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Further vocal evidence for treating the Bahama Nuthatch *Sitta (pusilla) insularis* as a species

by Peter Boesman & N. J. Collar

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SUMMARY.—The case for recognising Bahama Nuthatch *Sitta insularis* as a species separate from Brown-headed Nuthatch *S. pusilla* has been made several times since 2004, based on plumage, morphometrics, voice and genetic distance, but only one of four world lists currently accepts it as such. We assembled three new sets of recordings and recently published evidence on playback responses. We found that *S. insularis* has at least five vocalisations that are homologous to but always much higher pitched (by 2–3 kHz) than those of *S. pusilla*, such that the main calls of the latter are strikingly different from those of the former, and playback studies all suggest a consistently weak response in one species to the calls of the other. Moreover, genetic divergence of *insularis* from mainland *pusilla* is greater than that of another Bahamian taxon, Bahama Warbler *Setophaga flavescens*, recently accepted by all world lists as a species, from mainland Yellow-throated Warbler *S. dominica*. Taken together with the notably larger bill of *Sitta insularis*, these factors reinforce the case for treating Bahama Nuthatch as a (regrettably now almost certainly extinct) species.

A form of nuthatch present in pinelands on the island of Grand Bahama, in the northern Bahama Islands, has long been considered to represent a distinct subspecies, *insularis*, of Brown-headed Nuthatch *Sitta pusilla*. The description of this form, by Bond (1931), was based on two specimens, both of which showed longer bills and ‘darker loreal and auricular regions’ than the mainland, nominate form of *S. pusilla*, whose range (synonymising the undiagnosable *caniceps*) extends through pineland formations from Delaware south to Florida and west to Texas, in the eastern USA (AOU 1998, Harrap 2008).

This arrangement, with the differences between the two taxa considered ‘slight’ and indeed requiring confirmation (Harrap 1996, 2008; also Smith & Smith 1994), went unchallenged until Hayes *et al.* (2004) confirmed the morphometric distinctiveness of *insularis* (longer bill and tarsi, shorter wing) and supplemented this with evidence that it also possesses a ‘warble’ call never recorded in nominate *pusilla*. On this basis, although finding the plumages of the two taxa ‘virtually indistinguishable (Grand Bahama forms exhibit more white and less gray on the throat and belly)’, Hayes *et al.* (2004) argued that *insularis* merits species rank. This and several other taxonomic recommendations were, however, collectively set aside by what was then the American Ornithologists’ Union (AOU) ‘because of insufficient or conflicting information’, albeit with the proviso that ‘Action on these proposals awaits further studies that include additional data’ (Banks *et al.* 2006). Further data were duly furnished by Metcalf *et al.* (undated [c.2009]) who, using two markers from mtDNA, ‘estimated that the average level of sequence divergence between individuals collected on Grand Bahama and in the United States was 1.37%’. However, the case was not re-opened by the AOU, leaving Slater *et al.* (2013) to judge that the molecular finding ‘likely reflects nothing more than a) the population on Grand Bahama has been

isolated a long time and b) gene flow between it and mainland populations is minimal (i.e., nothing about reproductive isolation can be inferred).'

This last remark overlooked the report by Hayes *et al.* (2004) of a distinctive call unique to the Bahama population. By contrast, a peer-reviewed molecular study (Han *et al.* 2015) not only pointed out that the unpublished 1.37% genetic difference was 'higher than the genetic divergence reported for Bahama Warbler *Setophaga flavescens*' in McKay *et al.* (2010), a split (from Yellow-throated Warbler *S. dominica*) which *was* accepted by the AOU (Chesser *et al.* 2011), but also reported moderate to high divergence through different genotyping techniques and reported that 'calls of the Bahama population do not elicit a strong territorial response from individuals on the mainland (H. Levy unpubl. data)'. Moreover, an independent vocal analysis (Boesman 2016a) provided the decisive evidence in the acceptance of *Sitta insularis* as a species in del Hoyo & Collar (2016), where the four characters differentiating it from *S. pusilla* were: 'darker brown facial stripe; much longer bill; considerably shorter wings; and unique call, a rapid high "warble", which is apparently the principal vocalisation'.

Del Hoyo & Collar (2016) afforded these four characters scores of 1, 'at least' 2, 'at least' 1, and 3, respectively, hence at least 7 in total, under the system of taxonomic evaluation proposed by Tobias *et al.* (2010), in which a score of 4 represents an exceptional character (radically different coloration, pattern, size, or sound), a score of 3 a major character (pronounced difference in body part colour or pattern, measurement or sound), a score of 2 a medium character (clear difference, e.g. a distinct hue rather than a different colour), and a score of 1 a minor character (weak difference, e.g. a change in shade). Under these criteria, a threshold of 7 is set to allow species status, but species status cannot be triggered by minor characters alone, and only three plumage characters, two vocal characters, two biometric characters (assessed for effect size using Cohen's *d* where 0.2–2.0 is minor, 2–5 is medium, 5–10 represents major and >10 is treated as exceptional) and one behavioural or ecological character (allowed 1) may be counted. The scores given to Bahama birds for bill and wing length were considered minimal ('at least') because they were not based on direct evidence from specimens but inferred conservatively from the highly indicative box-plots in Hayes *et al.* (2004), who, incidentally, also found a longer tarsus in *insularis* but with 'considerable' overlap.

