

Proposal to AviList for requesting taxonomic changes within the Spotted flycatcher complex

Manuel Schweizer, 24.2.2026

Below, you can find the original pre-proposal prepared and submitted by the foremost specialists of the complex.

Six members of the Palearctic RAG have voted on this case and unanimously support the proposed split of *Muscicapa tyrrenica* Schiebel 1910 as a polytypic species with subspecies *M. t. tyrrenica* and *M. t. balearica* Jordan 1913 from *Muscicapa striata* (Pallas, 1764).

The case is well documented, and the split supported by integrating multiple lines of evidence from different data sources – genomics, vocalisation, morphometrics, plumage features.

The members of the Pal RAG stress the following:

- robust genomic data supports the differentiation of *balearica* and *tyrrenica*. Importantly, *tyrrenica*, breeds in peninsular Italy, without strict allopatry from *striata*, but genomic data suggest no admixture – which is interpreted as compelling evidence for differentiation at species level. There is admixture in Malta, however it is restricted in extent and amount.
- The taxonomic treatment of the complex should be set in relation to AviList's handling of other endemic taxa in the Mediterranean region. E.g. *Carduelis Corsicana* and *Curruca subalpina* are treated as different species. Moreover, *Curruca sarda* (Corsica, Sardinia, Montecristo, Pantelleria, Giannutri, and Zembraand) is split from *Curruca balearica* (Balearic Islands, except Menorca). None of these treatments, but chiefly the latter two, is supported by a similar amount of data from various sources.
- The only reservation is that some of the Pal RAG member do not consider convincing or even confusing that different migration routes should support the split. However, given all the other evidence presented supporting the split, this can be disregarded, and even if taken into account, it would not argue against a split.

Two papers dealing with morphological differentiation are added to the bottom of the proposal (Viganò and Corso 2015)

Apart from the nominate form (Europe to northern Africa, Türkiye, and Siberia; winters to southern Africa), AviList currently accepts the following additional ssp:

Muscicapa striata neumanni Poche, 1904 (eastern Siberia to Caucasus, southern China, and southern Asia; winters to eastern Africa)

Muscicapa striata sarudnyi Snigirevski, 1928 (Caucasus Mountains to northern Iran and Afghanistan; winters to East Africa)

Muscicapa striata inexpectata Dementiev, 1932 (Crimea; non-breeding Africa.)

Muscicapa striata mongola Portenko, 1955 (southeastern Altai to northern Mongolia to southeastern Transbaikalia)

It was noted that, ideally, all taxa within the entire complex ought to be considered. As presented in the proposal, genomic data from the continental Eurasian and northern African populations was included with samples from Spain, Tunisia, France, Switzerland, Italy, Lithuania, Serbia, Russia. There was a split into an Ibero-Maghreb clade and another consisting of the remaining Eurasian samples. Hence, the eastern subspecies were not comprehensively sampled, although on sample from southwestern Russia seem to originate from the range or from close to the range of *M. s. neumanni*. In addition, there seem to be no differentiation in mtDNA between nominate, *M. s. neumanni* and *M. s. saurdnyi* (Pons et al. 2016).

From a morphological point of view, Shirihai & Svensson (2018) thoroughly revised the complex and proposed to synonymise '*inexpectata*' with the nominate form as well as '*saurdnyi*' and '*mongola*' with *M. s. neumanni* – the relevant part is added at the end of this proposal.

There is no indication that further cryptic diversity close to species level separation might be prevalent among continental Eurasian and North African population. Hence, given that Shirihai & Svensson (2018) provide the most compelling recent work on infraspecific taxonomy of Palearctic passerines, AviList best follows their proposal by treating *M. striata* as consisting of two subspecies, nominate *M. s. striata* and *M. s. neumanni*, pending further studies on genomic structure of Spotted Flycatcher across Eurasia.

Pons J -M., Thibault J -C., Aymí R, et al (2016) The role of western Mediterranean islands in the evolutionary diversification of the spotted flycatcher *Muscicapa striata*, a long-distance migratory passerine species. *J Avian Biol* 47:386–398. <https://doi.org/10.1111/jav.00859>

Shirihai H, Svensson L (2018) *Handbook of Western Palearctic Birds*. A. & C. Black, London

Viganò M, Corso A (2015) Morphological differences between two subspecies of spotted flycatcher *Muscicapa striata* (Pallas, 1764)(Passeriformes Muscicapidae). *Biodivers J* 6:271–284

Viganò M, Corso A, Illa, M & Starnini L (2019) Identification of Mediterranean Flycatcher. *Dutch Birding*, 41: 295-317

Proposal to AviList for requesting taxonomic changes within the Spotted flycatcher complex

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Purpose of the proposal

Insular Spotted flycatchers of the western Mediterranean are currently assigned to two subspecies in the latest AviList; *Muscicapa striata tyrrhenica* and *M. s. balearica*. The aim of this proposal is to bring support to an alternative taxonomic solution by assigning a species rank to insular populations that, in our view, better fit phenotypic and genetic variability and reproductive isolation existing between mainland and insular populations of this species complex.

Current taxonomy in AviList

Muscicapa striata is a polytypic species that comprises five continental subspecies (*striata*, *neumanni*, *mongola*, *inexpectata*, *sarudnyi*) and two insular subspecies whose distribution is mainly restricted to Corsica, Sardinia (*tyrrhenica*) and the Balearics islands (*balearica*). Contrary to the IOC list in which species level is warranted for these insular taxa (*M. tyrrhenica*), as suggested by Pons et al. (2016) and Viganò et al. (2019), and in line with other major avian species list, the check AviList 2025 assigns subspecies status to insular Mediterranean spotted flycatchers (*M. s. tyrrhenica* and *M. s. balearica*).

Geographic distribution of subspecies and mitochondrial genetic lineages

The spotted flycatcher (*Muscicapa striata*) is a trans-Saharan migrant whose breeding distribution encompasses a very large area extended from the British Isles to Mongolia eastward and from northern Scandinavia to North Africa southward (Figure 1). Mainland subspecies were described on the basis of slight differences in plumage (Vaurie 1959, Taylor 2020). Pons et al. (2016) shown that two of them distributed over a very wide geographical distribution, *striata* and *neumanni*, are not genetically differentiated and thus belong to the same genetic lineage. In addition, two subspecies have been described in western Mediterranean islands that distinctively differ in plumage from each other and from their mainland counterparts (Taylor 2020, Viganò and Corso 2015, Viganò et al. 2019). *Muscicapa s. tyrrhenica* breeds in Corsica, Sardinia and the Tuscan archipelago and along a narrow band of the Tyrrhenian coast (Italy) (Baudrin 2024, Pons et al. 2016,). We recently discovered that this subspecies is also present on Malta (Baudrin 2024) where a very small number of individuals reproduce, and in the western part of Sicily (Corso et al. 2020b). *Muscicapa s. balearica* has the smallest geographic distribution restricted to the Balearic Islands (Mallorca, Minorca, Ibiza, and Formentera). **Four differentiated mitochondrial lineages** are distributed in the western range of the spotted flycatcher (Figure 2); two insular lineages corresponding to *M. s. tyrrhenica* and *M. s. balearica* and two *M. s. striata* continental lineages including on the one hand Eurasian populations and on the other hand Iberian-North African populations.

Figure 1: Geographical Distribution of the spotted flycatcher. (Modified from Taylor 2020). The Spotted flycatcher complex has a very unusual **nested peripatric distribution**, in particular for birds having such high dispersal abilities. The range of the insular taxa (*tyrrhenica*, *balearica*) is several orders of magnitude smaller than the one of the continental taxon that surrounds it. All populations overwinter in sub-Saharan Africa.

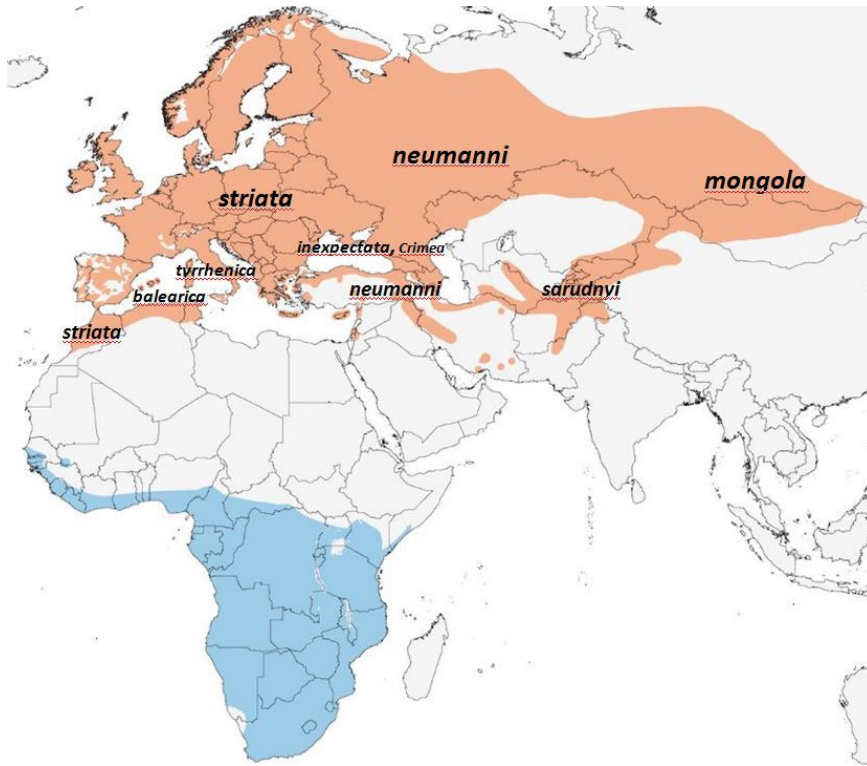
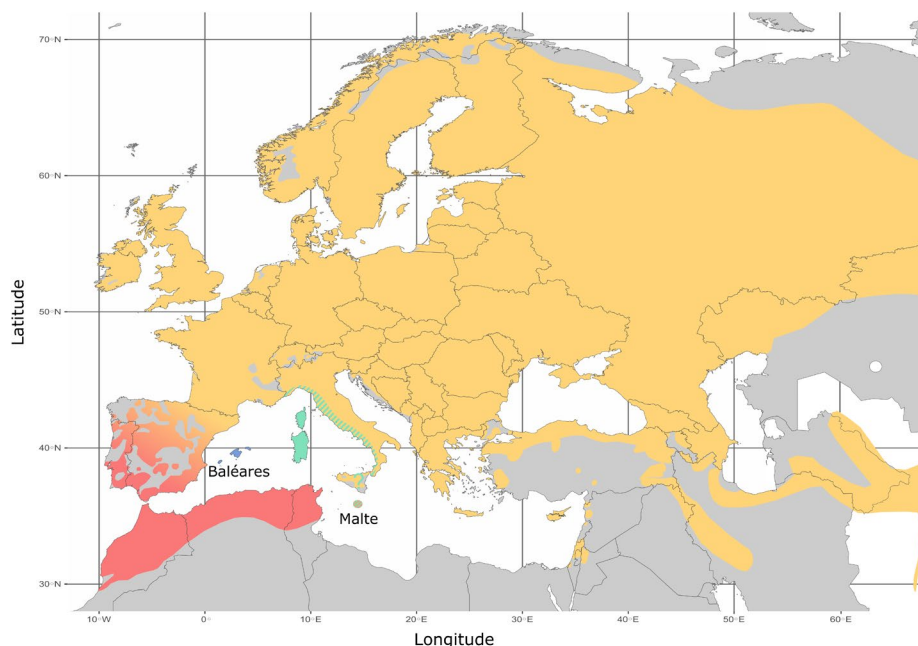


Figure 2: Distribution of the four mitochondrial lineages of *Muscicapa striata*. *M. s. striata* comprises two divergent genetic lineages; one African-Iberian lineage (red) and one Eurasian lineage (yellow) that form a second contact zone in northern Spain; *M. s. tyrrhenica* (green) and *M. s. balearica* (blue) are insular taxa genetically well differentiated from their mainland counterparts and to a lesser extent from each other (see below). (Modified from Baudrin 2024).



Morphological aspects

There are **diagnostic differences** in several morphological characters that distinguish insular spotted flycatchers from their mainland counterparts.

Wing shape and wing length

Wing chord is **significantly longer** in *striata* than in *tyrrhenica* and *balearica* ($p < 0.0001$, see Viganò and Corso 2015, Corso et al. 2020a). Both insular taxa also possess **more rounded** wings than *striata* (Table 1, Figure 3). Gargallo (1993) using large samples ($n > 130$) also demonstrated that *balearica* possesses significantly shorter and more rounded wings than *striata*.

Table 1: Differences in wing chord length and wing shape between insular (tyrrhenica, balearica) and mainland spotted flycatchers (striata) (mean and range in mm, followed by number of specimens). Values for p2-5 indicate distance (in mm) between second and fifth primary (numbered from outside); positive values indicate that p2 is longer than p5, negative values the opposite. Same for third and fourth primary (p3-4), where p3 is almost always wing-tip in striata, while in tyrrhenica and balearica p3 is very often bunched with p4.

