Significant proportion of the french coastal endemic Bluethroat (*Cyanecula svecica namnetum*) discovered in a Bluethroat population wintering in the Sidi Moussa-Walidia complex (Morocco)

Proportion significative de Gorgebleues à miroir endémiques des côtes françaises (Cyanecula svecica namnetum) découverte dans une population de Gorgebleues hivernant dans le complexe de Sidi Moussa-Walidia (Maroc)

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Abstract. In order to start to document the potential importance of north west african coastal marshes for the wintering of the French coastal endemic Bluethroat (*Cyanecula svecica namnetum*), we carried out a ringing campaign in the Sidi Moussa-Walidia complex, a 10,000 hectares Ramsar site, located in the Moroccan Atlantic coast, over ten days of winter 2015-2016. Analysis of capture data with a non-parametric bootstrap resampling method revealed within the wintering Bluethroat population sampled a minimal mean proportion estimated at 38% of individuals belonging to *Cyanecula svecica namnetum* subspecies (17 - 54% within the 95% CI). Thanks to data collected for the first time in North Africa over a limited spatial and temporal scale, despite a small data set, our results confirm: 1) the potential significant proportion of *C. s. namnetum* among Bluethroat populations wintering in North African coastal wetlands and 2) the particular attention that should be given to North African grounds for a better consideration of threats to populations belonging to this subspecies of conservation concern given its restricted range and numbers and its dependence on Atlantic coastal wetlands.

Keywords : Marshland passerines, North African coastal wetlands, ringing in Moroccan wetlands, wetland conservation.

Résumé. Afin de commencer à documenter l'importance potentielle des marais littoraux nord africains pour la Gorgebleue à miroir endémique des côtes françaises (*Cyanecula svecica namnetum*), nous avons conduit une campagne de baguage dans le complexe de Sidi Moussa-Walidia, site Ramsar localisé sur la côte atlantique marocaine, pendant dix jours de l'hiver 2015-2016. L'analyse des données de captures par une méthode de ré-échantillonnage non paramétrique a révélée au sein de la population échantillonnée une proportion moyenne minimale estimée à 38% d'individus appartenant à la sous espèce *Cyanecula svecica namnetum* (17 - 54% dans l'intervalle de confiance 95%). Grâce a des données collectées pour la première fois en Afrique du Nord sur une échelle spatiale et temporelle limitée, malgré un petit jeu de données, nos résultats confirment : 1) la proportion potentiellement significativement importante de *C. svecica namnetum* parmi les populations de Gorgebleues à miroir hivernant dans les zones humides côtières d'Afrique du Nord et 2) l'attention particulière qui devrait être portée aux zones nord africaines pour une meilleure prise en compte des menaces pesant sur les populations de cette sous-espèce au statut de conservation préoccupant compte-tenu de son aire de distribution, de ses effectifs limités et de sa grande dépendance à l'égard des zones humides littorales atlantiques.

Mots clés : Passereaux paludicoles, zones humides côtières nord africaines, baguage dans les zones humides marocaines, conservation des zones humides.

INTRODUCTION

The Bluethroat (*Cyanecula svecica*) is a Holarctic songbird species requiring special vigilance in Europe (Tucker & Heath 1994) particularly in the context of global changes that may affect habitats of particular populations or subspecies breeding in restricted geographical areas (Musseau *et al.* 2017). This passerine is a complex polytypic species with 11 currently acknowledged subspecies distributed in Europe, Asia and Alaska. Ten subspecies have been documented by Cramp (1988) to which must be added *C. s. azuricollis*, breeding in Central Spain, anciently considered as a simple variant of *C. s. cyanecula*, often denominated "*wolfi*" (Svensson 1992, Peiro 1997) but now well genetically defined (Johnsen *et al.* 2006, Arizaga & Alonso 2015). These different subspecies are partially distinguishable by body size and often by the color pattern of males' throats (Cramp 1988, Svensson 1992) or by genetic analyses (Johnsen *et al.* 2006). Seven subspecies breed in the Western Palearctic: nominate race, *C. s. svecica* (breeding from Scandinavia to Siberia), *C. s. cyanecula* (breeding from Eastern and Northern France and the Netherlands to Northwestern Ukraine), *C. s. namnetum* (breeding in the Western Atlantic French coast), *C. s. volgae* (breeding from Western Siberia and Northeastern Ukraine to East of the Volga), *C. s. pallidogularis* (breeding in the East of the Volga and Southwestern Siberian steppes), *C. s. magna* (breeding in Eastern Turkey, Caucasus and Iran) and *C. s. azuricollis* (breeding in mountains of Northwestern and Central Spain). Subspecies *C. s. cyanecula*, *C. s. svecica, C. s. namnetum* and *C. s. azuricollis* winter in Southern Europe and / or in West Africa (Cramp 1988, Zucca & Jiguet 2002, Arizaga *et al.* 2006, Arizaga & Alonso 2015) but the distribution and the relative abundance of these different subspecies in the African continent remains confused (Cramp 1988, Arizaga *et al.* 2015).

