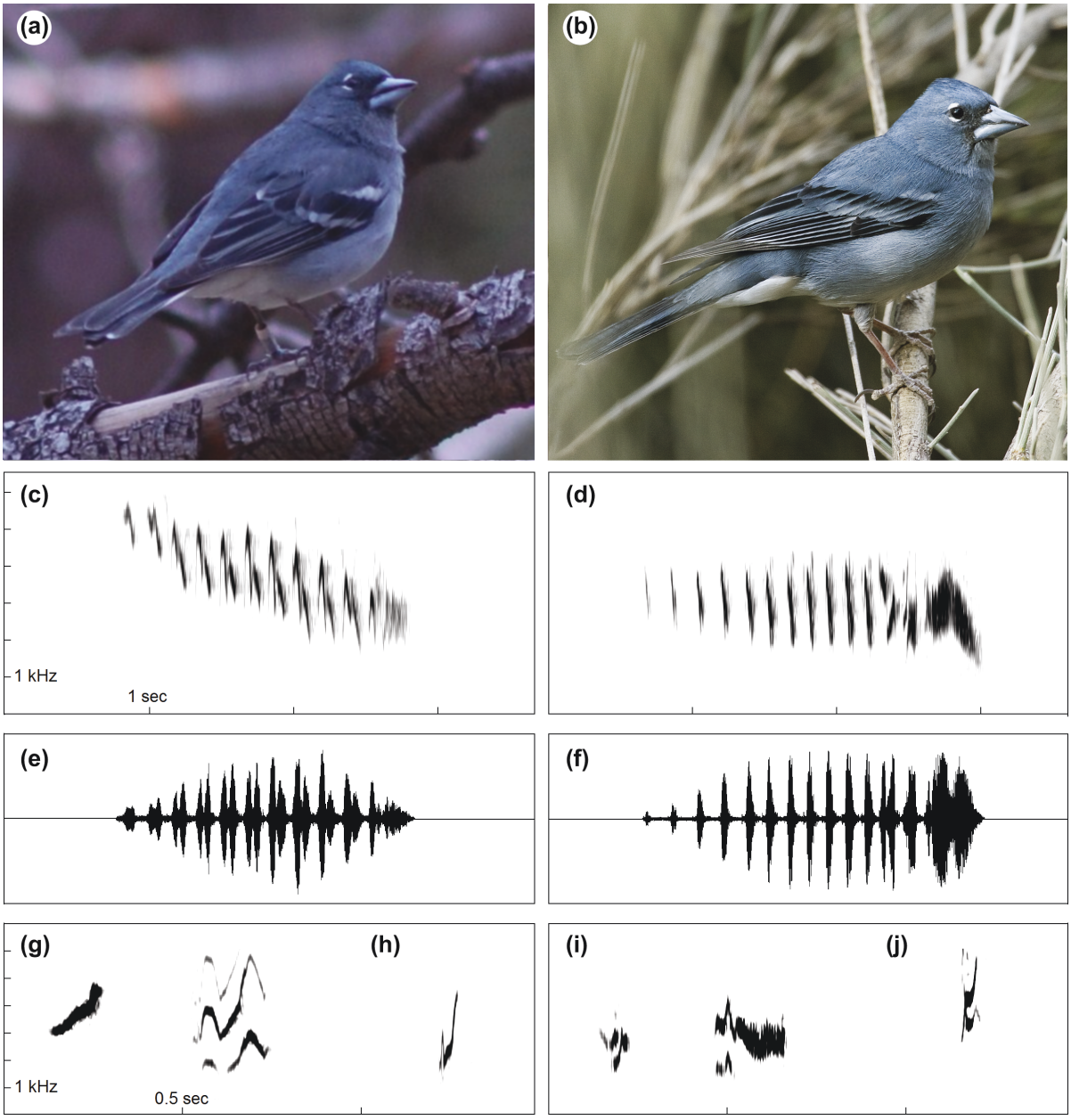

Figure 1. (a) adult male *Fringilla t. polatzeki,* Gran Canaria (J. A. Luksenburg); (b) adult male *F. t. teydea*, Tenerife (I. Merrill); sonagrams of (c) song of *F. t. polatzeki* (G. Sangster); (d) song of *F. t. teydea* (G. Sangster); oscillograms of (e) same song of *F. t. polatzeki*; (f) same song of *F. t. teydea*; sonagrams of (g); social call of *F. t. polatzeki* (M. S. Robb); (h) flight call of *F. t. polatzeki* (M. S. Robb); (i) social call of *F. t. teydea* (G. Sangster); (j) flight call of *F. t. teydea* (M. S. Robb).

was strongly descending, whereas in *teydea* the first phrase was always level. As a result, the maximum frequency, frequency range and mean frequency of *polatzeki* were much higher than those of *teydea*. The second phrase of the song of *polatzeki* was much softer than the first (and was often not noticeable in the field), whereas in *teydea* the second phrase was often the loudest part of the song. The pitch of the second phrase of *polatzeki* was always level or nearly so, whereas in *teydea* it was always either clearly ascending at first and then descending, or strongly descending.

