

# Scopoli's Shearwater collected in Faeroes in August 1877

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Until recently, Scopoli's Shearwater *Calonectris diomedea*, first described by Joannes Antonius Scopoli in 1769, was considered the nominotypical subspecies of the polytypic Cory's Shearwater *C borealis*. The taxonomic split of Scopoli's from Cory's was proposed by Sangster et al (1999) based on differences in genetic data, morphology and vocalisation. The split of the two taxa was not universally accepted at the time, although subsequently it has been adopted by Dickinson & Remsen (2013) and the International Ornithological Congress (IOC; Gill et al 2020).

The Natural History Museum of Denmark in København (NHMD) houses a specimen of *Calonectris* shearwater labelled Scopoli's Shearwater, collected in the Faeroes on 9 August 1877. The Danish rarities committee (Sjældenhedsudvalget – SU) follows taxonomic recommendations given by the IOC and evaluates records from the Faeroes. Thus, following the split, SU undertook a re-assessment of all Danish *Calonectris* shearwater records, including the aforementioned skin held at NHMD catalogued as Scopoli's (plate 448-451). Notes about the skin published in Danish state that the

**448-449** Scopoli's Shearwater / Scopoli's Pijlstormvogel *Calonectris diomedea*, adult female (collected in Faeroes on 9 August 1877), Natural History Museum of Denmark, København, 1 March 2020 (Kent Olsen)





FIGURE 1 Maximum likelihood tree based on cytochrome b fragment, confidently placing Faeroese specimen (marked by blue diamond) within genetic diversity of other publicly available Scopoli's Shearwater *Calonectris diomedea* samples. Red dots: nodes with >95% bootstrap support.

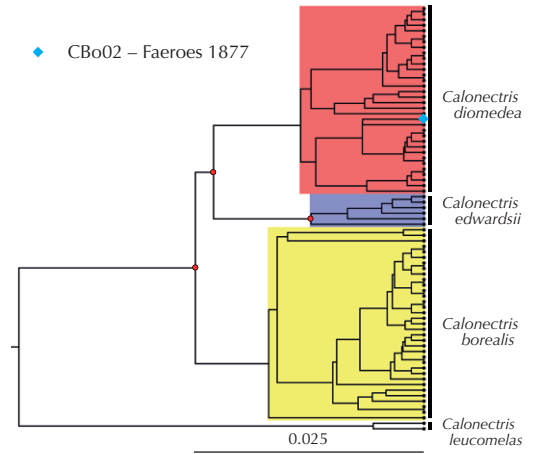


FIGURE 2 Maximum likelihood tree based on mitochondrial control region sequence, confidently placing Faeroese specimen (marked by blue diamond) within genetic diversity of other publicly available Scopoli's Shearwater *Calonectris diomedea* samples. Red dots: nodes with >95% bootstrap support.

specimen is an adult female that was shot in the Faeroes on 9 August 1877 (Andersen 1899). The NHMD specimen was originally identified as Great Shearwater *Ardenna gravis* (Andersen 1901) and included as such in the museum collection. The skin was re-identified and published as Scopoli's (Andersen 1899). Similar cases of re-identification of old shearwater skins are known from other natural history museum collections (eg, Flood et al 2020) and result from improved knowledge about the morphology of shearwater taxa and in recent times the separation of cryptic taxa by DNA testing.

Scopoli's Shearwater is an extreme rarity in north-western Europe, particularly north of south-westernmost France, with only two other records, both photographed off Scilly, England; one on 2 August 2004 (Fisher & Flood 2010) and one on 11 July 2019 (Flood & Fisher 2020). There are records for central Europe from Austria, Poland and Switzerland (Flood & Fisher 2020). The Faeroese specimen represents the northernmost record for Europe and possibly for the Atlantic Ocean.

Our study confirmed with confidence that the specimen concerns a Scopoli's Shearwater. The study involved DNA analysis, measurements and assessment of plumage aspect, and tracing the history of the specimen.

### DNA analysis

A toepad sample was taken from the skin for DNA analysis (see appendix). Two mitochondrial fragments, one from the cytochrome b gene and one from the highly variable control region, were analysed. The Faeroese specimen control region sequence is identical to a number of Scopoli's Shearwater sequences, while being at least 3 base pairs (bp) and 9 bp different from Cory's Shearwater and Cape Verde Shearwater *C. edwardsii*, respectively. At the cytochrome b locus, the Faeroese specimen is identical to the majority of Scopoli's reference sequences, and a minimum of 1 bp and 3 bp divergent from Cape Verde and Cory's respectively. A maximum likelihood tree was constructed for each gene, and in each case placed the Faeroese specimen confidently with other Scopoli's (figure 1-2). While the exact relationship between the three shearwater species is not reliably resolved with such short fragments, the Faeroese specimen nests deep within the *diomedea* (Scopoli's) clade.