In allowing *S. insularis* species rank, del Hoyo & Collar (2016) omitted to mention the molecular evidence which, as the comparison above with *Setophaga flavescens* shows, only adds to the case. Despite these convergent items of authentication, no other world list has accepted the Bahama Nuthatch as a species (Dickinson & Christidis 2014, Clements *et al.* 2019, Gill *et al.* 2020). We therefore sought to find, preserve and analyse other sound-recordings of the species on Grand Bahama, particularly in the light of its almost certain extinction there, in an attempt to improve the evidence base for a dependable decision on its taxonomic status. We continue to be guided by the Tobias criteria, which remain the only system for taxonomically ranking allopatric taxa under the Biological Species Concept other than voting by experts on a taxonomic committee. While not perfect, the system continues to garner independent support for its decisions (del Hoyo & Collar 2014, del Hoyo & Collar 2016) in peer-reviewed research (del Hoyo 2020).

Methods

The only publicly available recording of *S. insularis* (Macaulay Library [ML] 163289) was analysed in Boesman (2016a). Two other recordings are mentioned in the literature, the first used in playback searches by Hayes *et al.* (2004) and by Lloyd & Slater (2011), and the second made by P. Merritt and used to catch four birds by Han *et al.* (2015). The recording

used by Hayes *et al.* (2004) was for a time available on a website (<https://medicine.ltu.edu/research/department-earth-and-biological-sciences/biology/research/william-k-hayes-phd-ms/bahamian-0#brownheadednuthatch>) but it could not be accessed, nor could its owner be traced. However, information kindly provided by Jim Cox, John Lloyd and Gary Slater enabled us to contact Peter Merritt and Mark Oberle, who both very generously took the time to recover and format their recordings, and make them available to us. To these we were able to add recordings made during field work in April–June 2018 and kindly sent to us by the recordist, Matthew A. Gardner.

In addition to the single Macaulay Library recording (by Jeff Gerbracht) we therefore now had access to:

- eight sound recordings made by P. Merritt on 15–17 May 2005 in the central pinewoods of Lucaya Estates, extracted from video taken using a Canon XL1 digital camcorder equipped with a Sennheiser ME66/K6 shotgun microphone;
- 35 sound-recordings made by M. Oberle on 18–19 April 2007 near a nuthatch nest in Lucayan National Park, with a Sound Devices 702 recorder and a Telinga PRO 5W stereo parabolic microphone;
- two sound recordings made by M. A. Gardner on 29 May 2018, in the central pinewoods of Lucaya Estates, extracted from video without external microphone, and one recording made on 26 June 2018 in the same area.

These recordings, which have already been submitted to public digital archives (ML 274427–463) and will be available as soon as possible, complement the earlier recordings used by Hayes *et al.* (2004) and made by Gerbracht, all from July–August, and increase the chances of capturing the full vocabulary of this taxon during the breeding and post-breeding periods.

For comparison with mainland *pusilla*, we used the sound-recordings available in the Macaulay Library (<https://www.macaulaylibrary.org/>) and Xeno-canto databases (<https://www.xeno-canto.org/>). We made sonograms of all recordings using CoolEdit Pro (Blackman-Harris window at 512 band resolution) and, where necessary, we measured sound parameters manually on these using visual rulers for time and frequency on screen. To construct an overview of the full vocabulary of *S. insularis*, we used as a guideline what is known for *S. pusilla* (Harrap 2008, Slater *et al.* 2013, Pieplow 2017). We aligned our descriptions of vocalisations with commonly used terminology in North America (McCallum 2011, Pieplow 2017), considering a ‘note’ to be any continuous line on a sonogram up to a pause, and the term ‘overslurred’ to describe a rise and then fall in pitch.

Results

The vocabulary of *S. insularis* was found to be as extensive as that of *S. pusilla*, and most of its vocalisations possess homologous counterparts in the mainland taxon, including the ‘warble’ call that Hayes *et al.* (2004) considered unique to *insularis*. Five out of six of the counterpart vocalisations were nevertheless found to be much higher pitched in *S. insularis* vs. *S. pusilla* (Table 1). Most calls in *insularis* are faint and unobtrusive, suggesting use in close-range communication between members of a pair or group. From the available sound-recordings we distinguished the following different vocalisations.