The two taxa differed significantly in all song characters ($p < 0.001$; Mann–Whitney U-test), except song duration and minimum frequency. Three principal components with eigenvalues > 1 were extracted from the song dataset (Fig. 2b). The songs of *polatzeki* and *teydea* differed significantly for the first principal component ($p < 0.001$; Mann–Whitney U-test), which was determined mostly by variables relating to frequency and relative amplitude. Factor loadings and eigenvalues are given in Table 4.

Calls

Differences in calls are described in Table 3. We found no overlap in the most commonly given calls of *polatzeki* and *teydea* (Fig. 1g–j). The social calls of both *polatzeki* and *teydea* consist of two notes. In *polatzeki*, the first note is an upward-

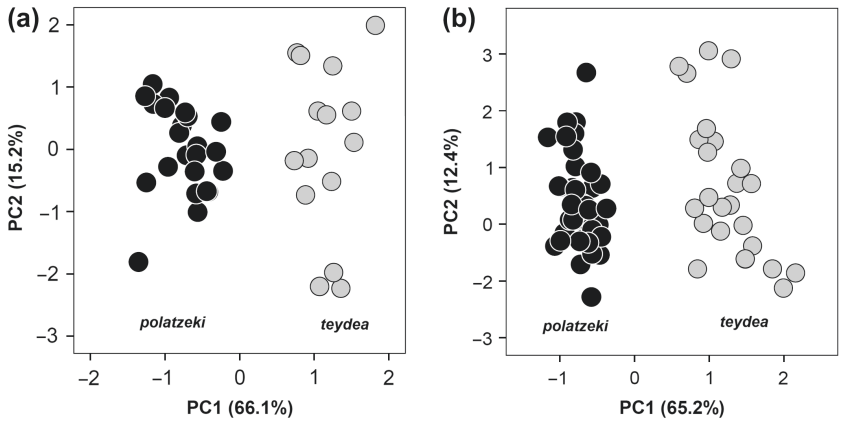

Figure 2. Principal component analysis scatterplot of the Eigenvectors of the first and second principal components of (a) five morphometric variables of male *F. t. polatzeki* and *F. t. teydea* (n = 38), and (b) 14 acoustic variables measured for territorial songs of *F. t. polatzeki* and *F. t. teydea* (n = 64).

inflected whistle, resembling that of some *Phylloscopus* warblers, followed by a strongly frequency-modulated note with multiple overtones (but never broadband) (Fig. 1g). In *teydea*, the first note is brief and low-pitched and the second is often, but not always, a broadband note (Fig. 1i). Flight calls of *polatzeki* also differ from those of *teydea* (Fig. 1h, j).

Playback tests

We performed seven playback trials on *polatzeki*. Two individuals reponded very lightly to playback of *teydea* songs but strongly or very strongly to songs of *polatzeki* (Table 5). The other individuals did not respond to songs of *teydea* but showed medium to very strong responses to those of *polatzeki*. All responses were within one minute. The effect size of the difference in response was very large ($z = 2.41$, exact two-tailed $p = 0.016$, $r = 0.91$).

Discussion

Taxonomy

Modern views of species delimitation acknowledge that species are hypotheses which should be based on as many lines of evidence as possible and be revisited whenever new evidence becomes available (Padial et al. 2010, Yeates et al. 2011). Our results show that blue chaffinches from Gran Canaria and Tenerife are well-marked taxa which 1) are diagnosable by multiple plumage characters, 2) can be distinguished by morphometric data, 3) have distinctive songs that show no overlap in multivariate character space, and 4) possess distinct call repertoires. These differences, along with previously published differences in mitochondrial DNA (Pestano et al. 2000, Suárez et al. 2009, Rando et al. 2010), suggest that these taxa have remained isolated for a considerable time, and are on independent evolutionary trajectories. Because divergence of the two populations involves multiple character systems (morphology, behaviour and genetics) there is strong, independent support that Gran Canaria and Tenerife blue chaffinches are separate evolutionary lineages which merit species rank. Thus, we recommend that two species are to be recognised: Gran Canaria blue chaffinch *F. polatzeki* and Tenerife blue chaffinch *F. teydea*.

Playback tests have been succesfully applied to study song discrimination in chaffinches, including *F. teydea* and *F. coelebs* on Tenerife (Lynch and Baker 1990, Slater and Catchpole 1990). Our study is the first to test song discrimination in *F. polatzeki* and indicates that *F. polatzeki* can distinguish between territorial songs of their own species and those of its sister species, and that territorial male *F. polatzeki* may not regard *F. teydea* as potential competitors. Due to its small sample size and its focus on *F. polatzeki* our playback study should be regarded as preliminary. Further studies using larger samples and reciprocal tests in *F. teydea* are necessary to confirm our findings.