### Measurements

Kent Olsen measured the skin using calipers and his results agree with Andersen (1899). The biometrics largely support identification as a female Scopoli's Shearwater (table 1; sources cited in cap-

tion). The wing measurements fall in the central range for female Scopoli's, and outside of the ranges for male Scopoli's, male and female Cory's Shearwater and Cape Verde Shearwater. The tail measurement falls in the central range of female Scopoli's and the central range for female Cory's, but outside of the ranges for male Cory's and male and female Cape Verde. The bill measurement falls in the central range for female Scopoli's, and outside of the ranges for male Scopoli's, and male and female Cory's and Cape Verde.

### Plumage

Field characters by which to differentiate the two taxa have been widely debated (Granadeiro 1993, Gutiérrez 1998, Camphuysen & van der Meer 2001, Howell & Patteson 2008, Robb et al 2008, Fisher & Flood 2010, Flood & Gutiérrez 2019). Recent advances recognise that the combination of three aspects of the underwing are the most important for separating Cory's Shearwater and Scopoli's Shearwater (Flood & Fisher 2020, Flood & Gutiérrez in prep):

**1** Of greatest importance is the absence, or presence and length, of a white basal tongue running up the inner web of p10, measured as a percentage of the visible under primary. C 3% of 545 Cory's had a white tongue but with just one extreme outlier longer than 20%; c 70% of 462 Scopoli's had a white tongue longer than 20%. Thus, a white tongue longer than 20% may be considered diagnostic of Scopoli's.

**2** Following Robb et al (2008), our study found that the great majority of Scopoli's have a single small or large dark spot or mark only in the outer-

most greater primary covert (gpc10). Some Cory's are the same but others have two large dark spots or marks, one in each of the two outermost greater primary coverts (gpc9 and gpc10). However, some Cory's have a single dark spot or mark like a typical Scopoli's but, importantly, very few Scopoli's have two dark spots or marks like some Cory's.

**3** Typically, Scopoli's has fairly clean-looking underwing secondary coverts with largely unmarked lesser coverts; Cory's has dirtier looking underwing secondary coverts with more and denser dark markings mainly in the lesser coverts (overlap and reverse cases occur); a scoring system has been developed (Flood & Fisher 2020, Flood & Gutiérrez in prep).

Robert Flood and KO examined the plumage of the Faeroese skin. The wings were fixed to the body and it was not possible to fully examine the underwing secondary coverts without causing substantial damage to the specimen. The length of the white tongue on the inner web of p10 is 25%, (plate 451). While this measure is not particularly high, the key observation is that it is outside the range of Cory's Shearwater and within the range of Scopoli's Shearwater, thus strongly supporting identification as Scopoli's (Flood & Gutiérrez in prep). Of the two outermost greater primary coverts gpc9 and gpc10 in the underwing, there was a dark mark only in gpc10 (gpc9 unmarked; plate 450). This plumage character supports identification as Scopoli's.

### Range, movements and vagrancy

The breeding range of Scopoli's Shearwater lies within the Mediterranean basin east of the Almería-

TABLE 1 Comparison of wing, tail and bill measurements (mm) of the Faeroese shearwater with Cory's *Calonectris borealis*, Scopoli's *C diomedea* and Cape Verde Shearwater *C edwardsii*. Data are: single measurements; or mean  $\pm$  1SD, range (sample size); or range (sample size). <sup>1</sup>Andersen (1899), <sup>2</sup>BWPI (2006), <sup>3</sup>Howell (2012), <sup>4</sup>Murphy & Chapin (1929). Additional measurements of the Faeroese shearwater: middle toe without claw 55.5 mm and tarsus 47.5 mm (Andersen 1899).