	<i>striata</i>	<i>tyrrhenica</i>	<i>balearica</i>
wing chord	85.84 (83-90; 44)	81.59 (79-84; 17)	78.82 (76-82; 17)
p2-5	2.57 (0/5; 44)	-0.59 (-2/1; 14)	-1.94 (-4/0; 17)
p3-4	1.25 (0/3; 44)	0.06 (-1/1; 17)	-0.18 (-1/0; 17)

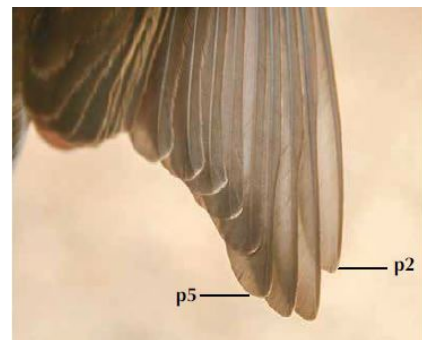
Both insular taxa possess shorter and more rounded wings than *striata*. Modified from Viganò et al. (2019).

Figure 3: Differences in wing shape between striata (mainland) and insular forms (tyrrhenica, balearica).

Insular spotted flycatchers



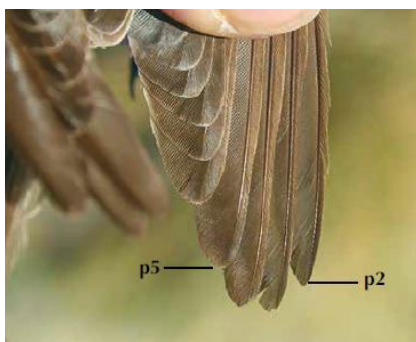
M. s. tyrrhenica



M. s. balearica

Wing formula in *balearica* is similar to that in Tyrrhenian Flycatcher *tyrrhenica*, or sometimes with even shorter p2.

Mainland spotted flycatchers



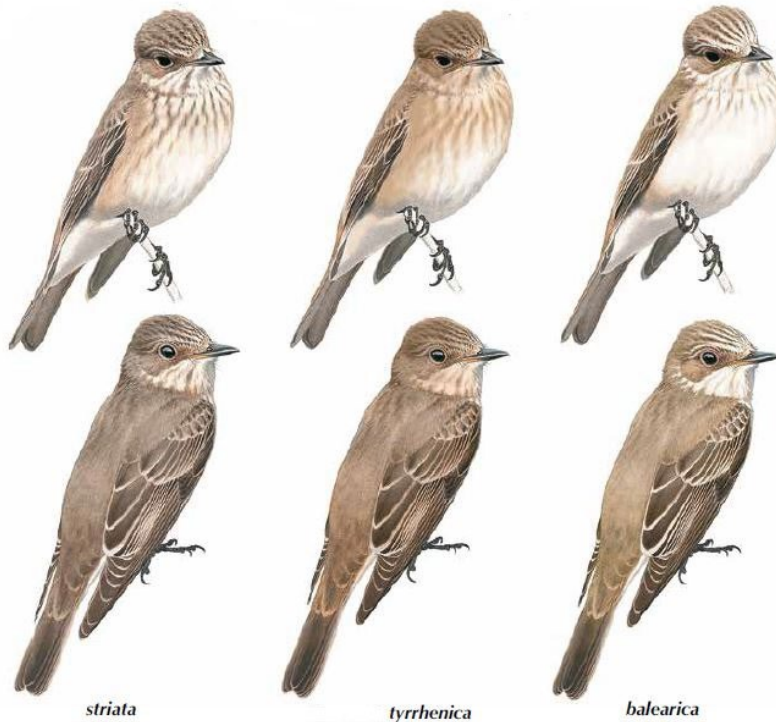
M. s. striata

In *striata*, p2 is (almost) always longer than p5 (see Viganò et al. 2019 for details). Therefore, the wings are more pointed compared to those of insular flycatchers.

Plumage

Slight but diagnostic plumage differences allow the identification of insular birds with respect to mainland ones in hand and most often at distance in the field when conditions of observation are good. Insular *tyrrhenica* and *balearica* are also recognizable thanks to fixed differences in plumage colour and pattern (Figure 4 and Table 2).

Figure 4: Plumage variations between continental (*striata*) and island forms (*tyrrhenica* and *balearica*) of the Spotted Flycatcher (from Viganò et al. 2019)



Tyrrhenica shows rusty tones to plumage, weak contrast between upperparts and underparts, weak head streaking, diffuse streaking on underparts, creamy tinge to throat and lack of clear demarcation between ear-coverts and throat. *Balearica* harbours paler tones to plumage (more creamy/beige) than *striata* and *tyrrhenica*, clear contrast between upperparts and underparts, very pale underparts with almost immaculate flanks, very pale (whitish) base to head feathers making the head streaking even more evident than in *striata*, few, pale and thin streaking on throat and breast, rusty ear-coverts appear as mask due to contrast with pale crown, throat and some white neck feathers and immaculate white underwing coverts.

Table 2: Main plumage differences between continental (*striata*) and island forms (*tyrrhenica* and *balearica*) of the Spotted Flycatcher

	<i>striata</i>	<i>tyrrhenica</i>	<i>balearica</i>
Upperparts	cold brownish grey	warmer brown	pale ochre grey-brown
Breast streakings	strong	diffuse	barely visible
Contrast wings and tail/back	none	light	light
Ground colour of crown and forehead	brownish	grey pale brownish	grey whitish
Crown streakings	strong	faded	very obvious
Underparts	clearly tinged with ochre	creamy ochre	white, barely ochre
Primary projection	long	shortish	shortish

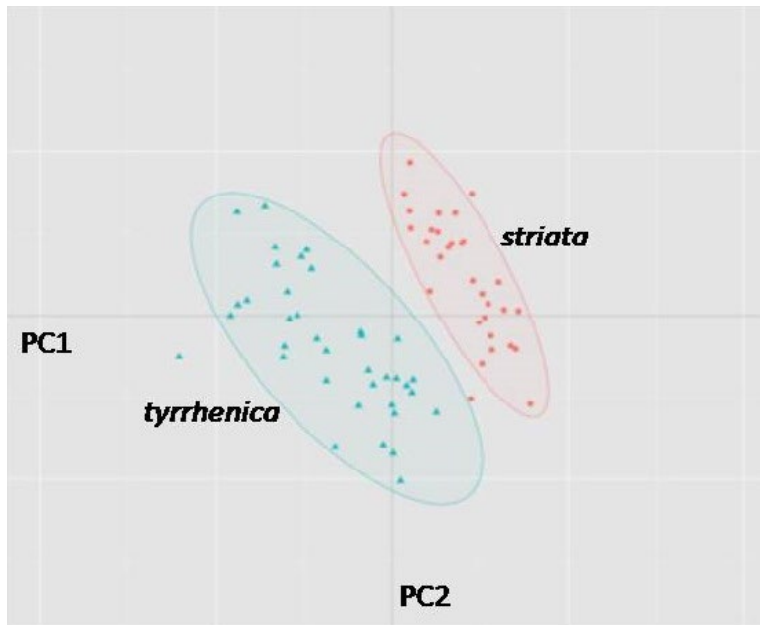
From Oliso et al. (2019)

Vocalisations

Several studies highlighted **significant acoustic differences** between *striata*, *tyrrhenica* and *balearica* (Comolet-Tirman 2017, 2018, 2020, Viganò 2015, Viganò et al. 2019, Wroza 2019). Mainland and insular birds can be told apart by their songs, both in the field and through analysis of spectrograms. Using a multivariate analysis, Viganò (2015) showed that vocalizations of *striata* and *tyrrhenica* do not overlap (Figure 5). Although, the overall structure of the song of *tyrrhenica* resembles to that of

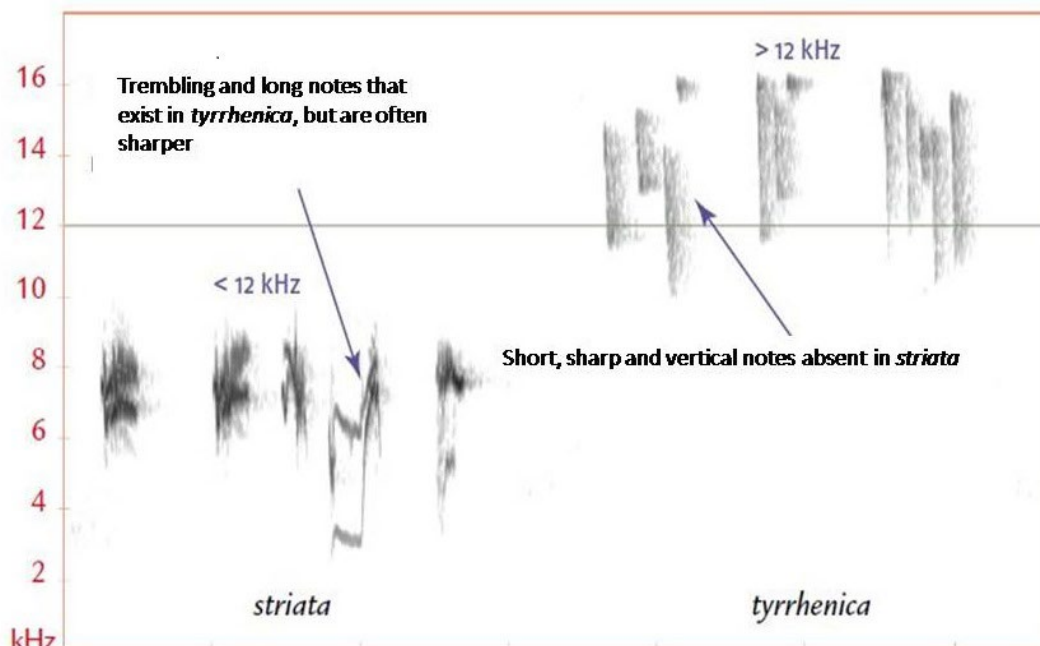
striata, *tyrrhenica* emits some notes of extremely high frequency never produced by *striata* (Figure 6). Both *tyrrhenica* and *balearica* always include notes of very high frequencies in their repertoires, unique among European passerines. These ‘electric’ notes can reach 17-19 kHz in *tyrrhenica* (Comolet-Tirman 2017, 2020, Viganò 2015, Viganò et al. 2019, Wroza 2019). The general structure of sounds emitted by *balearica* is extremely similar to that of *tyrrhenica*, including the diagnostic high-pitched elements that give it its distinctive electric tone. The maximum frequency reached by *balearica* is nevertheless not quite as high as in *tyrrhenica*, generally remaining below 15 kHz (Comolet-Tirman 2018, 2020, Viganò 2015, Viganò et al. 2019).

Figure 5: Principal Coordinate Analysis based on 13 acoustic variables



The first principal coordinate identified (PC01) explains 44.95% of the total variance in the data, the second (PC02) 24.58%. *Tyrrhenica* individuals were from Sardinia, Corsica and one bird from Tuscany; *striata* individuals were from Italy (including the swiss Canton of Ticino, which shares biogeographical characteristics with northern Italy). The ellipses drawn around the population groups show the area within which 95% of any new individuals analyzed will fall. There is **no overlapping between both ellipses**. The results of the principal coordinate analysis based on geographical populations (not shown) are consistent with those of the taxa analysis: both taxa are always clearly separated, while within each of them no particular differences are observed between the different geographical populations under examination. From Viganò (2015).

Figure 6: Sonogram comparing songs of *striata* and *tyrrhenica*



Whereas both taxa are producing long notes around 7 kHz, the rapid succession of vertical notes reaching extreme high frequencies (> 12 kHz and up to 18 kHz) are typical of *tyrrhenica*. Compared with those of Goldcrest and Chiffchaff, the song of *tyrrhenica* is much sharper. *Tyrrhenica* emits high frequencies (up to 20 kHz, (Comolet-Tirman 2020, Viganò 2015, Viganò et al. 2019) not fully perceptible by a human ear, or even inaudible by ornithologists aged over 60 years. To date frequencies up to 20 kHz common in bats are unknown in other passerines species. Modified from Wroza (2019).

Genetics and genomics

Mitochondrial genetic structure and divergence

The Spotted flycatcher complex comprises two main mitochondrial lineages, one insular and one continental, which are further divided into four monophyletic subgroups. **Significant mitochondrial COI genetic distance** exists between insular and mainland lineages (**3.4 – 4.2%**) (Pons et al. 2016) which is of the same order of magnitude as interspecific genetic distances found among other passerines sister species (e.g. Pied and collared flycatchers ($D \sim 3\%$; Sætre et al. 2001); American and Siberian Pipits ($D = 2.2\%$; Doniol-Valcroze et al. 2023). The mainland lineage and the insular lineages diverged around 1.2 million year ago (Figure 7). The moderate genetic distance (1.7%) between *balearica* and *tyrrhenica* together with the absence of mitochondrial haplotypes sharing suggest that these two allopatric insular taxa have probably evolved independently without any significant gene flow since a long time (corroborated by genomics, see below).