Cyanecula svecica namnetum is a french coastal endemic subspecies of conservation concern given its restricted range and numbers (only 8.000 to 12.000 pairs, Caupenne *et al.* 2015) and its dependency throughout all its life cycle on Atlantic coastal marshes (Arizaga *et al.* 2015, Musseau *et al.* 2017). The subspecies is known to winter in large number in

the Iberian Peninsula (more particularly in South-Western Portugal (Eybert *et al.* 1989, Eybert *et al.* 2004) and have also been identified in different North-African grounds inMorocco (Zucca & Jiguet 2002, Thevenot *et al.* 2003) but data documenting the wintering of this bird in the African continent remain relatively scarce and the rare existing data are distributed over large spatial and temporal scales. Recently, a study based on analysis of atmospheric stable isotopes carried out by Arizaga *et al.* (2015), Arizaga *et al.* (2016) suggested the potential high importance of North African Atlantic wetlands for the wintering of the subspecies. Nevertheless, up to now, in grounds of the African continent supporting wintering Bluethroats, no precise proportions of *C. S. namnetum* have been estimated. In order to start to characterize the potential importance of North African grounds for *C. s. namnetum*, during winter 2015-2016, we carried out over 10 days a ringing campaign in the Sidi Moussa-Walidia eco-complex (Southern Morocco) from 18th December 2015 to 4th January 2016.

MATERIAL AND METHODS

Ringing scheme

Ringing sessions were spread over 10 days (from 18th December 2015 to 4th January 2016) at Sidi Moussa-Walidia eco-complex (10.000 ha, 32°54'N 008°49'W), a Ramsar site and a permanent hunting reserve located on the Atlantic coast in the Southern part of the El Jadida province (El Hamoumi *et al.* 2011). During each sampling day, ringing sessions were conducted for an average of four hours, between 07:30 AM and 11:30 AM (local time). Captures were performed using mist nets installed in the low vegetation of salt marshes, swamps or salines mostly dominated by bushes of the genus *Sarcocornia* (Fig. 1 & Fig.2).

Figure 1. Example of suitable habitat for Bluethroat (*Cyanecula svecica*) sampled in the South of the Walidia lagoon (Morocco) during winter 2015-2016.

Given the low height of the vegetation on the whole site and the important detection risk of nets by birds, ringing sessions were conducted using ultrathin (monofilaments) low height mist nets manufactured by the company Ecotone. To optimize the number of captures at each sampled locations, between two or three mist nets (depending on the installation opportunities) were installed for an average of 20 minutes, allowing us to sample around three locations each morning (i.e. about thirty locations sampled during the ringing campaign, a relatively low number due to the time needed for identification of suitable sites for mist netting sessions, travels between sites…).

Figure 2. Example of suitable habitat for Bluethroat (*Cyanecula svecica*) sampled in the North of the Walidia lagoon (Morocco) during winter 2015-2016.

After capture, birds were identified (species, age and sex) according to the criteria detailed by Svensson (1992), ringed and measured. Wing lengths were measured using the flattened straightened method (Svensson 1992) with a stopped ruler to the nearest 0.5 mm and birds were weighed with an electronic scale to the nearest 0.1 g. Tarsus, bill and tail lengths were also measured, using a flat ruler or a caliper.

Subspecies identification

Given a relatively low number of captures (24 birds), the principal component approach proposed by Neto & Correia (2012) to discriminate the different possible subspecies sampled was not suitable. To identify subspecies sampled, we thus focused on plumage and biometrical characteristics defined by Cramp (1988) and Svensson (1992). Plumage features allowed us to identified only two subspecies in the sampled population: *C. s. cyanecula* and *C. s. namnetum*. We used extremes values of wing length documented in the literature to determine *C. s. namnetum* and *C. s. cyanecula*. We thus considered the *cyanecula* wing length (WL) inferior limits outlined by Cramp (1988) to identify *namnetum* and the *namnetum* WL superior limits outlined by Neto & Correia (2012) to identify *cyanecula*. Yearling birds were thus classified as *cyanecula* if WL > 72 mm for males or if WL > 70 mm for females, and as *namnetum* if WL < 71 mm for males or < 69 mm for females. Birds whose age was not determined were classified as *cyanecula* if WL > 73 mm for males and if WL > 71 mm for females (superior limit outlined for adults *namnetum*) and as *namnetum* if WL < 71 mm for males and if WL < 69 mm for females (inferior limit for yearlings *cyanecula*). For individuals with measurements situated within the overlap area of this groups, tarsus, tail and bill lengths were unusable to determinate the origin of birds given the huge overlap area of these measurements for the two subspecies. Given possible similar biometric and plumage characteristics in winter for *C. s. cyanecula* and *C. s. azuricollis* (Arizaga *et al.* 2016) the presence of *C. s. azuricollis* within captures cannot be ruled out, but possible captures of this subspecies did not interfere in the estimation of the proportion of *C. s. namnetum* we aimed to evaluate within the Bluethroat population sampled.