1. Skew-doo (‘rubber ducky’ vocalisation).—In *S. insularis* this call type was present in the three sets of sound-recordings from April, May and June, although Hayes *et al.* (2004) heard it only occasionally in July. To the ear, the *skew-doo* of *insularis* sounds much higher pitched and less nasal than in *S. pusilla*. This was confirmed by measurement of all available recordings of *insularis* compared to a random selection of recordings of *pusilla* from six

TABLE 1

Max. (fundamental) frequency in kHz for five of six homologous vocalisations in the repertoire of Brown-headed Nuthatch *Sitta pusilla* and Bahama Nuthatch *S. insularis* (mean values), and their calculated difference (Δ). Missing in this list is the ‘twitter’ call (vocalisation 3), which proved too variable in frequency to be worth measuring and testing. With the exception of the commonly heard *skew-doo* call (see Table 2) and high-pitched *pit* calls, sound-recordings of other vocalisations are rare even for *pusilla*, and measurements are based on just 1–2 available recordings, as detailed in the text. * = an estimate, as the fundamental frequency is not fully visible on the sonogram for the available recordings.

	<i>Sitta pusilla</i>	<i>Sitta insularis</i>	Δ
<i>Skew-doo</i> call	4.3	6.3	2.0
High-pitched chitter	5.0	8.0	3.0
High-pitched <i>pit</i>	3.8	6.2	2.4
High-pitched <i>tink</i>	5.0	7.2	2.2
Begging call	3.0*	8.0	5.0*

TABLE 2

Measurements of sound parameters of the *skew-doo* call in Brown-headed Nuthatch *Sitta pusilla* and Bahama Nuthatch *S. insularis*. Means and standard deviation are given. Each sample of *S. pusilla* is from a different state in the USA (ML 207586931, ML 206324781, ML 172477891, ML 120782681, ML 40782, ML 50234281).

	<i>S. pusilla</i> (<i>n</i> = 6)	<i>S. insularis</i> (<i>n</i> = 8)	effect size
Max. base freq. <i>skew</i> (Hz)	4,300 \pm 161	6,288 \pm 653	4.18
Duration <i>skew</i> (seconds)	0.147 \pm 0.020	0.22 \pm 0.039	2.35
Max. base freq. first <i>doo</i> (Hz)	1,367 \pm 125	3,363 \pm 219	11.19
Duration first <i>doo</i> (seconds)	0.093 \pm 0.021	0.090 \pm 0.021	0.14

different states on the mainland (Table 2). An exceptional difference in max. frequency was found for the *doo* note (effect size 11.2, score 4), with a less powerful but still significant difference in the *skew* note, which is both longer in duration and higher in frequency in *insularis* (score 2). A further clear difference is in note shape, as the *skew* is typically overslurred on the mainland and mainly downslurred on Grand Bahama (Fig. 1). The relative importance of these differences in creating a reproductive barrier is unknown, but we follow standard practice in vocal analysis for taxonomic studies by focusing primarily on the quantification of basic spectral and temporal sound parameters.

In *pusilla* this is the commonest call and the only one that carries more than short distances, being used in a variety of situations linked to territorial song, excitement and long-distance communication. It is uttered by both sexes and is heard year-round, although long series uttered in spring may well be produced by the male alone. *Skew-doo* (*ziu-uu* in Harrap 2008, *tyah-dah* or *chee-da* in Slater *et al.* 2013) consists of two notes, but the *doo* can occasionally be absent, or it can occur in series of up to 12 repetitions when a bird is excited (Harrap 2008, Slater *et al.* 2013, Pieplow 2017). Recordings reveal that this call is given in a context similar to that used by *insularis*.

2. High-pitched chitter and ‘warble’ call.—This was the main vocalisation given by *S. insularis* in July 2004, described by Hayes *et al.* (2004) as ‘a rapid, high-pitched “warble” call’, and it was also the only vocalisation recorded in July 2011 (ML 163289). By contrast, this call was almost absent in recordings made in April and May, and only a few examples were found in recordings made at the end of May, but it was more frequently heard in