The mitochondrial variation pattern within the spotted flycatcher complex is supported by nuclear genomics results (Figure 8). **The genomic variation is clearly partitioned among the insular and mainland taxa** along the PC1 axis. Consequently, insular spotted flycatchers not only significantly differ in mitochondrial DNA but also in nuclear DNA at the genome level. These results support that insular spotted flycatchers have been on their own evolutionary trajectories since a long time. In addition, genomes of both insular taxa separated along the PC2 axis are clearly different from each other (Figure 8). By contrast, the genomes of the Eurasian and Ibero-North African populations of *striata* are only slightly differentiated (Figure 8, Baudrin 2024).

Highest values of F_{st} (a measure of genomic differentiation) were found between *striata* and *tyrrhenica*, *balearica* (Table 3). The lowest value was found between Eurasian and Ibero-North African populations of *striata*. Z chromosome F_{st} values are much higher values in line with numerous studies showing that sexual chromosomes are more differentiated than autosomal and probably play a major role in the speciation process (Baudrin 2024).

Figure 7: Nearly complete mitochondrial genome (14,900 bp) phylogenetic tree depicting relationships among 67 spotted flycatchers. Divergences dates were estimated using three mitochondrial loci (ND2, Cytochrome b, COI, see Pons et al. 2016 for details). Genetic distance between insular and mainland lineages based on the complete mitochondrial genome is around 3% (Modified from Baudrin, 2024).

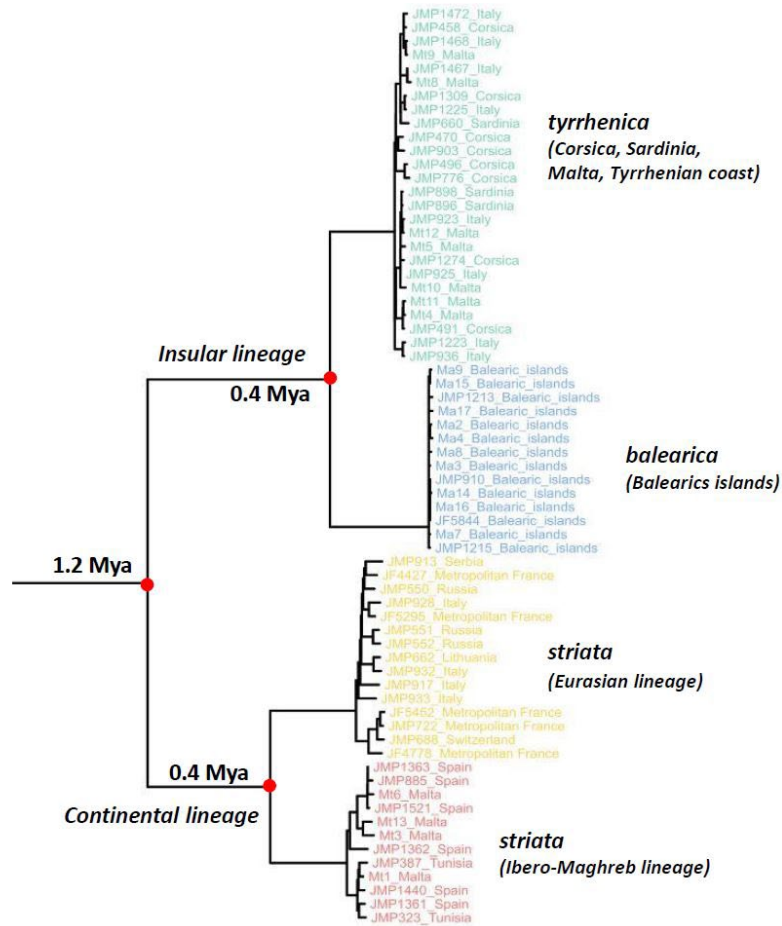


Figure 8: Principal component analysis ran on 5,678,253 genomic SNPs. The 68 resequenced samples are positioned on the principal components 1 and 2 which explain 18% and 8.2% of the genomic variance in the dataset. The individuals are colored according to their mitochondrial lineage assigned.

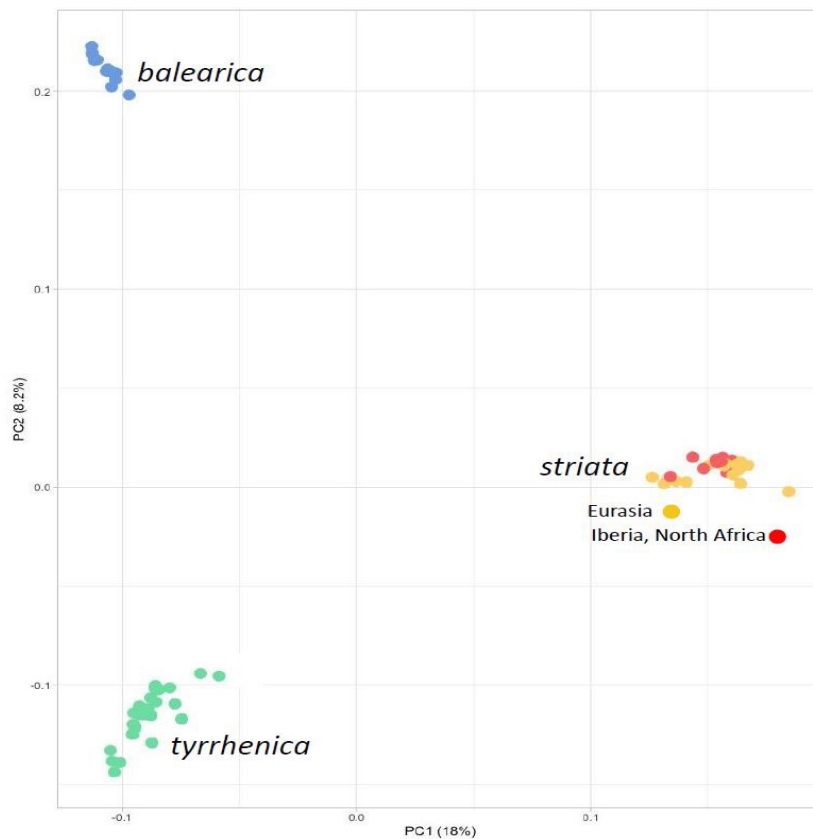


Table 3: Mean Weir and Cockerham F_{ST} computed for the autosomes (upper table, more than 5 million SNPs) and Z chromosome (lower table, 600 000 SNPs) between all pairs of mitochondrial lineages.

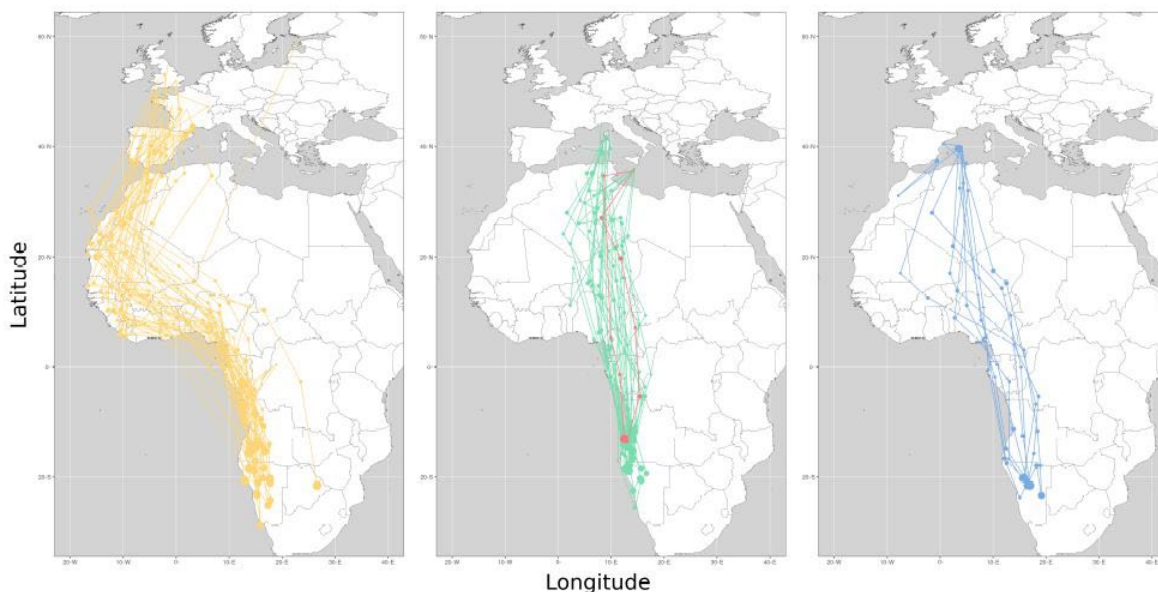
Mean autosomal F_{ST}	<i>M. striata</i> WEC lineage	<i>M. striata</i> INWA lineage	<i>M. tyrrhenica tyrrhenica</i>	<i>M. tyrrhenica balearica</i>
<i>M. striata</i> WEC lineage				
<i>M. striata</i> INWA lineage	0.016			
<i>M. tyrrhenica tyrrhenica</i>	0.087	0.107		
<i>M. tyrrhenica balearica</i>	0.100	0.128	0.098	

Mean Z chrom F_{ST}	<i>M. striata</i> WEC lineage	<i>M. striata</i> INWA lineage	<i>M. tyrrhenica tyrrhenica</i>	<i>M. tyrrhenica balearica</i>
<i>M. striata</i> WEC lineage				
<i>M. striata</i> INWA lineage	0.073			
<i>M. tyrrhenica tyrrhenica</i>	0.282	0.290		
<i>M. tyrrhenica balearica</i>	0.349	0.360	0.218	

Migration

Using light-level data of 46 birds equipped with geolocators, Baudrin (2024) showed that most mainland and insular spotted flycatchers overwintered in Angola and Namibia. However, while mainland populations from France and Great-Britain cross the Mediterranean Sea close to the Gibraltar Strait and follow the Atlantic coast of Western Africa, the two insular taxa follow shorter and more direct routes consisting in crossing the Sahara in its center. Hence, migration distances of mainland birds were on average 9,240 km while for *tyrrhenica* and *balearica* they were 6,780 and 7,720 km respectively. Insular birds which possess shorter and more rounded wings have also a shorter migration distance to complete. This correlation between wing shape and migration distance has often been noted in several bird species (Seebohm's rule, see e.g. Forschler and Bairlein 2011).

Figure 9: Differences in migratory routes between mainland and insular taxa established from GLS data



Mainland *striata* birds from France and Great Britain and Mediterranean insular birds (*tyrrhenica*, *balearica*) use the same wintering regions (Angola and Namibia) but **do not use the same migration flyways** to reach

them. Insular birds leave their breeding grounds significantly later than continental birds and use a more direct route across the Sahara. Yellow = *striata*, green = *tyrrhenica*, blue = *balearica* (Baudrin 2024).

Reproductive isolation

Thousands of mainland spotted flycatchers (*striata*) are temporarily sympatric to local insular spotted flycatchers when they stop-over in Corsica, Sardinia and the Balearics islands during their spring migration. Despite this close geographic proximity, we failed to detect any introgression of mainland genes into the populations of these western Mediterranean islands on which nearly all insular *tyrrhenica* and *balearica* breeders are concentrated (Pons et al. 2016, Baudrin 2024). We have genotyped (COI) 110 breeders in Corsica, Sardinia and 80 breeders in the Balearics islands, all possessed *tyrrhenica* or *balearica* haplotypes respectively. We never detected any mainland haplotypes in these populations.

Migration and breeding life history stages follow one another in a chronological sequence (usually on an annual schedule) that is under genetic control (Gwinner 1996). For physiological and behavioural reasons, the simultaneous expression of both stages is not possible and the transition from one stage to another is a complex process. Migration and the onset of breeding are mutually exclusive events, implying transition from a social hyperphagic and highly mobile state to territoriality and pair bonding involving complex physiological and behavioural changes (Ramenofsky and Wingfield 2006, 2017). We propose that such mechanisms form an efficient **pre-mating isolating barrier** between insular spotted flycatchers and their mainland counterparts belonging to the Eurasian *striata* lineage that stop-over in Corsica, Sardinia and the Balearics. These mechanisms cannot be effective in peripheral areas where *striata* and *tyrrhenica* breed in close proximity after finishing their migration. This is the case in Malta where introgressive inbreeding between Ibero-North African *striata* (probably originating from Tunisia) and *tyrrhenica* occurs (Baudrin 2024) and in the contact zone located along the Tyrrhenian coast where rare hybridization events may have occurred. However, the clear genetic differentiation between these sympatric populations indicates that the gene flow that might result from these few hybridization events is not sufficient to generate genomic convergence. This proves the rarity of the phenomenon and/or the strength of post-zygotic isolating barriers.

To sum up in our opinion **reproductive isolation is very efficient** at preventing interspecific gene flow over the core area of the insular populations that have been evolved independently from mainland populations since a long time (around one million years). Introgressive hybridization occurring in the small Maltese peripheral population and possibly along the Tyrrhenian coast of Italy has not played any significant role in the evolution of the *tyrrhenica* genome and do not constitute a valid argument against recognizing *tyrrhenica* as a full biological species. Incomplete reproductive isolation and hybridization between “good” species are common in birds (between 10 and 20% of avian species may hybridize Ottenburghs 2023; for Muscicapidae, hybridization between the black and collared pied flycatchers has been extensively studied, e.g. Sætre et al. 2001) and hybridization is accepted even in the framework of the biological species concept as long as it is low, spatially restricted and do not lead to merging of the genomes (Johnson et al. 1999).