Statistical analysis

Given the relative small number of data collected, to obtain robust statistical standard errors (SE) and robust confidence intervals (CI) for proportions of the subspecies sampled, we analyzed the number of birds belonging to the different subspecies using inferential statistic methods. SE and CI for proportions of the different subspecies were thus calculated using non-parametric bootstrap resampling method (BRM), consisting of 1.500 random samples taken with replacement from the original dataset of the same size as the original (details about the method in Efron 1979 and in Efron & Tibshirani 1993). Analysis was performed using the *R* software environment (version 3.2.3, *R* Development Core Team 2013) and statistical parameters have been calculated using the "boot" *R* package (Canty & Ripley 2015, based on methods described by Davison & Hinkley 1997). For CI, we used the Bias Corrected and accelerated bootstrap method (BCa, detailed by Efron 1987 and by Preacher & Selig 2012).

RESULTS

Mist-netting ringing sessions allowed the captures of 24 birds, which represents about 0.8 bird / sampled location. The sex ratio of the captures is clearly unbalanced: 19 males (12 yearlings and 7 age-undetermined) and 5 females (3 yearlings and 2 age-undetermined). Wing length analysis reveal the following subspecies ratios: 8 birds identified as belonging to the *cyanecula* subspecies, i.e. 33.67 ± 9.58% (12.50% - 48.92% within the 95% CI estimated with BRM); 9 birds identified as belonging to the *namnetum* subspecies, i.e. 37.77 ± 9.91% (16.67% - 54.17% within the 95% CI estimated with BRM, see wing length values in tab. 1) and 7 birds, i.e. 29.46 ± 9.16% (8.33% - 41.67% within the 95% CI estimated with BRM) for which the subspecies remained undeterminable given the overlap of measures between the two subspecies indentified.

Tableau 1: Wing length distribution of *Cyanecula svecica namnetum* identified in a Bluethroat population wintering in the Sidi Moussa-Walidia complex (Morocco) during winter 2015-2016.

Sexe	Age	Wing lenght	Number of individuals
Males	Yearling	67	1
	Undetermined	68	1
	Yearling	70	1
	Undetermined	70	4
Femelles	Yearling	65	1
	Undetermined	68.5	1

CONCLUSION

Despite a small data set, our results confirm the potentially significant proportion of *C. s. namnetum* among Bluethroat populations wintering within West African Atlantic wetlands and the potential key role of these grounds for the wintering of these taxa as suspected by Arizaga et al. (2015) and Arizaga *et al.* (2016). Bias in the proportion we assessed may be possible, particularly given the use of playback and possible attractiveness that may differ between the two subspecies sampled. Nevertheless, the mean proportion of the *namnetum* subspecies we estimated (38%, 17 - 54% within the 95% CI) accords with the proportion estimated by Zucca & Jiguet 2002 who, thanks to the analyze of French ringing data collected on multiple Moroccan sites and during several wintering seasons found 7 birds for 21 (i.e. 33%) certainly belonging to the *namnetum* subspecies. These different works clearly question the classic view of the almost exclusive importance of coastal Atlantic Iberian wetlands for the wintering of populations belonging to *C. s. namnetum* (Eybert *et al.* 1989, Eybert *et al.* 2004, Arizaga & Tamayo 2013). Our study, the first to our knowledge allowing to document the ratio of *C. s. namnetum* for a Bluethroat wintering population of a North African area, sampled on a single site and during a single wintering season, highlights that future similar research developed in North Africa may be useful for a better understanding of threats to this subspecies of conservation concern given its restricted range and numbers and its high dependency on coastal wetlands.

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REFERENCES

Arizaga J. & Alonso D. 2015. Phenological parameters of a Bluethroat *Luscinia svecica azuricollis* population breeding at high altitude in spain. *Ardeola*, 62, 173-178.