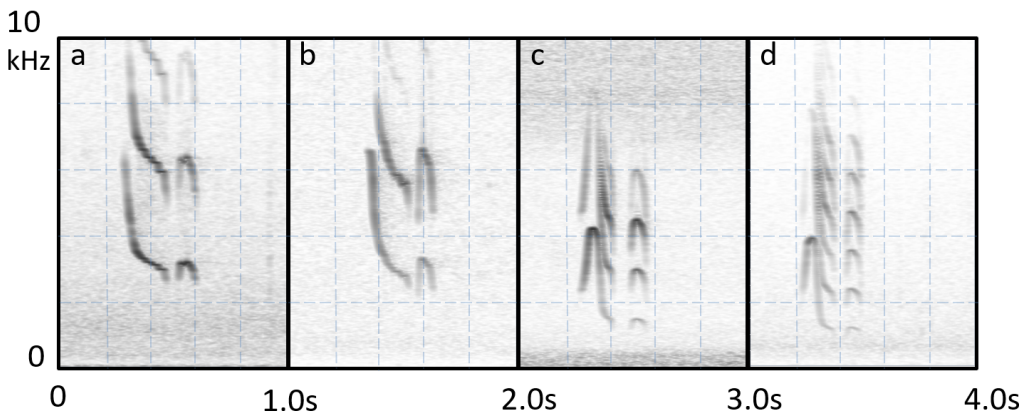


Figure 1. Sonogram of vocalisation 1. Typical *skew-doo* call, Bahama Nuthatch *Sitta insularis* (a–b) and Brown-headed Nuthatch *S. pusilla* (c–d). Extracts from recordings (a) P. Merritt; (b) M. Oberle; (c) ML172477891 (Florida; J. Graham); (d) ML50234281 (Georgia; E. Cormier).

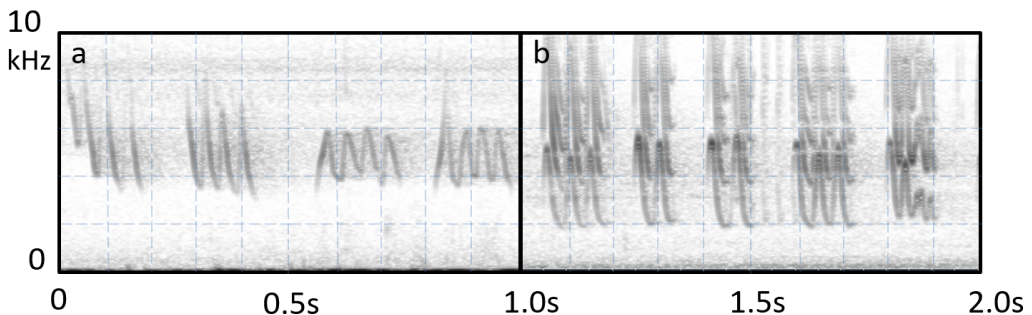


Figure 2. Sonogram of vocalisation 2. (a) High-pitched chitters (first two calls) and warble (second two calls) of Bahama Nuthatch *Sitta insularis* (extract from ML 163289; J. Gerbracht); (b) rarely given, structurally similar vocalisation of Brown-headed Nuthatch *S. pusilla*: ML 196494 (Florida; B. McGuire).

recordings from the end of June. This may well be the primary vocalisation of feeding groups in the non-breeding season, and indeed it was used by Hayes *et al.* (2004) and Lloyd & Slater (2011) to attract feeding flocks with playback. It consists of bursts of short high-pitched chitters that could be transcribed as *tree..tre-ree-ree..tree-tree*. On a sonogram each chitter call consists of 3–7 downstroke elements that are sometimes interconnected, when they appear as a continuous oscillation (hence the ‘warble’ call) (Fig. 2). Duration is quite variable (0.10–0.40 seconds), depending on the number of included elements, and frequency typically ranges from *c.*3.5 to 8.0 kHz.

We assume this vocalisation is homologous to the ‘rattle’ described for *S. pusilla* by Pieplow (2017), although we have found surprisingly few sound-recordings of it (e.g. ML 196494) in the extensive material available. While the structure of the bursts is similar to that of *S. insularis*, including at times the oscillating lines on sonograms (Fig. 2), the difference in frequency is again striking. Fundamental frequency for *pusilla* ranges from 1.5 to 5.5 kHz, rendering it a very different sound to the ear that can be transcribed as a rather harsh *tchrr...tchrrr*. It is thus unsurprising that this apparent homology was not identified by Hayes *et al.* (2004), and we cannot exclude the possibility that this vocalisation type has an entirely different function in each taxon.

Pieplow (2017) provided a second, somewhat different sonogram of these rattles that depicts short monotone bursts of sharply overslurred notes (extracted from ML 14767). This

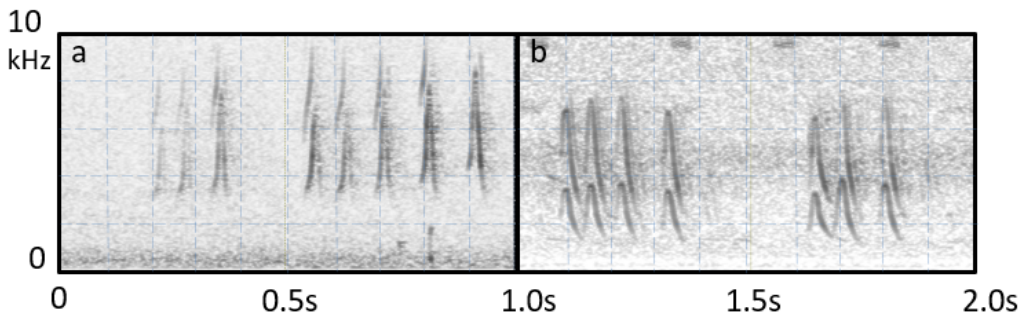


Figure 3. Sonogram of vocalisation 2. Short chattering bursts (a) Bahama Nuthatch *Sitta insularis* (M. Gardner); (b) Brown-headed Nuthatch *S. pusilla* (extract from ML 14767, South Carolina; C. Sutherland).