Systematic issue: *tyrrhenica* is a biological species

Delimiting young sister species that have diverged recently is challenging because avian speciation is a gradual and complex process that generally takes a long time to be completed. Using an integrative taxonomic framework based on the combination of multiple types of complementary evidences may help in correctly delimited young species limits (Sangster 2018, Schweizer et al 2023). Applying this approach to the Spotted flycatcher complex, our results do suggest that *tyrrhenica* deserves to be elevated at the species level because this taxon significantly differs from *striata* by a set of independent phenotypic, acoustic and genetic characters.

Genetic data at hand allow us to affirm that all insular spotted flycatchers (*tyrrhenica*, *balearica*) share a common evolutionary history and have been isolated for a sufficient amount of time from mainland birds (ca 1 million years) to accumulate differences in plumage colouration and pattern.

There are also significant differences in wing formula, both insular taxa possessing shorter and more rounded wings than mainland *striata* (Table 1, Figure 3). Vocalizations were previously not used to distinguish spotted flycatchers from different geographical origins probably because the songs of spotted flycatchers are discreet and difficult to perceive by human ear. The acoustic data collected independently by three different ornithologists mentioned above have demonstrated that the songs of *balearica* and *tyrrhenica*, although distinct, share certain acoustic characteristics never recorded in *striata* (very high notes up to 15 kHz in *balearica* and 18-20 kHz in *tyrrhenica*, Figures 5 and 6).

Migratory data based on geolocators suggest that insular and mainland spotted flycatchers from France and Great Britain do not use the same migratory routes to reach their wintering regions located in Angola and Namibia (Baudrin 2024). As expected, with their shorter and more rounded wings, the island birds had on average 2,000 km shorter migration routes than the continental birds (Baudrin 2024, Figure 9). Although more studies including eastern European spotted flycatchers are required to fully assess the differences in migratory phenotypes between insular and mainland birds, results from Baudrin (2024) confidently suggest that *tyrrhenica* and *balearica* migrate independently from mainland birds.

When posing species limits under the Biological species concept, assessing the level of isolating reproductive barrier is of crucial importance. In the present case, the time lag between the life history stage of insular breeders and mainland migrants (i.e. reproductive vs migratory) when they co-occur during spring migration in Corsica, Sardinia and Balearics islands forms an efficient pre-mating barrier. Difference in life history stages between insular and mainland spotted flycatchers impedes the formation of mixed pairs during spring migration when thousands of mainland *striata* stop over in western Mediterranean islands and are therefore temporarily sympatric to local insular populations. This pre-mating barrier may not be efficient in peripheral populations where hybridization may occur (Baudrin 2024). It is important to underline here that limited gene flow between mainland and insular birds only involved a small number of peripheral individuals. It does not interact with the evolution of the insular lineages which are on their own evolutionary trajectories. The Biological species concept does not imply that complete reproductive mechanisms must be achieved to be applied. Low and geographically restricted interspecific gene flow between two species is fully acceptable under the BSC (Mayr 1942, Johnson et al 1999).

We thus propose the following taxonomic arrangement:

Mediterranean spotted flycatchers belong to *Muscicapa tyrrhenica* Schiebel 1910 which is polytypic. *M. t. tyrrhenica* (Corsica, Sardinia, Tyrrhenian coast, Malta, W Sicily) diverged from *M. t. balearica* Jordan 1913, only encountered in the Balearics islands, around 0.5 million years ago. The two taxa between which gene exchanges are null or very weak diverge by several genomic, mitochondrial DNA, and phenotypic characters, and may constitute incipient species.

The English name suggested for *Muscicapa tyrrhenica* is Mediterranean Flycatcher, already used in various publications and in the IOC World List (Gill & Donsker 2019). Vernacular names for the two subspecies have also been proposed, respectively 'Tyrrhenian Flycatcher' for *M. t. tyrrhenica* and 'Balearic Flycatcher' *M. t. balearica* (Viganò et al 2019).

References

- Baudrin G. (2024). Génomique et écologie de la spéciation d'un complexe d'espèces migratrices : les gobemouches gris et tyrrhénien. PhD thesis Muséum national d'Histoire naturelle, Paris. 298 p. <https://theses.hal.science/tel-05019605>
- Comolet-Tirman J. (2017). Les vocalisations du Gobemouche gris *Muscicapa striata tyrrhenica* en Corse : perspectives pour les décisions relatives à son statut taxonomique. *Alauda* 85 : 295-306.
- Comolet-Tirman J. (2018). Note sur le chant nuptial du Gobemouche des Baléares *Muscicapa tyrrhenica balearica* à Majorque. *Alauda* 86 : 235-236.
- Comolet-Tirman, J. (2020). Apport de la bioacoustique à la systématique des oiseaux chanteurs: discussion à partir d'exemples chez les grimpeurs, merles dyals et gobemouches. *Naturae* 11: 165-184.
- Corso A., Speranza G. & Viganò M. 2020b. Status of the Mediterranean Flycatcher *Muscicapa tyrrhenica* Schiebel, 1910 (*Aves Muscipapidae*) in Sicily. *Naturalista sicil.*, S. IV, XLIV, 2020, pp. 187-196.
- Corso A., Viganò M. & Starnini L. 2020a. Additional identification character for Mediterranean Flycatcher. *Dutch Birding* 42: 269-270.
- Doniol-Valcroze, P., P. Coiffard, P. Alström, M. Robb, P. Dufour, and P. A. Crochet (2023). Molecular and acoustic evidence support the species status of *Anthus rubescens rubescens* and *Anthus [rubescens] japonicus* (Passeriformes: Motacillidae). *Zootaxa* 5343: 173–192.
- Förschler, M. I., & Bairlein, F. (2011). Morphological shifts of the external flight apparatus across the range of a passerine (Northern Wheatear) with diverging migratory behaviour. *PLoS One*, 6, e18732.
- Gargallo, M. (1993). Identificació de la subspècie balear de menjamosques (*Muscicapa striata balearica*). *Anuari Ornitol. de les balears* 8: 21- 30.
- Gill, F & Donsker, D (editors) 2019. IOC world bird list (version 9.2). Website: www.worldbirdnames.org.
- Gwinner, E. (1996). Circannual clocks in avian reproduction and migration. *Ibis*, 138: 47-63.
- Johnson, N K, Remsen Jr, J V & Cicero, C 1999. Resolution of the debate over species concepts in ornithology: a new comprehensive biological species concept. *Proc Int Ornithol Congr* 22: 1470-1482.
- Mayr, E. (1942). *Systematics and the origin of species*. Columbia University Press, New York.
- Oliosio G., J.-C. Thibault, J.Piacentini & J.-M.Pons (2019). Le Gobemouche tyrrhénien : nouvel endémique des îles de Méditerranée occidentale. *Ornithos* 26: 67-77.
- Ottenburghs, J. (2023). How common is hybridization in birds? *Journal of Ornithology* 164: 913-920.
- Pons J.-M., Thibault J.-C., Aymí R., Grussu M., Muntaner J., Oliosio G., Sunyer J. R., Touihri m. & Fuchs J. (2016). The role of western Mediterranean islands in the evolutionary diversification of the Spotted Flycatcher *Muscicapa striata*, a long-distance migratory passerine species. *Journal of Avian Biology* 46: 1-13.
- Ramenofsky, M., & Wingfield, J. C. (2006). Behavioral and physiological conflicts in migrants: the transition between migration and breeding. *Journal of Ornithology* 147: 135-145.
- Ramenofsky, M., & Wingfield, J. C. (2017). Regulation of complex behavioural transitions: migration to breeding. *Animal Behaviour* 124: 299-306.
- Sætre, G.-P., Borge, T., Lindell, J., Moum, T., Primmer, C. R., Sheldon, B. C., Haavie, J., Johnsen, A. and Ellegren, H. (2001). Speciation, introgressive hybridization and nonlinear rate of molecular evolution in flycatchers. *Molecular Ecology* 10: 737-749.

- Sangster, G. (2018). Integrative Taxonomy of Birds: The Nature and Delimitation of Species. In: Tietze, D. (eds) Bird Species. Fascinating Life Sciences. Springer, Cham. https://doi.org/10.1007/978-3-319-91689-7_2.
- Schweizer, M, Marques, D A, Olsson, U & Crochet, P-A (2023). The Howard & Moore Complete Checklist of Birds of the World: framework for species delimitation. *Avian Syst* 1: 35-41.
- Taylor, B. (2020). Spotted Flycatcher (*Muscicapa striata*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bow.spofly1.01>
- Vaurie, C. (1959). The Birds of the Palearctic Fauna. Passeriformes. H. F. & G. Witherby, London, xii + 762 pp.
- Viganò M. (2015). Indagini bioacustiche e genetiche sul Pigliamosche tirrenico (*Muscicapa striata tyrrhenica*). Master thesis, Università degli studi di Pavia. 59 p.
- Viganò, M. et Corso, A. (2015). Morphological differences between two subspecies of Spotted Flycatcher *Muscicapa striata* (Pallas, 1764) (Passeriformes Muscicapidae). *Biodiversity Journal*, 61: 271-284.
- Viganò, M., Corso, A., Illa, M. et Starnini, L. (2019). Identification of Mediterranean Flycatcher. *Dutch Birding*, 41: 295-317.
- Wroza S. (2019). Le Gobemouche tyrrhénien *M. tyrrhenica* : un exemple de vocalisation extrême. *Ornithos* 26: 78-82.

Morphological differences between two subspecies of Spotted Flycatcher *Muscicapa striata* (Pallas, 1764) (Passeriformes Muscicapidae)

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ABSTRACT

Four subspecies of Spotted Flycatcher (*Muscicapa striata* Pallas, 1764) (Passeriformes Muscicapidae) are usually recognized within the Western Palaearctic. We carefully analysed two of these in order to determine and quantify their morphological differences: *M. striata striata* (inhabiting most of continental Europe east to the Ural mountains and a small portion of north-western Africa) and *M. striata tyrrhenica* Schiebel, 1910 (breeding on the Tyrrhenian islands of Corsica, Sardinia and the Tuscan Archipelago). We examined total of 58 Spotted Flycatcher specimens from Italian museums (of which 18 *M. striata tyrrhenica*) and obtained data about morphological features such as wing point, length and formula, and bill length, width and depth; furthermore, we investigated plumage colour using a spectrometer. Biometric measurements and an analysis of plumage streaking confirmed the presence of important differences between the two taxa; the colorimetric analysis did not produce the expected results, although it had some interesting implications concerning the preservation of museum specimens and their use in studies of plumage colour.

KEY WORDS

Spotted Flycatcher; *Muscicapa striata tyrrhenica*; morphology; museum specimens.

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INTRODUCTION

The Spotted Flycatcher (*Muscicapa striata* Pallas, 1764) is a songbird in the family Muscicapidae and is the only member of its genus in Europe, with at least twenty more species in Asia and Africa. The Spotted Flycatcher is found through most of the Palaearctic, with a continuous distribution from the Iberian peninsula to the Mongolia-China border. It is a long-distance, trans-Saharan migrant, and most of the population winters south of the Equator (Cramp & Perrins, 1993).

Seven subspecies are currently recognized in this extensive range (del Hoyo et al., 2006): *M. striata striata* (Pallas, 1764) (Figs. 1, 2) breeds in

Europe east to the Ural mountains and in north-western Africa, and winters south of the Sahara; *M. striata balearica* von Jordans, 1913 (Fig. 1), breeds in the Balearic islands and winters in western and south-western Africa; *M. striata tyrrhenica* Schiebel, 1910 (Figs. 1, 2), breeds in Corsica and Sardinia and presumably winters in Africa; *M. striata inexpectata* Dementiev, 1932, breeds in Crimea and winters in Africa; *M. striata neumanni* Poche, 1904, breeds in the islands of the Aegean Sea east to the Caucasus and northern Iran and south to Cyprus and the Levant, in addition to central Siberia, and winters in eastern and southern Africa; *M. striata sarudnyi* Snigirewski, 1928, breeds from eastern Iran to northern and western

Pakistan and presumably winters in southern and eastern Africa; *M. striata mongola* Portenko, 1955, breeds from the south-eastern Altai mountains to northern Mongolia, and presumably winters in southern and eastern Africa.

Only two (*M. striata striata* and *M. striata tyrrhenica*) of these seven subspecies are regularly found in Italy, while *M. striata neumanni*, which could potentially occur in migration, has not yet been confirmed (Corso, 2005; Bricchetti & Fracasso, 2008). The nominate subspecies breeds throughout continental Italy and Sicily, where it is considered common and widespread, although its distribution is somewhat patchy with gaps in high mountain areas. The core breeding range of *M. striata tyrrhenica* comprises Corsica and Sardinia, but contra del Hoyo et al. (2006) and Cramp & Perrins (1993), it also breeds in the Tuscan Archipelago (Bricchetti & Fracasso, 2008), while its presence along a narrow band of the Tyrrhenian coast remains to be confirmed (Bricchetti & Fracasso, 2008; Tellini et al., 1997). The authors provide some interesting information on the abundance of Spotted Flycatcher subspecies in Italy.