	Faeroese Cory's Shearwater		Scopoli's Shearwater	Cape Verde Shearwater
<b>wing</b>	♀ 335 <sup>1</sup>	♂ 361-367 (n=2) <sup>2</sup> ♀ 358 $\pm$ 4.50, 347-363 (n=11) <sup>2</sup>	♂ 346 $\pm$ 4.68, 339-351 (n=9) <sup>2</sup> ♀ 339 $\pm$ 6.83, 330-347 (n=5) <sup>2</sup>	♂ 313.6 $\pm$ 5.21, 298-321 (n=15) <sup>2</sup> ♀ 308.7 $\pm$ 7.31, 299-319 (n=11) <sup>2</sup> ♂ 304.6 $\pm$ 6.16, 287-322 (n=50) <sup>4</sup> ♀ 297.6 $\pm$ 7.67, 282-317 (n=50) <sup>4</sup>
<b>tail</b>	♀ 133 <sup>1</sup>	♂ 138, 145 (n=2) <sup>2</sup> ♀ 136 $\pm$ 3.01, 131-141 (n=11) <sup>2</sup> 121-144 <sup>3</sup>	♂ 130.0 $\pm$ 1.00 (n=3) <sup>2</sup> ♀ 135.3 $\pm$ 7.23 (n=3) <sup>2</sup> 117-135 <sup>3</sup>	♂ 124.4 $\pm$ 2.77, 121-130 (n=8) <sup>2</sup> ♀ 123.8 $\pm$ 4.11, 120-129 (n=4) <sup>2</sup> 115-130 <sup>3</sup>
<b>bill</b>	♀ 48 <sup>1</sup>	♂ 55.5 $\pm$ 1.73, 51-59 (n=52) <sup>2</sup> ♀ 52.8 $\pm$ 1.85, 49-57 (n=60) <sup>2</sup> 50-60 <sup>3</sup>	♂ 51.2 $\pm$ 1.51, 49-55 (n=17) <sup>2</sup> ♀ 47.3 $\pm$ 1.78, 45-50 (n=16) <sup>2</sup> 35-55 <sup>3</sup>	♂ 44.0 $\pm$ 0.75, 43.2-44.7 (n=8) <sup>2</sup> ♀ 44.4 $\pm$ 1.16, 43.0-45.6 (n=4) <sup>2</sup> 40-45 <sup>3</sup>



**450** Scopoli's Shearwater / Scopoli's Pijlstormvogel *Calonectris diomedea*, adult female (collected in Faeroes on 9 August 1877), Natural History Museum of Denmark, København, 1 March 2020 (*Kent Olsen*). Note that in outermost two greater primary coverts (gpc10 and gpc9; dashed outlines) there is dark mark only in gpc10 whereas gpc9 is unmarked. **451** Scopoli's Shearwater / Scopoli's Pijlstormvogel *Calonectris diomedea*, adult female (collected in Faeroes on 9 August 1877), Natural History Museum of Denmark, København, 1 March 2020 (*Kent Olsen*). Dashed lines outline the white tongues, from right to left, in p10, p9 and p8 (difficult to capture in photograph of museum specimen). Note that length of white basal tongue running up inner web of outer three primaries measured as percentage of visible under primary falls in categories p10=25%, p9=40%, p8=40% (see main text for explanation).

Oran Oceanographic Front, with a small isolated outpost on the French Atlantic coast of Gironde (Mays et al 2006, Robb et al 2008, Flood & Gutiérrez 2019). The global population estimate is 141 000-223 000 breeding pairs (Defos du Rau et al 2015). Breeding colonies of Cory's Shearwater are found on north-eastern Atlantic islands with a small colony in the western Mediterranean Sea west of the Almería-Oran Oceanographic Front (Gómez-Días et al 2006, Genovart et al 2013, Flood & Gutiérrez 2019, Flood & Fisher 2020). The global population is larger than that of Scopoli's with an estimated 252 000-253 000 pairs (Brooke 2004). Hybridisation between the two taxa in the Mediterranean is rare (Flood & Gutiérrez 2019).

The majority of Scopoli's Shearwaters depart from the Mediterranean from mid-October, pass through the Strait of Gibraltar into the Atlantic late October/early November in large numbers, then move rapidly south, and return through the Strait mainly in February into March (de Juana & García

2015). Birds undertake long-distance movements to the tropical and South Atlantic in the Angola and Canary Currents (Ristow et al 2000, González-Solís et al 2007, Ramos et al 2013). Cory's/Scopoli's Shearwaters frequent the eastern coast of South America mainly in May-November and some remain in the South Atlantic during the breeding season (Cardoso de Sousa et al 2005). Cory's/Scopoli's Shearwaters are occasional visitors to the south Caribbean Sea in September-October, including Colombia (Ruiz-Guerra & Cifuentes-Sarmiento 2010), Venezuela (Marín et al 2002) and Aruba (eg, Luksenburg & Sangster 2013). They are uncommon to fairly common in the Lesser Antilles in May-July (Howell 2012) and occasional in the Gulf of Mexico off Mexico (Brewer & Brewer 1997). Scopoli's likely occurs throughout the North American range of Cory's, although in much smaller numbers (Howell 2012). Both species are present off the eastern coast of the USA mainly in May-November, where roughly 5-10% in May/

June and 10-15% in August are Scopoli's (Howell 2012; based on rough scores of white tongues in the under primaries). However, Cory's occurs regularly off north-western Europe in June-October whereas Scopoli's is extremely rare here with just the three above mentioned records (mid-July to early August), meaning that Scopoli's from the eastern coast of the USA that subsequently continue to the Mediterranean Sea must follow a fairly direct or southern route.