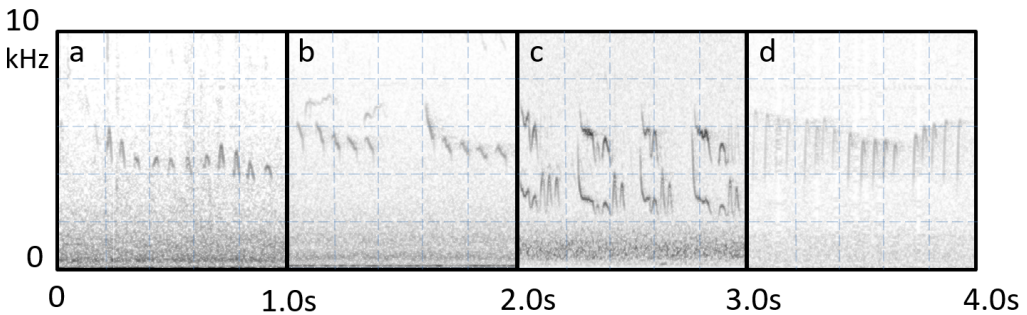


Figure 4. Sonogram of vocalisations 3 and 7, all of Bahama Nuthatch *Sitta insularis*. (a–b) Twitters (M. Oberle); (c) twitters (P. Merritt); (d) high-pitched trill (M. Gardner).

matches a variant found in Gardner's recordings of *insularis* surprisingly well, except again for frequency range: max. frequency is 3.3–4.0 kHz in *pusilla* but a striking 6.0–9.0 kHz in *insularis* (Fig. 3).

3. Twitters.—In *S. insularis* many mellow semi-nasal twitters were recorded around the nest site. Their structure was highly variable, with some examples reminiscent of, but mellow than, the long versions of the *skew-doo* call, whereas others simply represented random up-and-down twittering (Fig. 4a–c). Compared to the 'chitter/warble' call (vocalisation 2), twitters are less stereotypic and less emphatic, suggesting communication between a pair at close range than the louder chitter at group level. In general, sonograms of these calls look quite similar to the 'twitter' mentioned for *pusilla* by Pieplow (2017), who described them as 'soft, short, peeping'. Given the variability involved, we did not make pair-wise measurements to evaluate possible frequency differences between calls given by the two taxa, which seem to be less apparent than in the other vocalisations.

4. High-pitched pit.—In *S. insularis* the *pit* is a very short, soft, upslurred note that is probably homologous when compared on a sonogram to the *wink* call of *S. pusilla* (Pieplow 2017), which is also transcribed as *tip* or *pit* (Harrap 2008). The short *pic* notes mentioned by Hayes *et al.* (2004) for *insularis* most likely also involve this vocalisation. It can vary considerably in pitch, depending somewhat on the level of excitement of the bird, but the max. frequency in *insularis* reaches 5.0–7.5 kHz, whereas in *pusilla* it is *c.* 2.5–5.0 kHz ($n = 8$), once again revealing a strikingly different frequency range in the two taxa (Fig. 5).

5. High-pitched tink.—In *S. insularis* this is another high-pitched, faint vocalisation, consisting of short notes over a narrow frequency range, given either singly or in pairs or triples, sounding like a pure *tink* or *ti-tink*. It is structurally very similar to, but again