Although the nominate subspecies breeds almost throughout continental Italy, it is never abundant, with population densities that rarely exceed 0.2

pairs/hectare. On the other hand, as many as 0.6 pairs/hectare have been found in *M. striata tyrrhenica* (VV. AA. in Thibault & Bonaccorsi, 1999); so the species seems to fit the usual pattern on islands of density inflation due to lower species richness (eg MacArthur & Wilson, 1967; George, 1987; Blondel et al., 1988). Interestingly, high population densities have been recorded along the Tyrrhenian coast in Tuscany; densities are far lower only 50 km inland (Tellini et al., 1997).

There are currently no reliable data on the wintering range of *M. striata tyrrhenica* (Cramp & Perrins, 1993, del Hoyo et al., 2006). The *M. striata tyrrhenica* subspecies of the Spotted Flycatcher was described for the first time by Schiebel (1910) in a paper on the Corsican avifauna and a syntype taken in Aitone, Corsica, on 19 May 1910 is currently held at the Zoologisches Forschungs institut und Museum Alexander Koenig in Bonn, Germany. The identification of this subspecies is generally dealt with very superficially in the ornithological literature, with limited discussion of its distinguishing characteristics. Several examples are below:

- Arrigoni degli Oddi (1929): “similar to the previous species [authors’ note: the subspecies

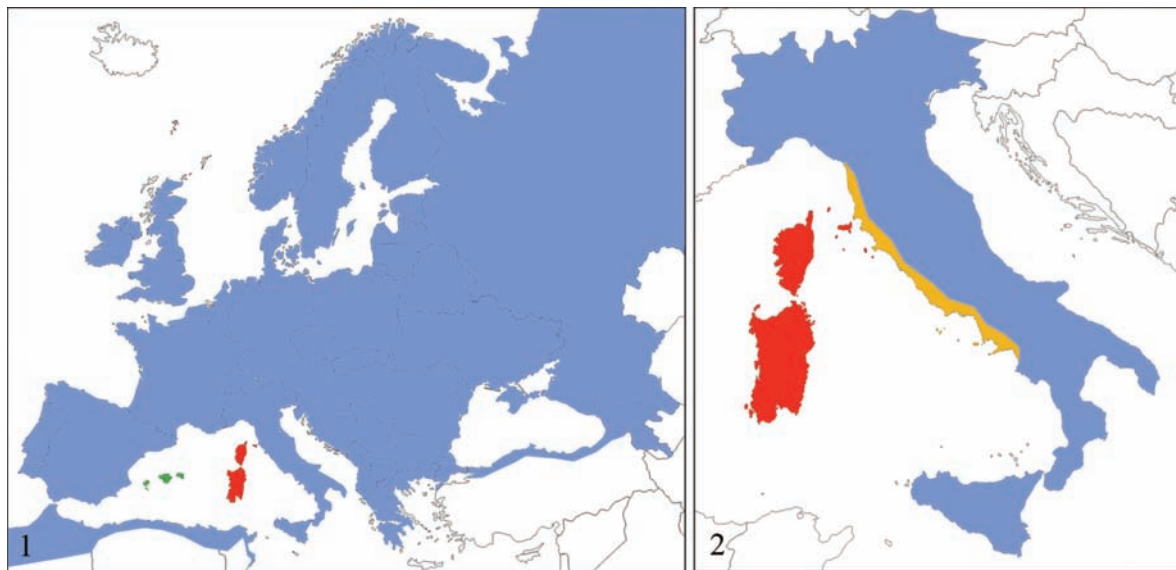


Figure 1. In Western Europe three subspecies of Spotted Flycatcher are found: *Muscicapa striata striata* (blue), *M. striata tyrrhenica* (red) and *M. striata balearica* (green). Figure 2. Two subspecies of Spotted Flycatcher breed in Italy: *M. striata striata* (blue) and *M. striata tyrrhenica* (red); *M. striata tyrrhenica* could be present in the yellow area too, but further research is needed.

striata]; central spots on the cervix and streaking on breastless distinct”;

- Cramp & Perrins (1993): “more warm brown on upperparts, distinctly less streaked on breast, streaks replaced by broader, coalescing spots”;

- Bricchetti & Fracasso (2008): “upperparts browner and warmer-toned, and streaking on the underparts less well-defined and tending to merge into spots”;

- van Duivendijk (2010): “Primary-projection slightly shorter than *striata*; upperparts warmer brown, underparts almost unstreaked but with broad, faint spots”.

Over the last ten years we have carried out in-depth field and museum studies on the morphological differences between the two taxa in question (Figs. 3–6). In the field, the immediate impression given by *M. striata tyrrhenica* is of a paler bird with warmer tones to the back and more homogeneous underparts. The breast markings, which are generally well defined streaks in *M. striata striata*, appear faded and more spot-like. The streaking on the nape is also less well defined compared to the nominate subspecies, due to the lower contrast between the streaks and the nape’s background colour. Primary projection is one of the most important characters: while the primary projection beyond the tertials is longer than the tertials themselves in continental birds, individuals from Corsica and Sardinia have a primary projection that is shorter than, or at most equal to the length of the tertials.

This paper mainly reports the results of our museum studies, while an article on field identification criteria is forthcoming (Viganò et al., personal data).

MATERIAL AND METHODS

Our first observations on the morphological differences between the two subspecies were made in the field: *M. striata tyrrhenica* was studied in southern Sardinia near Villasimius (Cagliari) in July 2004, August 2005, July 2006, and May 2011 and on the island of Elba in July 2014. We have studied this taxon in Corsica as well, in the area of the Gulf of Calvi, in July 2007, July 2008, and May 2012. Our studies of *M. striata striata* have taken place continuously during the breeding season since 2005

in northern Italy; additionally, we have studied this taxon during spring migration on various small islands off central and southern Italy, especially Ventotene (Latina) in April 2010 and 2011 and Linosa (Agrigento) in May 2006, April 2007, and April 2009, where on good days hundreds or even thousands of individuals can be seen.

Other observations took place opportunistically elsewhere in the Western Palaearctic, both during the breeding season and in migration. Studies of museum skins complemented our field observations and were of fundamental importance for this paper (Figs. 7, 8; Table 1). There are very few specimens of *M. striata tyrrhenica* in Italian and foreign museums; indeed, there are none at all in the largest bird collection in Europe at the Natural History Museum at Tring, U.K. We arranged for all of the *M. striata tyrrhenica* specimens held at the Museo Civico di Storia Naturale in Milan, Italy (MCSM), Museo Civico di Zoologia in Rome, Italy (MCZR), and Museo di Scienze Naturali in Forlì, Italy (MSNF) to be sent on short-term loan to the Museum of the Institute for Environmental Protection and Research (Istituto Superiore per la Protezione e la Ricerca Ambientale - ISPRA) in Ozzano dell’Emilia (Bologna, Italy) so that they could be studied side-by-side along with the specimens held in the last-named institution.

We took the following measurements: wing chord, longest primary (P3), distance of each primary from P3, bill length from the nostrils, bill height and thickness at the nostrils. Measures that are generally taken during ringing activities such as tail, tarsus, and bill-to-cranium length were not taken since they vary depending on the way the specimen was prepared (Winker, 1998; Eck et al., 2011; Kuczynski, 2003). The measurements considered here are also subject to some degree of variation depending on specimen preparation; measurements taken on live animals may add a degree of precision and some additional information, but we felt that museum specimens were better suited to taking biometrical and plumage colour data together.

As concerns wing chord length, one study that looked at the wings of Rooks (*Corvus frugilegus*) measured upon capture, after 8 weeks, and again after 144 weeks found a difference in length between fresh and dried wings of about 1.84% (Knox, 1980). Measurements were taken using a stopped ruler (to the nearest 0.5 mm), callipers (to



3



4



5



6

Figures 3, 4. Spotted Flycatcher (*Muscicapa striata tyrrhenica*), Villasimius (Cagliari), Sardinia, May 2011. Note the quite pale and warm general colour, the subtle head and breast markings and the short primary projection compared to tertials length. Figures 5, 6. Spotted Flycatcher (*Muscicapa striata striata*), Ventotene, Latina, Italy, April 2011 (Fig. 5) and Pantelleria, Trapani, Sicily, May 2009 (Fig. 6, photo by Igor Maiorano). The overall impression is of a colder and less homogeneous bird, with bold markings on breast and head; primary projection is longer than tertials length.

the nearest 0.1 mm) and a thin strip of graph paper (to the nearest 0.5 mm) strengthened by an equally thin strip of transparent plastic.

The latter tool was necessary to measure P3: this feather is usually measured using a special ruler, but due to the specimens' age, their rigidity, and their historic value, some are from the prized Arrigoni degli Oddi collection, we decided to use graph paper as it is thinner and less invasive. Colour analysis of the upperparts of Spotted Flycatcher specimens was undertaken using an Ocean Optics USB 2000 spectrometer at ISPRA.

Before proceeding with the spectrometer analysis of Spotted Flycatcher plumage we had to calibrate the instrument and its associated software, Ocean Optics Spectrasuite, which is provided by the manufacturer of the spectrometer and the lamp. The spectrometer was calibrated by reading and recording on the software two values that were to correspond with white and black. In order to do so we used Ocean Optics' WS1 Diffuse Reflectance Standard for white, while for black we placed the lighting fibreover the black square on X-Rite's Color Checker's colour scale.

Once the programme was launched, only two parameters needed to be set. Scan-to-average was set at 5: for each colour reading of a given point, five scans are automatically made, and their average is recorded as the final value. Integration time was set at 300 in order to prevent peaks in the graph

above the upper margin when the scanner was placed above the white standard; in other words, to ensure that reflectance on a white standard would not return excessively high values that would have led to a loss of information on the portion of the graph falling outside the margins.

Once calibration was completed, we sampled colours on each specimen as follows: three measurements were taken from the mantle (usually two from the right-hand side and one from the left) and three more from the rump (by moving the scanner along a vertical line from the top to the bottom of the rump).

This means that for each specimen, the data reported in the Table 2 comprises the averages of 15 measurements on the mantle and 15 on the rump. In accordance with the instructions reported by Hill & McGraw (2006) we selected and ranked the data before analyzing them: we only considered values with wavelengths between UV and red ($299.74 \leq \lambda \leq 700.28$), then sub-divided them into intervals of approximately 10 nm, e.g. from 410nm to 420nm.

The values we calculated (for both mantle and rump) are as follows:

- Total Reflectance: the sum of all intervals
- UV Component: the sum of values falling between 300nm and 400nm

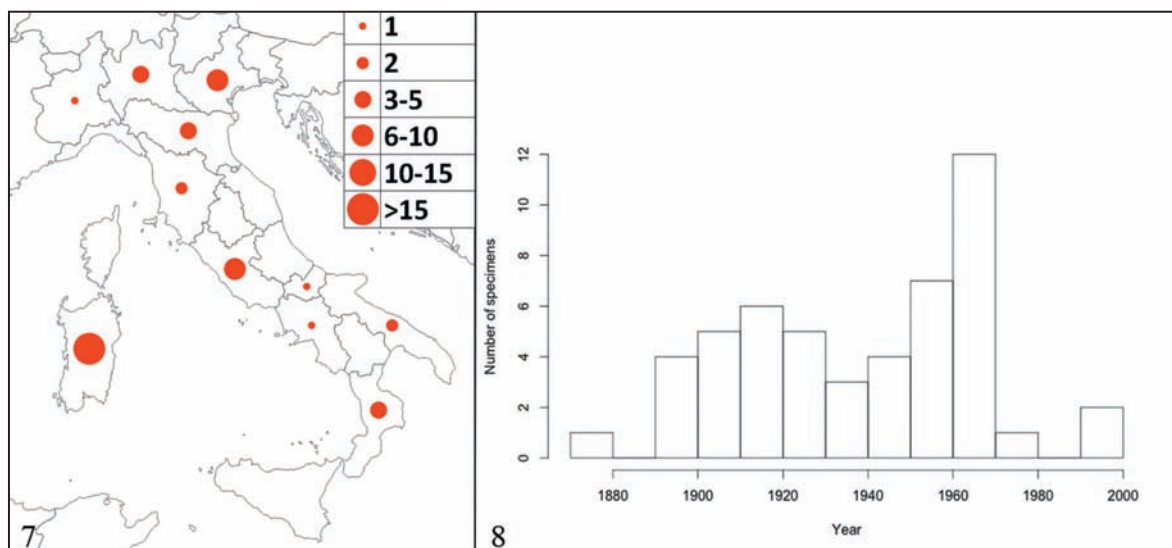


Figure 7. The provenience of the museum specimens analysed. Figure 8. The number of birds collected per decade.

Museum	<i>M. striata striata</i>	<i>M. striata tyrrhenica</i>
MCSM	10	7
MCZR	15	6
MSNF	5	4
ISPRA	8	1
Total	38	18

Table 1. This table summarizes the number of specimens studied, the museum they belong and their subspecific identification.