Avian species-level taxonomy is currently in flux. This is reflected by a great increase of species numbers, mostly resulting from revisions that are based on new taxonomic data (Sangster 2009). An important trend in taxonomy is that species designations have improved due to the increased use of multiple lines of evidence and the more elaborate documentation of taxonomic studies (Sangster 2014, Sangster and Luksenburg 2015). The recognition of *F. polatzeki* as a species distinct from *F. teydea* mirrors that of several other insular bird species that have only recently been identified as full species by taxonomic studies that employed multiple types of data. These include *Ptilinopus* fruit-doves (Rheindt

Table 2. Factor loadings of five morphometric variables on the first two principal components in male *Fringilla t. polatzeki* and *F. t. teydea*. Eigenvalues and percentage of variance explained by the respective components are given at the bottom of the table. n.s., not significant.

Variable	PC1	PC2
Wing length	0.928	−0.086
Tail length	0.791	−0.390
Bill length	0.925	−0.355
Bill depth	0.692	0.612
Bill width	0.812	0.317
Eigenvalue	3.306	0.761
Variance explained	66.1%	15.2%
F (ANOVA)	313.585	0.008
Significance (ANOVA)	$p < 0.001$	n.s.
Degrees of freedom (ANOVA)	37	37

Table 3. Vocal differences between Gran Canaria and Tenerife blue chaffinches. Measurements are mean ± standard deviation (range; sample size).

Character	Gran Canaria blue chaffinch (*Fringilla t. polatzeki*)	Tenerife blue chaffinch (*Fringilla t. teydea*)
Song		
Song duration (s)	2.281 ± 0.295 (1.617–3.052; 40)	2.419 ± 0.316 (2.067–3.144; 24)
Duration of 1st phrase (s)	1.941 ± 0.264 (1.429–2.744; 40)	1.573 ± 0.503 (0.815–2.518; 24)
Duration of 2nd phrase (s)	0.330 ± 0.081 (0.156–0.473; 40)	0.784 ± 0.289 (0.310–1.361; 24)
Lowest frequency of first note (Hz)	4492 ± 196 (4136–4822; 40)	2350 ± 288 (1726–2816; 24)
Lowest frequency of last 3 notes of 1st phrase (Hz)	1544 ± 212 (1108–2120; 40)	2099 ± 291 (1452–2518; 24)
Maximum frequency (Hz)	5676 ± 334 (4715–6421; 40)	4152 ± 338 (3638–4880; 24)
Minimum frequency (Hz)	1512 ± 171 (1108–2018; 40)	1565 ± 163 (1317–1992; 24)
Frequency change from start to end of 1st phrase (Hz)	–2948 ± 318 (–3456 to –2255; 40)	–252 ± 272 (–803–336; 24)
Frequency range (Hz)	4164 ± 364 (3496–4851; 40)	2587 ± 383 (1894–3357; 24)
Mean frequency (Hz)	3594 ± 193 (2967–4001; 40)	2858 ± 184 (2523–3241; 24)
Number of notes in 2nd phrase	1.0 ± 0.0 (1.0–1.0; 40)	2.1 ± 0.8 (1.0–4.0; 24)
Number of strongly ascending and descending, or strongly descending, notes in 2nd phrase	0.0 ± 0.0 (0.0–0.0; 40)	1.8 ± 0.8 (1.0–4.0; 24)
Difference between maximum of first and maximum of second phrase (dB)	–12.7 ± 4.2 (–19.8 to –1.7; 40)	3.8 ± 5.4 (–4.8–17.1; 24)
Time to highest amplitude, measured from start of 2nd phrase (s)	–0.435 ± 0.240 (–1.094 to –0.014; 40)	0.278 ± 0.332 (–0.211–1.137; 24)
Calls		
Social call	High-pitched, upward-inflected note ('hooeet'), followed by a frequency-modulated note with multiple overtones (but never broadband). Both notes are also given separately	Highly variable. Brief, low-pitched note followed by a complex, frequency-modulated, often broadband note
Flight call	Upward-inflected, with most energy at ca 2 kHz	Upward-inflected, with most energy above 3 kHz

Table 4. Factor loadings of 14 acoustic variables on the three principal components in *Fringilla t. polatzeki* and *F. t. teydea*. Eigenvalues and percentage of variance explained by the respective components are given at the bottom of the table. n.s., not significant.