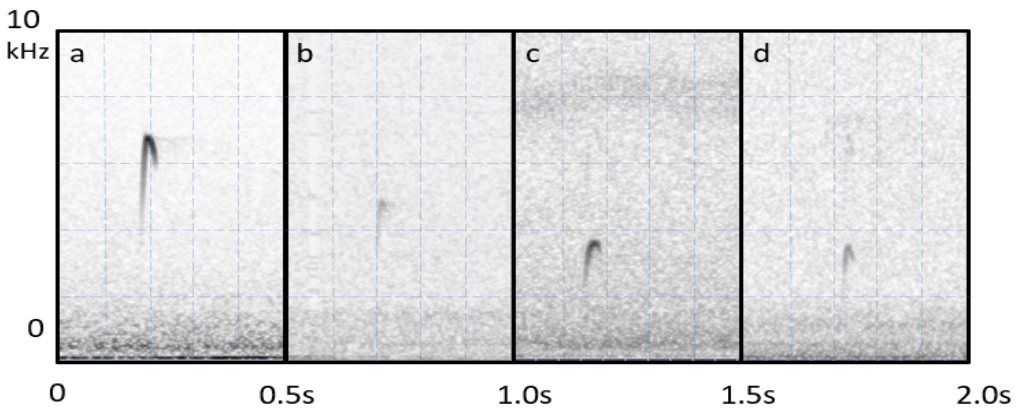


Figure 5. Sonogram of vocalisation 4. Single high-pitched *pit* note. Bahama Nuthatch *Sitta insularis* (a) high-pitched example (M. Oberle); (b) lower pitched example (M. Gardner); Brown-headed Nuthatch *S. pusilla* (c) extract from XC 130526 (Florida; M. Nelson); (d) extract from ML 87147361 (Florida; T. Auer).

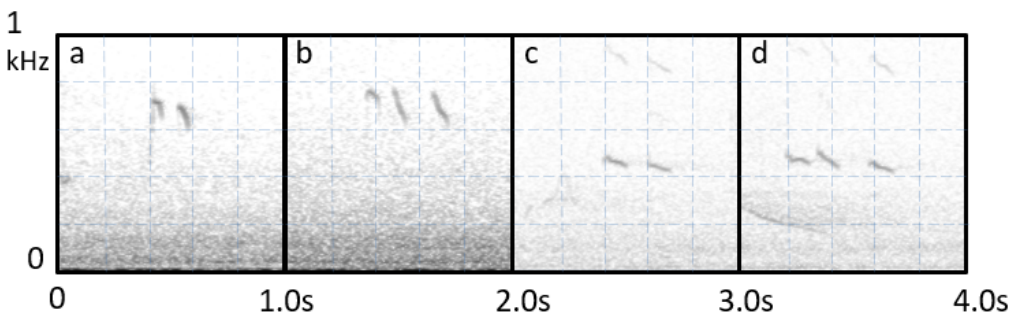


Figure 6. Sonogram of vocalisation 5. High-pitched *tink* calls: (a–b) Bahama Nuthatch *Sitta insularis* (M. Oberle); (c–d) Brown-headed Nuthatch *S. pusilla* extract from XC 112506 (Georgia; L. Wolff).

clearly higher pitched than, calls in a recording of *S. pusilla* made near a nest site in Georgia (XC 112506) (Fig. 6). The sonogram in Pieplow (2017) for the *seet* call in *S. pusilla* bears a superficial resemblance, but the original recording (ML 14767) on which that graphic was based reveals differences discernible both to the ear and on a sonogram in its rather polyphonic quality, with the lowest frequency around 3.7 kHz, slightly longer duration, and very faint hissing quality. Moreover, this call was uttered only singly.

6. Begging call.—In *S. insularis* this vocalisation, a high-pitched incessant *see...see..* (Fig. 7), was only recorded at the nest site and undoubtedly uttered by the young inside. Remarkably, even for this vocalisation, the few available recordings of juvenile *pusilla* suggest a significant difference in frequency, the latter more than 3.0 kHz lower when comparing the fundamental frequency (e.g. XC 179671, ML 57525031, ML 164553561; Table 1). We do not know the age of the begging juveniles in every recording, however, so these findings should be treated cautiously.

7. High-pitched trill.—This vocalisation was found only a few times among the recordings of *S. insularis*, and it is probably therefore uncommon, perhaps representing only a variant of the twitters (vocalisation 3) or an excited version of the *pit* call (vocalisation 4). Different from the chattering (vocalisation 2), these rattling trills are long series of upstroke *pit* notes uttered at a very fast pace of *c.*20 notes per second (Fig. 4d). We have found no clear equivalent of this call in *S. pusilla*.

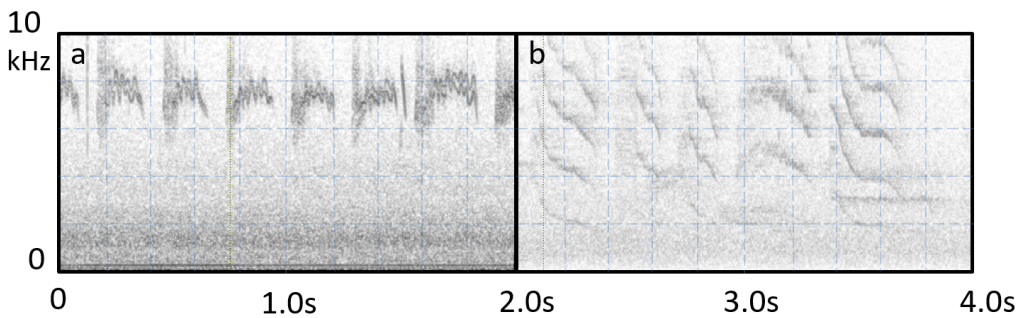


Figure 7. Sonograms of vocalisation 6. (a) Begging calls at the nest of Bahama Nuthatch *Sitta insularis* (M. Oberle); (b) Brown-headed Nuthatch *S. pusilla* 'juvenile begging calls', extract from ML 164553561 (North Carolina; L. Beegle).