- UV Chroma: UV Component to Total Reflectance ratio
- RED Component: the sum of values falling between 600nm and 700nm
- RED Chroma: RED Component to Total Reflectance ratio

The results are reported in the Tables 2 and 3 in the following chapter. In order to better investigate the results obtained with the colorimeter, we made subsets of the original data (Figs. 9–20): we began by removing from the sample of *M. striata striata* all individuals from the narrow strip of Tyrrhenian coastline in Tuscany, Latium, and Campania where *M. striata tyrrhenica* may be breeding; we did not remove two individuals captured on Ventotene Island (Latina) and Capri (Naple) because they matched *M. striata striata* in every regard and we considered them to be spring migrants of *M. striata striata* with a reasonable degree of certainty. A second subset was made comparing the usual sample of Sardinian specimens with a subset (n=6) of *M. striata striata* specimens that show particularly cold plumage tones on visual inspection. We also divided the sample into old “pre-1960” and recent “post-1960” subsets, meaning that ‘recent’ specimens were no more than fifty years old, following Armenta et al. (2008).

In order to evaluate the differences in nape and breast streaking between the two subspecies, we compared the specimens visually (see, for example, Galeotti et al. 2009). After an initial evaluation of all specimens, we established categories that could

represent in sufficient detail the variability present in the two taxa. We scored breast streaking on a 0 to 6 scale (0 indicating no streaking and 6 the heaviest streaking) and nape streaking on a 0 to 5 scale. We assigned those values to each specimen; when necessary, we compared the specimen under observation directly with the reference specimens.

RESULTS

Biometric analyses found significant differences in wing morphology. Differences in maximum wing chord were found to be statistically significant using a t-test ($t = 9.4407$, $p = 6.079e-12$), confirming our field observations of a shorted primary projection in *M. striata tyrrhenica*.

Similar wing measurement data are reported in the literature (e.g. Cramp & Perrins, 1993; Bricchetti & Fracasso, 2008). On the other hand, in a study of birds ringed between mid-April and mid-May at Capo Caccia, Sardinia (Marchetti & Baldaccini, 1995) did not report such a difference, although the authors themselves suggested that such comparisons were better made using birds caught on their breeding grounds during the reproductive season in order to ensure correct subspecific identification. In addition to the wing chord, significant differences were found in the wing formula as well. The values calculated for each primary are summarized in figure 22, which shows wing formula for each taxon. The most significant difference concerns the relative distance between the longest primary (P3) and P2; this characteristic is also depicted in figure 21, which shows the distance (in mm) between P2 and P3 in each taxon. The t-test reveals significant differences between the two subspecies concerning this character ($t = -5.1674$, $p = 6.536e-06$), as well as in the distance between P3 and P4 ($t = 5.8634$, $p = 6.768e-07$). Differences in wing shape of this type and extent are highly interesting. Similar discrepancies have been found between sister species in which one is a short-distance migrant and the other a long-distance migrant (Chandler & Mulvihill, 1988; Mönkkönen, 1995), or where there is a gradient between more or less migratory subspecies of the same species (Arizaga et al., 2006; Winkler et al. 2010) or again in similar species where one is migratory and the other sedentary (Chandler & Mulvihill, 1990; Milá et al., 2008).



Figures 9–14. A value for underpart markings was given to each specimen; seven categories were determined (one central category not depicted), ranging from least marked (value 0) to boldly marked (value 6).



15



16



17



18



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20

Figures 15–20. A value for head streakings was given to each specimen; six categories were determined, ranging from least marked (value 0) to boldly marked (value 5).

This phenomenon is known as “Seebohm’s rule” and can be summed up as follows: long-distance migrants have more pointed wings (shorter inner primaries and longer outer primaries) compared to short-distance migrants or non-migratory species, since longer and more pointed wings make for more powerful flight compared to shorter, more rounded wings (Seebohm, 1901; Calmaestra & Moreno, 2001).

We also found differences in bill length measured from the distal end of the nostrils to the tip of the bill, with $p = 0.01582$ and $t = 2.5203$, with *M. striata striata* showing on average a longer bill; we did not use the commonest bill measurement method, from the tip of the bill to the base of the skull, because for museum specimens it is less reliable than the parameter used in this study (Winker, 1998; Kuczynski et al., 2003). Our scores for breast and nape streaking also confirmed our field observations, namely that nape and breast streaking is less well defined in Sardinian and Corsican birds.

Colour analysis did not reveal any statistically significant differences except in the sum of λ falling between 300 and 400nm, or within the UV

spectrum. These differences fade away if one considers the UV chroma, namely by dividing the UV value by total reflectance. In order to better understand the reasons for this, we carried out a number of tests by modifying the data sample used in the analysis in an attempt to remove the effect of certain parameters that may have generated background noise and muddled the results. The first subset excludes all individuals from the narrow strip of Tyrrhenian coastline where *M. striata tyrrhenica* may breed: using this sample, differences in mantle UV are no longer significant, but differences emerge in terms of total reflectance and the red component of the mantle, with *M. striata tyrrhenica* slightly redder and paler than *M. striata striata*, albeit with low statistical significance. However, further manipulation of the sample for colorimetric analysis, comparing *M. striata tyrrhenica* specimens with six particularly cold plumaged *M. striata striata* specimens did not find statistically significant differences for any variable.

This unexpected result, involving *striata* specimens that showed clear differences in mantle tones compared to *M. striata tyrrhenica* on visual inspec-

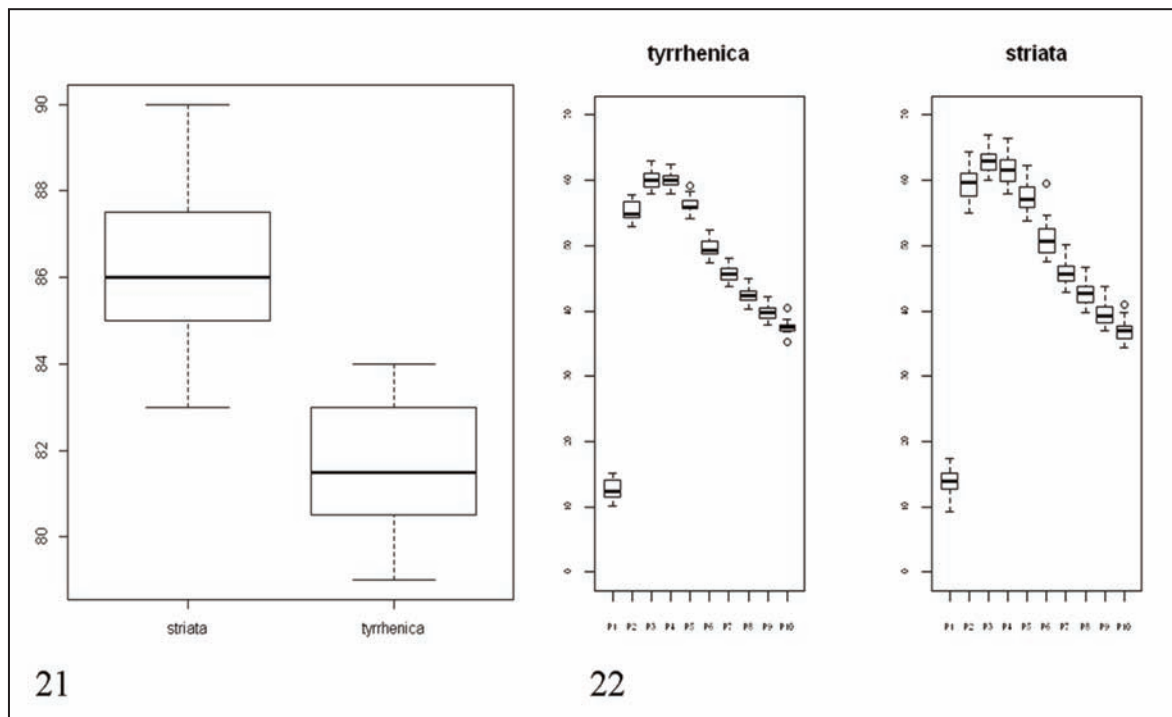


Figure 21. Chord values (in mm) recorded on *Muscicapa striata striata* and *M. striata tyrrhenica* specimens.
Figure 22. Wing formula for both subspecies; note the rounder shape of *M. striata tyrrhenica* birds.

	<i>Muscicapa striata striata</i>			<i>Muscicapa striata tyrrhenica</i>				
variable	mean + sd	n	range	mean + sd	n	range	t	p
P1	13.75926 ± 1.931572	27	9.3-17.4	12.67500 ± 1.438286	16	10.2-15.1	1.9448	0.05868
P2	59.57778 ± 2.469247	27	55.0-64.4	55.33125 ± 1.520841	16	52.9-57.8	6.2002	2.245e-07
P3	62.96429 ± 1.914509	28	60-67	60.12500 ± 1.258306	16	58-63	5.3003	3.996e-06
P4	61.64074 ± 2.176670	27	58.0-66.5	60.06250 ± 1.223043	16	58.0-62.5	2.6544	0.01126
P5	57.36667 ± 2.300000	27	53.8-62.2	56.26154 ± 1.413352	13	54.2-59.1	1.5879	0.1206
P6	50.97407 ± 2.695094	27	47.5-59.5	49.61250 ± 1.433353	16	47.4-52.4	1.8645	0.06943
P7	45.86667 ± 1.840568	27	42.9-50.2	45.67333 ± 1.258381	15	43.7-48.1	0.3616	0.7195
P8	42.66296 ± 1.784581	27	39.7-46.6	42.35625 ± 1.175284	16	40.2-44.9	0.6118	0.544
P9	39.69259 ± 1.836369	27	36.9-43.8	39.73125 ± 1.151068	16	36.9-43.8	-0.0757	0.9401
P10	36.84074 ± 1.727662	27	34.3-40.9	37.56000 ± 1.136913	15	35.2-40.4	-1.444	0.1565
chord	86.14286 ± 1.603567	28	83-90	81.50000 ± 1.505545	16	79-84	9.4407	6.079e-12
bill L	8.392593 ± 0.2758566	27	8.0-8.9	8.140000 ± 0.3680062	15	7.2-8.6	2.5203	0.01582
bill W	3.496429 ± 0.1990387	28	3.1-3.9	3.420000 ± 0.1373213	15	3.2-3.7	1.3244	0.1927
billT	4.357143 ± 0.2379365	28	3.6-4.8	4.353333 ± 0.3888934	15	3.6-5.1	0.0399	0.9683
breast	4.096774 ± 0.7897189	31	3-6	1.466667 ± 0.9904304	15	0-3	9.7384	1.504e-12
head	3.586207 ± 0.7327659	30	2-5	1.333333 ± 0.8164966	15	0-3	9.2998	9.361e-12
f_R_tot_refl	385.2981 ± 74.04245	36	263.55-603.68	397.1140 ± 55.03810	15	316.97-486.38	-0.556	0.5807
f_R_UV	59.08778 ± 15.51324	36	36.00-99.42	61.77267 ± 13.38254	15	41.97-85.83	-0.5849	0.5613
f_R_CROM A UV	0.151982 ± 0.0151761	36	0.11943-0.18782	0.154283 ± 0.0155461	15	0.1324-0.1910	-0.49	0.6263
f_R_RED	141.8281 ± 22.45401	36	100.9-200.3	148.8973 ± 20.66444	15	114.11-181.89	-1.0476	0.3
f_R_CHRO MA RED	0.370492 ± 0.0201814	36	0.331798-0.41221	0.375287 ± 0.0162703	15	0.35564-0.4098	-0.815	0.419
f_M_tot_refl	303.9143 ± 33.40160	36	236.78-344.78	329.1888 ± 40.71543	16	290.13-405.80	-1.5784	0.1302
f_M_UV	44.53722 ± 6.774240	36	31.52-57.73	49.10250 ± 7.547965	16	39.27-65.49	-2.1659	0.03512
f_M_CHRO MA UV	0.144340 ± 0.0137475	36	0.11600-0.171272	0.147015 ± 0.0119409	16	0.13113-0.1696	-0.6728	0.5042
f_M_RED	112.1264 ± 9.672242	36	92.18-126.12	120.3400 ± 11.764493	16	108.76-141.91	-1.773	0.09145
f_M_CHRO MA RED	0.376839 ± 0.0175326	36	0.338173-0.40683	0.375442 ± 0.0206807	16	0.34161-0.4047	0.2508	0.803

Table 2. All the statistical results from our study are here summarized; the variables highlighted in boldface are those for which the t-test found values <0.05.