Variable	PC1	PC2	PC3
Song duration	0.109	0.918	–0.160
Duration of 1st phrase	–0.576	0.802	0.092
Duration of 2nd phrase	0.854	–0.185	–0.327
Lowest frequency of first note	–0.969	–0.099	–0.012
Lowest frequency of last 3 notes of 1st phrase	0.693	–0.009	0.544
Maximum frequency	–0.921	–0.231	–0.055
Minimum frequency	0.198	–0.095	0.822
Frequency change from start to end of 1st phrase	0.956	0.076	0.156
Frequency range	–0.919	–0.202	–0.215
Mean frequency	–0.885	–0.252	0.116
Number of notes in 2nd phrase	0.860	–0.182	–0.226
Number of strongly ascending and descending, or strongly descending, notes in 2nd phrase	0.934	–0.086	–0.120
Amplitude difference between first and second phrase	–0.919	–0.013	0.029
Time to highest amplitude, measured from start of 2nd phrase	0.865	–0.022	–0.189
Eigenvalue	9.128	1.742	1.302
Variance explained	65.2%	12.4%	9.3%
Significance (Mann–Whitney U-test)	$p < 0.001$	n.s.	n.s.

et al. 2011), *Ceyx* kingfishers (Andersen et al. 2013), *Erythropitta* pittas (Irestedt et al. 2013), *Chasiempis* flycatchers (Vanderwerf 2007, Vanderwerf et al. 2009), *Passer* sparrows (Kirwan 2008, Ryan et al. 2010) and *Carduelis* finches (Sangster 2000, Förschler and Kalko 2007, Förschler et al. 2009). These studies highlight that many taxa which have been classified as subspecies do not merely represent geographic representatives of widespread taxa but are evolutionarily distinct taxa which may help clarify biological patterns and processes (Rheindt et al. 2011, Vanderwerf 2012, Irestedt et al. 2013).

Conservation implications

The reclassification of *F. polatzeki* as a single-island endemic species increases the urgency of ongoing conservation efforts. In the early 20th century, it was considered common in its core area, and no fewer than 76 specimens were collected by a single ornithologist in 1909 (Von Thanner 1910, 1912). However, in the past, large areas have been deforested on Gran Canaria and the area covered by pine forests has become fragmented (Pérez-de-Paz et al. 1994). The species now persists in a precariously small area (< 20 km^2). A second population was discovered in Pinar de Tamadaba in the 1950s (Hemmingsen 1958), but nowadays the species is extremely rare in this place and there have been very few recent records despite intensive searches (Molina et al. 2010). In view of its long-term population decline and extremely small range and breeding population, *F. polatzeki* is best classified as criti-

Table 5. Response of *F. t. polatzeki* to playback of songs of *F. t. teydea* (stimulus I) and *F. t. polatzeki* (stimulus II). Ad, adult; 2Y, second-year.

		Stimulus I (*teydea* song)		Stimulus II (*polatzeki* song)	
Indiv.	Age	Response	Distance	Response	Distance
1	Ad	none (0)		strong (4)	< 5 m
2	Ad	very light (1)	> 10 m	strong (4)	< 5 m
3	Ad	none (0)		strong (4)	2–5 m
4	2Y	none (0)		very strong (5)	2–5 m
5	Ad	none (0)		medium (3)	5–10 m
6	2Y	none (0)		strong (4)	2–5 m
7	Ad	very light (1)	> 10 m	very strong (5)	2–5 m

cally endangered (Rodríguez and Moreno 2004). *Fringilla polatzeki* is one of Europe's rarest bird species and Europe's rarest passerine species. The species' continued existence requires intensive conservation management, including protection of its remaining habitat, formation of at least one new population from captive breeding and translocation, and reforestation to connect pine forest fragments (Boletin Oficial de Canarias 2013).

During the past 30 yr when the two blue chaffinch taxa were considered to represent a single species, their combined conservation status was progressively downgraded from 'rare' (Collar and Stuart 1985), to 'conservation dependent' (Collar et al. 1994), to 'near-threatened' (BirdLife International 2015). These assessments were based almost entirely on the range size, population numbers and trends of the Tenerife taxon (now *F. teydea* s.str.), which overwhelmed that of the much rarer Gran Canaria taxon (now *F. polatzeki*). The range and population of *F. teydea* are increasing due to positive trends in the area of suitable habitat, and its population size is now estimated to range from 2750–7250 individuals (BirdLife International 2015). Thus, overall trends in the conservation status of composite 'species' may not reflect that of its component taxa, and precious time to prevent extinction may be lost if distinctive populations remain part of polytypic species.

Our study illustrates that highly threatened species may remain 'hidden' by their inclusion in polytypic 'species'. Until proper taxonomic study, population decline of one taxon may be obscured by the more favourable conservation status of the other(s). We argue that taxonomists are well advised to prioritise research on those polytypic species that include taxa that are likely threatened (Hayes 2006).

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Supplementary material (Appendix JAV-00825 at <www.avianbiology.org/appendix/jav-00825>). Appendix 1.