Arizaga J., Alonso D., Cortés J.A. & Eggenhuizen T. 2015. Migratory connectivity in european bird populations: feather stable isotope values correlate with biometrics of breeding and wintering Bluethroats *Luscinia svecica*. *Ardeola*, 62, 255-267.

Arizaga J., Campos F. & Alonso D. 2006. Variations in wing morphology among subspecies might reflect different migration distances in bluethroat. *Ornis Fennica*, 83, 162-169.

Arizaga J. & Tamayo I. 2013. Connectivity patterns and key non-breeding areas of whitethroated bluethroat (*Luscinia svecica*) European populations. *Animal Biodiversity and Conservation*, 36, 69-78.

Arizaga J., Van Wilgenburg S.L., Alonso *et al.* 2016. Breeding origins and pattern of migration of Bluethroats *Luscinia svecica* wintering from Iberia to Senegal as revealed by stable isotopes. *Bird Study*, 63,196-202.

Caupenne M., Jiguet F. & Nidal I. 2015. Gorgebleue à miroir *Luscina svecica*. *In* Issa N. & Muller Y. (eds). *Atlas des oiseaux de France métropolitaine, nidification et présence hivernale*, pp 942-945. LPO/SEOF/MNHN, 2, Paris: Delachaux & Niestlé.

Canty A. & Ripley B. 2015. *Boot: Bootstrap R (S-Plus) Functions*. R package version 1.

Cramp S. 1988. *The Birds of the Western Palearctic*, 5. Oxford University Press, Oxford, 1084 p.

Davison A.C. & Hinkley D.V. 1997. *Bootstrap Methods and Their Applications*. Cambridge University Press, Cambridge, 582 p.

Efron B. 1979. Bootstrap methods: another look at the jackknife. *Annals of Statistics* 7, 1-26.

Efron B. 1987. Better bootstrap confidence intervals. *Journal of the American Statistical Association*, 82, 171-185.

Efron B. & Tibshirani R.J. 1993. An introduction to the bootstrap. *In Monographs on Statistics and Applied Probability*. N° 57. Chapman and Hall, London, 436 p.

El Hamoumi R., Dakki M., Rguibi Idrissi H. & Radi M. 2011. Sites Ramsar du Maroc : Complexe de Sidi Moussa-Walidia. *In* Dakki M., Aziz El Agbani M. & Qninba A. (eds). *Zones humides du Maroc inscrites jusqu'en 2005 sur la liste de la Convention de Ramsar*, Série Générale 7, 103-114. Institut Scientifique de Rabat.

Eybert M.C., Bonnet P., Geslin T. & Questiau S. 2004. *La Gorgebleue*. Collection Approche, 32. Belin Eveil Nature, Paris, 71 p.

Eybert M.C., Constant P. & Allano L. 1989. Premières données sur le territorialisme hivernal observé chez la Gorgebleue (*Luscinia svecica* L.). *Comptes rendus de l'Académie des Sciences série III sciences de la vie*, 309, 243-249.

Johnsen A., Andersson S., Fernandez J.G. *et al.* 2006. Molecular and phenotypic divergence in the Bluethroat (*Luscinia svecica*) subspecies complex. *Molecular Ecology*, 15, 4033-4047.

Musseau R., Beslic S. & Kerbiriou C. 2017. Importance of intertidal wetlands for the French coastal endemic Bluethroat (*Cyanecula svecica namnetum*) and conservation implications in the context of global changes. *Ardeola*, 64, 325-345.

Neto J.M. & Correia E. 2012. Biometrics and subspecific identification of white-spoted bluethroats *Luscinia svecica cyanecula* and *L. s. namnetum* during autumn. *Ardeola*, 59, 309-315.

Peiró I.G. 1997. A study of migrant and wintering Bluethroats *Luscinia svecica* in south-eastern Spain. *Ringing and Migration*, 18, 18-24.

Preacher K.J. & Selig J.P. 2012. Advantages of Monte Carlo confidence intervals for indirect effects. *Communication Methods and Measures*, 6, 77-98.

R Development Core Team 2013. *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing.

Svensson L. 1992. *Identification guide to European Passerines (4th ed.)*., 368 p.

Thévenot M., Vernon R. & Bergier P. 2003. *The Birds of Morocco*. British Ornithologists' Union, Peterborough, 594 p.

Tucker G.M. & Heath M.F. 1994. *Birds in Europe: Population Estimates, Trends and Conservation Status*. BirdLife International, Cambridge, 600 p.

Zucca M. & Jiguet F. 2002. La Gorgebleue à miroir (*Luscina svecica*) en France: nidification, migration et hivernage. *Ornithos*, 9, 242-252.

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