	<i>Muscicapa striata striata</i>			<i>Muscicapa striata tyrrhenica</i>				
variable	mean + sd	n	range	mean + sd	n	range	t	p
M_tot_refl	309.2468 ± 31.11327	29	236.78-365.09	329.1888 ± 40.71543	16	290.13-405.80	-2.2777	0.0279
M_UV	45.6875 ± 6.037829	29	35.20-56.61	49.10250 ± 7.547965	16	39.27-65.49	-1.6468	0.1071
M_CHROMA_UV	0.1476630 ± 0.0113407	29	0.123644-0.171272	0.147015 ± 0.0119409	16	0.13113-0.1696	0.179	0.8588
M_RED	115.6518 ± 10.24447	29	92.18-126.12	120.3400 ± 11.764493	16	108.76-141.91	-2.5046	0.01623
M_CHROMA_RED	0.3748562 ± 0.0180199	29	0.338173-0.399920	0.375442 ± 0.0206807	16	0.34161-0.4047	-0.0983	0.9222
R_tot_refl	388.8814 ± 78.95214	29	263.55-603.68	397.1140 ± 55.03810	15	316.97-486.38	-0.3589	0.7215
R_UV	60.81893 ± 16.22125	29	36.00-99.42	61.77267 ± 13.38254	15	41.97-85.83	-0.1947	0.8466
R_CHROMA_UV	0.1549453 ± 0.0141347	29	0.121704-0.187822	0.154283 ± 0.0155461	15	0.1324-0.1910	0.1413	0.8884
R_RED	141.9193 ± 23.99409	29	100.9-200.3	148.8973 ± 20.66444	15	114.11-181.89	-0.9519	0.3468
R_CHROMA_RED	0.3674105 ± 0.0197631	29	0.331798-0.408994	0.375287 ± 0.0162703	15	0.35564-0.4098	-1.3203	0.1941

Table 3. Same colorimetric variables analyzed in the previous table, but with a different subset of data: birds collected from the narrow strip of Tyrrhenian coastline in Tuscany, Latium, and Campania, where *M. striata tyrrhenica* could occur, were removed.

tion, suggests that the method we used for our colorimetric analysis is not ideal for detecting such subtle differences in plumage pigmentation.

Additional comparisons looked at the effects of time on the state of preservation of specimen. In accordance with other works that tested colour deterioration in museum specimens (Armenta et al., 2008; Doucet & Hill, 2009), we found highly significant differences between old (pre-1960) and recent (post-1960) specimens.

We used this data to build a linear model to identify the variables that most affected colour variation. As expected, taxon did not have a statistically significant effect, while year of collection

did ($F(1.46) = 7$, $P = 8.408e-05$). In other words, specimens that were more than fifty years old showed a statistically-significant higher total reflectance, and thus appeared paler.

The biometric and colorimetric data collected in this study is summarized in Table 2, which also indicates sample size (n), the minimum and maximum values recorded (range) and the t and p values for the t-test as applied to each variable for the two taxa. The variables highlighted in boldface are those for which the t-test found values <0.05 , meaning that the differences between the two taxa for

the variable in question were statistically significant. The variables “P1” to “P10” indicate primary length from the outermost to the innermost; “chord” indicates the length of the maximum wing chord, namely the closed wing measured from the carpal joint; “bill L, H, and T” respectively indicate bill length, height, and thickness; “breast” and “head” indicate the amount of streaking in these two areas scored after a visual examination.

Colorimetric data follows: variables initiated with an M refer to the mantle, and those with an R to the rump; tot_refl refers to total reflectance, UV and RED respectively refer to the sum of λ falling between 300 and 400 and between 600 and 700; UV_CHROMA and RED_CHROMA indicate the ratio between these two variables and total reflectance.

DISCUSSION AND CONCLUSIONS

The objective of this study was to test the differences observed in the field between the *M. striata striata* and *M. striata tyrrhenica* subspecies of Spotted Flycatcher as objectively as possible, by using methods that would not be influenced by differences in perception of colour and proportions on the part of different observers. The results confirmed the morphological differences observed in the field and cited in the literature, and the different intensity and extent of streaking on the underparts and the nape. Nevertheless, to better assess these parameters a larger sample, in both quantitative and qualitative terms, would be preferable, and would ideally include a larger number of birds captured on their breeding grounds. Differences in wing-shape are important not only from an identification perspective, but also in light of the relationship between wing morphology and migratory distance (Baldwin et al., 2010; Mönkkönen, 1995).

The shorter, more rounded wings of *M. striata tyrrhenica* suggest that birds breeding in Corsica and Sardinia may have a shorter migration compared to birds from continental Italy and Europe. This is all the more interesting given that there is no solid data in the literature on the non-breeding range of *M. striata tyrrhenica* (Cramp & Perrins, 1993; del Hoyo et al., 2006), that should anyway be sub-saharan, given the absence of evidence of winter sightings north of the Sahara. On the other

hand, our colorimetric analyses failed to confirm the differences observed in the field and reported in the literature. To conclude, biometric measurements and an analysis of plumage streaking confirmed the presence of some important differences between the two taxa, including characters that can be seen in the field, while the colorimetric analysis did not produce the expected results, although it had some interesting implications concerning the preservation of museum specimens and their use in studies of plumage colour.

There are several other instances of taxa that have similar distributions to *M. striata tyrrhenica* Spotted Flycatchers and are morphologically very similar to the taxa breeding elsewhere in Italy and Europe being recognized as full species after in-depth analyses of morphology, voice, ecology and DNA: examples include Corsican Finch (*Carduelis corsicana*) (Cramp & Perrins, 1993; Sangster, 2000; Förschler & Kalko, 2007, Förschler et al. 2009) and Moltoni's Warbler (*Sylvia subalpina*) (Brambilla et al., 2008), both recently recognized as full species; further research on *M. striata tyrrhenica* Spotted Flycatcher is needed.

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REFERENCES

- 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.
- Armenta J.K., Dunn P.O. & Whittingham L.A., 2008. Effects of specimen age on plumage colour. *Auk*, 125: 803–808.
- Arrigoni degli Oddi E., 1929. *Ornitologia italiana*. Milano, Hoepli, 1046 pp.
- Baldwin M.W., Winkler H., Organ C.L. & Helm B., 2010. Wing pointedness associated with migratory distance in common-garden and comparative studies of stonechats (*Saxicola torquata*). *Journal of Evolutionary Biology*, 23: 1050–1063.
- Blondel J., Chessel D. & Frochot B. 1988. Bird species impoverishment, niche expansion, and density inflation in Mediterranean island habitats. *Ecology*, 69: 1899–1917.
- Brambilla M., Vitulano S., Spina F., Baccetti N., Gargallo G., Fabbri E., Guidali F. & Randi E. 2008. A molecular phylogeny of the *Sylvia cantillans* complex: cryptic species within the Mediterranean basin. *Molecular Phylogenetics and Evolution* 48: 461–472.
- Brichetti, P. & Fracasso, G. 2008. *Ornitologia italiana*. Vol. 5. Turdidae-Cisticolidae. Oasi Alberto Perdisa Editore, Bologna, 432 pp.
- Calmaestra R.G. & Moreno E., 2001. A phylogenetic analysis on the relationship between wing morphology and migratory behavior in Passeriformes. *Ardea*, 89: 407–415.
- Chandler C.R. & Mulvihill R.S., 1988. The use of wing shape indices: an evaluation. *Ornis Scandinavica*, 19: 212–216.
- Chandler C.R. & Mulvihill R.S., 1990. Wing-shape variation and differential timing of migration in dark-eyed juncos. *Condor* 92: 54–61.
- Corso A., 2005. *Avifauna di Sicilia*. L'Epos editore, Palermo, 324 pp.
- Cramp S. & Perrins C.M. (Eds.), 1993. *Handbook of the Birds of Europe and the Middle East and North Africa*. Vol. VII Flycatchers to Shrikes. Oxford University Press, Oxford, 584 pp.
- del Hoyo J., Elliot A. & Sargatal J., 2006. *Handbook of the Birds of the World*. Vol. XI. Lynx Edicions, Barcelona, 800 pp.
- Doucet S.M. & Hill G.E., 2009. Do museum specimens accurately represent wild birds? A case study of carotenoid, melanin, and structural colours in long-tailed manakins *Chiroxiphia linearis*. *Journal of Avian Biology*, 40: 146–156.
- Eck S., Fiebig J., Fiedler W., Heynen I., Nicolai B., Töpfer T., van den Elzen R., Winkler R. & Woog F., 2011. Measuring birds. *Vögel vermessen*. Deutsche Ornithologen-Gesellschaft. Wilhelmshaven, 118 pp.
- Förschler M.I. & Kalko E.K.V., 2007. Geographical differentiation, acoustic adaptation and species boundaries in mainland citril finches and insular Corsican finches, superspecies *Carduelis [citrinella]*. *Journal of Biogeography*, 34: 1591–1600.
- Förschler M.I., Senar J.C., Perret P. & Björklund M., 2009. The species status of the Corsican Finch (*Carduelis corsicana*) assessed by three genetic markers with different rates of evolution. *Molecular Phylogenetics and Evolution*, 52: 234–240.
- Galeotti P., Rubolini D., Sacchi R. & Fasola M., 2009. Global changes and animal phenotypic responses: melanin-based plumage redness of scops owls increased with temperature and rainfall during the last century. *Biology Letters*, 5: 532–534.
- George T.L., 1987. Greater land bird densities on island vs. mainland: relation to nest predation level. *Ecology*, 68: 1393–1400.
- Hill G.E. & McGraw K.J., 2006. *Bird Coloration*, Volume 1. Mechanisms and Measurements. Harvard University Press, Cambridge, 41–89.
- Knox A., 1980. Post-mortem changes in wing lengths and wing formulae. *Ringling & Migration*, 3: 29–31.
- Kuczynski L., Tryjanowski P., Antczak M., Skoracki M. & Hromada M., 2003. Repeatability of measurements and shrinkage after skinning: the case of the Great Grey Shrike *Lanius excubitor*. *Bonner Zoologische Beiträge*, 51: 127–130.
- MacArthur R.H. & Wilson E.O., 1967. *The theory of island biogeography*. Princeton University Press, 224 pp.
- Marchetti C. & Baldaccini N.E., 1995. I Pigliamosche (*Muscicapa striata*) in transito prenuziale su Capo Caccia: caratteri biometrici e fenologici. *Supplemento alle Ricerche di Biologia della Selvaggina*, 22: 537–538.
- Milá B., Wayne R.K. & Smith T.B., 2008. Ecomorphology of migratory and sedentary populations of the yellow-rumped warbler (*Dendroica coronata*). *Condor*, 110: 335–344.
- Mönkkönen, M. 1995. Do migrant birds have more pointed wings?: a comparative study. *Evolutionary Ecology*, 9: 520–528.
- Sangster G., 2000. Genetic distance as a test of species boundaries in the Citril Finch (*Serinus citrinella*): a critique and taxonomic reinterpretation. *Ibis*, 142: 487–490.
- Seebohm H., 1901. *Birds of Siberia*. Murray, London, 512 pp.
- Schiebel G., 1910. *Neue Vogelformen aus Corsica*. *Ornithologisches Jahrbuch*, 21: 102–103.
- Tellini F.G., Baccetti N., Arcamone E., Meschini A. & Sposimo P., 1997. *Atlante degli uccelli nidificanti e svernanti in Toscana (1982-1992)*. Provincia di

- Livorno e Centro Ornitologico Italiano. Quaderni del Museo Provinciale di Storia Naturale di Livorno. Monografie 1.
- VV. AA. in Thibault J.-C. & Bonaccorsi G., 1999. The birds of Corsica. BOU Checklist No. 17. British Ornithologists' Union. The Natural History Museum, Tring, Herts, 171 pp.
- vanDuivendijk N., 2010. Advanced bird identification. New Holland Publishers, London, 308 pp.
- Winker K., 1998. Suggestions for measuring external characters of birds. *Ornitologia Neotropical*, 9: 23–30.

Identification of Mediterranean Flycatcher

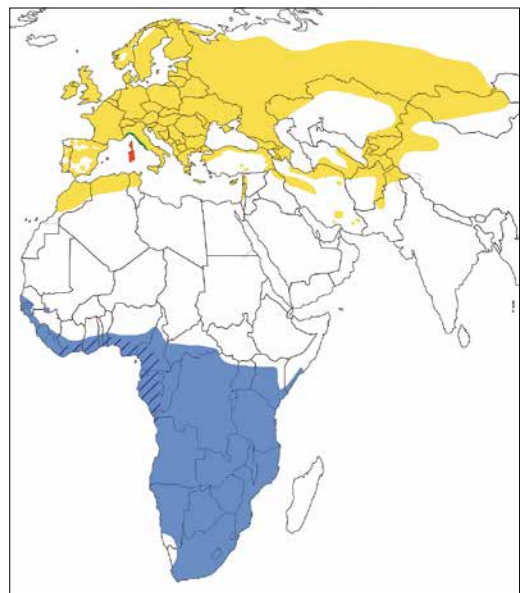
Michele Viganò, Andrea Corso, Marc Illa & Lorenzo Starnini

Some of the most interesting taxonomic studies of the last 15 years in Europe were carried out in the western Mediterranean, particularly in Sardinia, Corsica and the Balearic Islands. This biogeographical area is characterized by a unique fauna, which remained isolated and evolved separately from the rest of the European fauna as a result of glacial cycles (Kvist et al 2004, Weiss & Ferrand 2007, van der Geer et al 2010). Examples of such studies are those in Moltoni's Warbler *Sylvia subalpina* (Brambilla et al 2008ab, Svensson 2013), Marmora's Warbler *S sarda* and Balearic Warbler *S balearica* (Shirihai et al 2001), and Citril Finch *Carduelis citrinella* and Corsican Finch *C corsicana* (Förschler & Kalko 2007, Förschler et al 2009), which analysed morphological, vocal, and genetic differences between these taxa to provide a picture of their systematics as complete as possible. The *Muscicapa* flycatchers in the western Mediterranean are among the most recent objects of study. So far, studies have dealt with morphology (Gargallo 1993, Viganò & Corso 2015, Olioso et al 2019), genetics (Pons et al 2016) and, more recently, vocalizations (Viganò 2015, Comolet-Tirman 2017, 2018, Wroza 2019). Here, we will report our most recent studies on vocalizations, relevant to field identification and crucial for assessing systematic relationships. Sounds are especially important in European *Muscicapa* species, with their drab plumage and extensive use of songs and calls, especially during courtship and reproduction (Viganò 2015). Sufficient evidence has now been mustered to confirm the recognition of insular Tyrrhenian populations from continental ones as a separate species according to the Phylogenetic Species Concept (Cracraft 1983, 1997): Mediterranean Flycatcher *M tyrrhenica*. Morphological comparisons of *M t tyrrhenica* (hereafter nominate *tyrrhenica*) and *M t balearica* (hereafter *balearica*) versus Spotted Flycatcher *M striata* (hereafter *striata*) showed significant differences, several of which allowing certain identification both in the field and in the hand (Gargallo 1993, Viganò & Corso 2015, Viganò et al 2016). Additionally, the recent publications and our results of bioacoustic analyses reported here confirm differences in vocalizations (especially song) be-

tween *tyrrhenica* sensu lato and *striata*, and their usefulness as a diagnostic character, both in the field and through analysis of sonagrams.