### Origin of specimen and history of its identification

Andersen (1901) documented several collected specimens of Great Shearwater in the Faeroes between 1875 and 1891. These included the Scopoli's Shearwater shot on 9 August 1877 and sent to NHMD by sysselmann Hans Christopher Müller. Andersen (1901) remarks that the date on which the bird was shot was 9 August and not 4 August 1877, indicating that the record had previously been published with the wrong date, although we were unable to locate such a publication. Provenance of the Faeroese shearwater was accepted when identified as Great Shearwater and when re-identified as Scopoli's Shearwater. The fact that the bird was added to the collection at NHMD on 11 April 1878 simply as a Great Shearwater reinforces the credibility of the record. Furthermore, Andersen (1901) comments that the shearwater was 'a female with a brood patch, very skinny'. This strongly suggests that Müller received and skinned the bird. Müller was considered a most reliable source of information by ornithologists, both at the time and subsequently. Neither Andersen (1899, 1901) nor Salomonsen (1935) gave any reason to doubt the origin of the specimen or its general provenance. The location given as the Faeroes is rather imprecise but probably simply reflects that the bird was shot at sea. This raises the question about exactly where at sea and whether the record can be considered Faeroese. The SU only considers records from Denmark within the Danish exclusive economic zone (200 nautical miles zone). It could be argued that SU should apply similar guidelines for the Faeroes, considering only records from within the Faeroes' exclusive economic zone (200 nautical miles zone). In 1877, all fishing from the Faeroes was undertaken by small boats that remained close to the islands. We therefore consider it highly improbable that the Scopoli's Shearwater – and for that matter the said Great Shearwaters – were shot more than 200 nautical miles away from the islands.

### Acknowledgements

We are grateful to NHMD curator of birds, Peter A Holsner, and collection manager, Jan Bolding Kristensen, for allowing access to the skin and for taking a toepad sample for the DNA analysis. Thanks to the NHMD for permission to use photographs of the Faeroese Scopoli's Shearwater. We are grateful to Andreas Bruun Kristensen, Palle A F Rasmussen and Søren Sørensen for their assistance with the Danish literature.

### Samenvatting

SCOPOLI'S PIJLSTORMVOGEL VERZAMELD IN FAERÖER IN AUGUSTUS 1877 In het natuurhistorische museum van Denemarken in Kopenhagen (NHMD) bevindt zich een balg van een pijlstormvogel *Calonectris* die gelabeld is als Scopoli's Pijlstormvogel *C diomedea* en werd verzameld in Faeröer, Denemarken, op 9 augustus 1877. Het in dit artikel besproken onderzoek bevestigt deze determinatie. Het onderzoek omvatte DNA-analyse, biometrie en een aantal kleedkenmerken en ook de geschiedenis van dit exemplaar werd gereconstrueerd. Scopoli's is zeer zeldzaam in Noordwest-Europa met slechts drie gevallen (midden-juli tot begin augustus), inclusief de balg van Faeröer. Er zijn ook drie gevallen in Midden-Europa. Het exemplaar van Faeröer betreft het noordelijkste geval van Scopoli's voor Europa en mogelijk ook voor de Atlantische Oceaan.

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APPENDIX Procedure of DNA analysis

A toepad sample was taken from the specimen and DNA was isolated using a QIAGEN QIAamp DNA Micro Kit following the manufacturer's instructions, with the addition of 0.1 M dithiothreitol to the proteinase K digest. Two mitochondrial fragments, one from the cytochrome b gene and one from the highly variable control region, were amplified using bespoke primers (cf table 2) and PCR conditions described in Shannon et al (2014). PCR products were visualised on a 1.5% agarose gel and ex-

tracted using a QIAGEN QIAquick Gel Extraction Kit. Final products were sent to Source Bioscience (Nottingham, England) for Sanger sequencing. Sequencing reads were checked by eye for quality and possible contamination. Alignments were made in CLC Sequence Viewer 8 for both fragments separately (182 bp for control region, 234 bp for cytochrome b), utilising other publicly available shearwater sequences from GenBank.

TABLE 2 Primers used to amplify short diagnostic mitochondrial fragments from *Calonectris* shearwaters

primer name	sequence (5'-3')	mitochondrial locus
CDiBo-CR-F1	CCCTTAAGCCCAATAGTCCC	control region
CDiBo-CR-R1	CCCAGCTCGACAGCTACCGG	control region
CDiBo-F2	CTCAGCTATTCCTACATCG	cytochrome b
CDiBo-R2	CTTTAGGGTGAATAGGGG	cytochrome b