8. *Schwee* / *seet* calls.—In *S. pusilla* the *schwee* call (Slater *et al.* 2013) and *seet* call (Pieplow 2017) are both linked to food begging by the presumed female from her mate, but they are not necessarily the same vocalisation, as Slater *et al.* (2013) gave a duration of 0.7 seconds for *schwee* whereas the sonogram in Pieplow (2017) suggests 0.175 seconds for *seet*. An equivalent in *S. insularis*, although not found on the recordings, is likely to exist, but possibly given only or mainly prior to breeding, and thus primarily in the first few months of the year.

Discussion

This overview of the vocalisations of *S. insularis* and *S. pusilla* clearly establishes that their vocabularies are comparable, and we can with reasonable confidence identify the homologous vocalisations. For almost all pairings of homologous calls, the different frequency range is remarkable, such that to the human ear most of the calls sound rather unrelated. The frequency difference of both taxa has only been alluded to qualitatively (Smith & Smith 1994), but it is now quantified and clarified per vocalisation type: *S. insularis* has almost its entire vocabulary *c.*2.0–3.0 kHz higher in frequency than *pusilla* (Table 1), which is an astonishing finding given that they are similarly sized and closely related taxa.

We were, however, unable to elucidate the degree of differentiation in particular vocalisations between males and females, or determine the degree to which a particular vocalisation is used exclusively or predominantly by one sex or the other. Such differences are poorly documented in the literature (none is mentioned in Harrap 2008 or Slater *et al.* 2013), but are sufficient to be used in playback lures in Florida to capture males or females, as needed (J. A. Cox *in litt.* 2020). Even so, our finding of a consistently much higher frequency in the calls of *S. insularis* is maintained across recordings.

The characters distinguishing *S. insularis*, and the scores given to them that led del Hoyo & Collar (2016) to recognise it as a species, were based mainly on evidence in Hayes *et al.* (2004): 'darker brown facial stripe (1); much longer bill (at least 2); considerably shorter wings (at least 1); and unique call, a rapid high "warble", which is apparently the principal vocalization (3)'. Given the resistance to that evidence (Banks *et al.* 2005, Slater *et al.* 2013) we reconsider these features here. The eyestripe difference is the most difficult to confirm: Bond (1931), on the basis of a tiny sample, treated it as one of two diagnostic characters; Smith & Smith (1994), using an equally small sample, reported that the two Bahamian birds they saw had 'noticeably more prominent brown eyelines and purer white underparts' than birds recently seen in Florida; and Slater *et al.* (2013) included the eyestripe as a genuine diagnostic trait. Hayes *et al.* (2004) further agreed with Smith & Smith (1994) that 'Grand

Bahama forms exhibit more white and less gray on the throat and belly', but on the issue of the eyestripe they were silent: after examining 11 specimens of *insularis* and 99 mainland *pusilla* (but hampered by the poor condition of, evidently, *insularis*), they 'chose not to quantify plumage coloration because of substantial character overlap'. More detail on this problem would have been helpful, but after examining photographs on the internet and pending rigorous re-examination of museum material, we are inclined to agree that such overlap may exist and that, at present, this character (and the purer white underparts) should be treated as uncertain.

The much longer bill was, however, well established by Hayes *et al.* (2004), both in a photograph of three individuals of each taxon and in a boxplot based on all 11 *insularis* and 99 *pusilla* measured. This boxplot shows *insularis* and *pusilla* with median bill lengths (nares to tip) of 12.4 and 10.6 mm respectively, with very little overlap in range. A similar boxplot for wing length yielded medians of 60 and 63 mm, respectively, albeit with near-complete overlap. A single unsexed *insularis* and five random male *pusilla* in the American Museum of Natural History, New York (material not used by Hayes *et al.* 2004), yielded respective measurements (taken by NJC) of bill (skull to tip) 18.6 vs. mean 15.0 mm, wing (curved) 62.0 vs. mean 64.6 mm (no overlap) and tail 33.0 vs. mean 30.6 mm (no overlap), consistent with previous evidence on bill and wings. Although we cannot generate effect sizes from the data in Hayes *et al.* (2004), we are very confident that the bill length difference (2) and moderately confident that the wing length difference (1) were correctly scored in del Hoyo & Collar (2016).

This then leaves the new information on vocal divergence. Although Hayes *et al.* (2004) considered the 'warble' call unique to *insularis*, it apparently occurs in *pusilla* as the (lower pitched) 'rattle' (Pieplow 2017). However, in the dominant acoustic signal used by the two taxa, the *skew-doo* call, the differences in max. frequency (effect size 11.19, score 4) and duration plus frequency range (effect size 2.35, score 2) produce a score for voice of 6. Even discounting scores for eyestripe and wing length, this carries the Bahama Nuthatch to a total score (8) higher than that by which it earlier achieved species rank. That this large difference (which is also, as noted, reflected in the other vocalisations in its vocabulary) has biological significance has been increasingly apparent. In May 1993 Florida birds responded to a broadcast recording of *S. pusilla* but Grand Bahama birds, sounding 'briefer... weaker, faster and higher', did not (Smith & Smith 1994). In July–August 2004 Grand Bahama birds 'virtually ignored playback of the continental rubber ducky call' (Hayes *et al.* 2004). From October 2017 to March 2018 at St Marks National Wildlife Refuge, Florida, *S. pusilla* responded to recordings of their own 'rubber ducky' calls 72% of the time but only 30% to equivalent calls of Pygmy Nuthatch *S. pygmaea* and 27% to those of *S. insularis* (involving the Merritt recordings from May 2005), whereas in July 2012, on Grand Bahama Island, *S. insularis* responded 83% to their own calls and 25% to those of *S. pusilla* (Levy & Cox 2020; also Levy 2018). These consistent findings reflect recent work showing that significant vocal differences are highly correlated with degree of playback response in both suboscines and oscines (Freeman & Montgomery 2017).

While in New World avian taxonomy vocal characters have particularly been used for species delimitation in suboscine passerines, based on the finding that their songs are innate, there is a growing recognition that vocalisations are at least under partial genetic control in the voice-learning oscines, and are thus also useful for delimiting species (Remsen 2005, Cadena & Cuervo 2010). Even so, in some oscine passerine families local populations can be defined by dialects, so could the vocalisations of *Sitta insularis* simply be considered a dialect of those in *S. pusilla*? We argue not: there is no indication at all of local dialects in continental *Sitta pusilla*, in which on the contrary the stereotypic rendition of the *skew-doo*

call over its entire range is striking, as reflected by the low standard deviations in Table 2, and we are unaware of any case where the term 'dialect' has been applied to an entire vocabulary that occupies a completely different frequency range to that of a conspecific.

The relatively recent proposed split of Bahama Warbler from Yellow-throated Warbler, based on genetic and phenotypic evidence (McKay *et al.* 2010), has been accepted by all four world lists (Dickinson & Christidis 2014, del Hoyo & Collar 2016, Clements *et al.* 2019, Gill *et al.* 2020); yet, as noted above, the genetic distance recorded between the two is smaller than that between *Sitta insularis* and *S. pusilla*. There are many similar instances of closely related taxa in the Caribbean which were once considered conspecific and are now not, notably including Bahama Yellowthroat *Geothlypis rostrata* and Common Yellowthroat *G. trichas*, whose mostly minor morphological differences have been supplemented by a Tobias score of 4 for their level of acoustic divergence (Boesman 2016b). *Sitta insularis* clearly merits the same taxonomic rank as these two other Bahamas species, and incidentally shares with them the considerably larger bill than their mainland counterparts (Kirwan *et al.* 2019). Smith & Smith (1994) assumed that, since it was unknown from the neighbouring island of Abaco, the nuthatch must have colonised Grand Bahama after the two islands separated some 2,500 years ago, which would of course generally be regarded as far too recent to have permitted a speciation event. However, the genetic evidence indicates that *S. insularis* and *S. pusilla* diverged from a common ancestor around 685,000 years ago (Metcalf *et al.* undated), and this finding has now been complemented by late Pleistocene fossil remains of *insularis* from Abaco (Steadman & Franklin 2015, Steadman *et al.* 2015) and Long Island (Steadman & Franklin 2020).

The phenotypic and genetic evidence, results of playback experiments, and parallel circumstance of the two parulid warblers combine to create a situation in which the burden of proof, in Gill's (2014) formulation, now lies with those who would wish to continue to treat *S. insularis* as a subspecies of *S. pusilla*. This is now almost certainly a matter of 'academic' interest, however, since *insularis*, clearly in serious trouble throughout this century, can surely not have survived the devastating impact on Grand Bahama of Hurricane Dorian over 2–3 September 2019 (295 km/h winds for >24 hours). For this reason in particular we recommend that any other sound-recordings, videos, photographs or records be deposited in secure archives such as the Macaulay Library and Xeno-canto in order to preserve for posterity as much as possible of our knowledge and experience of the Bahama Nuthatch.

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