Genetic studies have shown constant differences in mitochondrial (about 3.5% in the CO1 region) and nuclear DNA between 'insular' (Corsica, Sardinia, Balearics, Tyrrhenian coast of Toscana) and continental populations (Pons et al 2016). Additional genetic studies of birds from Elba, in the Tuscan archipelago, and Sardinia, led to identical results of 3.5% different bases in the CO1 region of mitochondrial DNA (mtDNA) between nominate *tyrrhenica* and *striata* (Andrea Galimberti & Michele Viganò unpublished data). These populations can thus be considered two separate entities: the *tyrrhenica* group and the *stri-*

FIGURE 1 Distribution of Spotted Flycatcher *Muscicapa striata* (yellow: breeding; blue: wintering) and Mediterranean Flycatcher *M tyrrhenica* sensu lato (red: breeding; green: breeding range along Tyrrhenian coast of Italy in contact with or very close to that of Spotted; hatched blue: area of very few known winter records of *M t balearica*).



ata group, which separated about 1.1 million years ago, while *balearica*, though clearly grouped in *tyrrhenica* lineage, started differentiating from nominate *tyrrhenica* about 0.5 million years ago and shows a CO1 mtDNA distance from *tyrrhenica* of 1.7%, thus possibly acting as an incipient new species (Pons et al 2016). For decades, Mediterranean Flycatcher was almost completely neglected, with little if anything mentioned about its identification in the main field guides. Western Palearctic (WP) handbooks contain brief, vague, and often mistaken information. This is also the case for Shirihaï & Svensson (2018), where the only photograph of a presumed *tyrrhenica* is indeed most probably a *striata* due to cold greyish upperparts, heavy streaking on head, clear demarcation between ear-coverts and underparts and heavy, clear streaking on breast. In the text, they argue against the recognition of Mediterranean Flycatcher as a separated species based on two points: **1** morphological distinction of nominate *tyrrhenica* from Italian *striata* is poor and not comprehensively studied; and **2** genetically, nominate *tyrrhenica* seems to bridge *striata* and *balearica* rather than group with the latter. In our opinion point **1** is confuted by our past studies as well as the evidence shown here (but we agree that further study is needed in the contact zones), while point **2** is evidently a misreading of the data presented by Pons et al (2016) (see also Olivos et al 2019).

Our knowledge of migration routes and timing, wintering areas, and stop-over sites of *tyrrhenica* *sensu lato* is still very limited. Therefore, we summarize the available studies to provide a clear, concise and thorough framework for its identification. This paper mainly focuses on adult plumages of *striata*, nominate *tyrrhenica* and *balearica*; juvenile and first-winter plumages are more briefly analysed due to a lack in knowledge. In this paper, we use terms for *striata* such as 'the European Spotted Flycatchers' or 'Spotted Flycatchers of the European population', as we refer to populations breeding in Europe, or anyway within WP borders, rather than far eastern populations. By the same token, we use *tyrrhenica* *sensu lato* for Mediterranean Flycatcher as a whole, and nominate *tyrrhenica* and *balearica* for its two subspecies. Additionally, field identification of North African populations (and in part Iberian ones) should be investigated as well, since they likely concern an undescribed subspecies (Pons et al 2016; all authors' pers obs). However, the data at our disposal for North Africa are still incomplete and are only briefly mentioned here.

Materials and methods

We have studied the *Muscicapa* species groups in the field over the last decade in Balearic Islands (Mallorca and Menorca; Spain), Crete (Greece), Corsica (France), Cyprus, Georgia, Germany, Italy (including Sardinia and the Tuscan islands of Elba and Capraia), Switzerland and Turkey. We have also examined photographs from all taxa. Morphometric data were obtained using a stopped ruler (to the nearest 0.5 mm), callipers (to the nearest 0.1 mm) and a thin strip of graph paper (to the nearest 0.5 mm). On these birds we also measured the intensity of streaking on head and breast using the same categories used in Viganò & Corso (2015) (in the present study we added two additional ones for head streaking to include the heavier head pattern of *balearica*); after an initial evaluation of all specimens, we established categories that could represent in sufficient detail the variability. We scored breast streaking on a 0 to 6 scale (0 indicating the least streaked birds and 6 the most streaked ones) and head streaking on a 0 to 7 scale.

Collections visited for this research are: Natural History Museum, Tring, England (NHMUK); Museo Zoologico ISPRA, Ozzano dell'Emilia, Italy (MZI); Museo Civico di Storia Naturale di Milano, Milan, Italy (MSNM); Museo Civico di Zoologia di Roma, Roma, Italy (MCZR); Museo di Scienze Naturali in Forlì, Forlì, Italy (MSNF); Museu de Ciències Naturals de Barcelona, Barcelona, Spain (MCNB); and Muséum National d'Histoire Naturelle, Paris, France (MNHN). A total of c 300 skins were examined to study plumage characters and variability; morphometric measurements were also taken for 87 of these, whose geographic origin can be found in table 1. The recordings used to analyse songs (92 individuals) were obtained with a portable recorder and a parabolic microphone (table 2).

General information

Mediterranean Flycatcher – nominate M t tyrrhenica

Described in German (translated here) as 'Tyrrhenischer Grauer Fliegenfänger' by Guido Schiebel (1910). One of the syntypes is stored at Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK). The female is registered as ZFMK 57.1307, collected at Aitone near Evisa, Corsica, France, on 18 May 1910 (van den Elzen & Rheinwald 1984). Type description: '*Muscicapa striata tyrrhenica* subsp. nova. Tyrrhenian Flycatcher. Easily distinguished from a series of *M. s. striata* from Austria since the streaking on the underparts is very blurry and does not contrast strong-

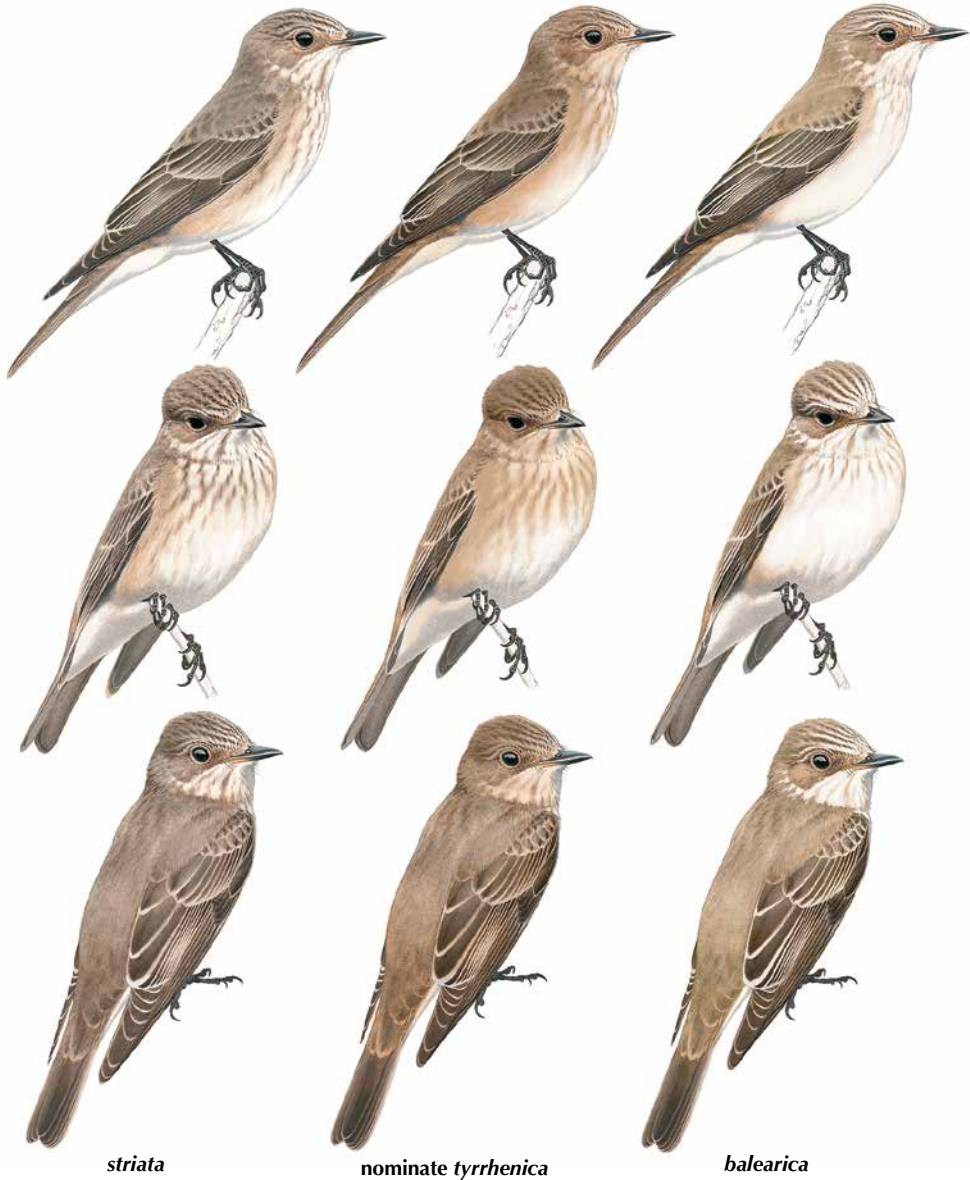


FIGURE 2 Spotted Flycatcher / Grauwe Vliegenvanger *Muscicapa striata* (left), Tyrrhenian Flycatcher / Tyrreense Vliegenvanger *M tyrrhenica tyrrhenica* (centre) and Balearic Flycatcher / Balearische Vliegenvanger *M tyrrhenica balearica* (right) (Lorenzo Starnini). For nominate *tyrrhenica* note especially: short wing not projecting beyond tail-coverts and with primary projection shorter than tertials length, rusty tones to plumage, weak contrast between upperparts and underparts, weak head streaking, diffuse streaking on underparts, creamy tinge to throat and lack of clear demarcation between ear-coverts and throat. For *balearica* note: same short wing as nominate *tyrrhenica*, warm but paler tones to plumage (more creamy/beige), clear contrast between upperparts and underparts, very pale underparts with almost immaculate flanks, very pale (whitish) base to head feathers making the head streaking even more evident than in *striata*, few, pale and thin streaking on throat and breast, rusty ear-coverts appear as mask due to contrast with pale crown, throat and some white neck feathers.

TABLE 1 Numbers and geographic origin of studied *Muscicapa* specimens

***Muscicapa striata* (53)**

M s striata (40) – Britain (5 NHMUK); France (1 NHMUK); Italy (29, from throughout continental Italy: 9 MSNM, 9 MCZR, 3 MSNF, 8 MZI); Netherlands (1 NHMUK); Poland (2 NHMUK); Sweden (2 NHMUK).

M s neumanni (4) – Crete, Greece (1 NHMUK); Iran (2 NHMUK); Palestine (1 NHMUK).

M s ssp (9) – Morocco (5: 2 NHMUK, 3 MCNB); Spain (3 MCNB); Tunisia (1 NHMUK).

***Muscicapa tyrrhenica* (34)**

M t tyrrhenica (17) – Corsica, France (1 NHMUK); Sardinia, Italy (16: 6 MSNM, 6 MCZR, 4 MSNF).

M t balearica (17) – Balearic Islands, Spain (15 NHMUK); Cameroon (2: 1 in spring (23 April 1921) and 1 in autumn (28 October 1907), NHMUK).

TABLE 2 Numbers and geographic origin of analyzed songs of *Muscicapa* taxa

***Muscicapa striata* (31)**

M s striata (31) – Britain (1 Martin Sutherland/xeno-canto.org XC256403); France (5 Julien Rochefort); Italy (13 this study); Poland (1 Krzysztof Deoniziak/xeno-canto.org XC101385); Sweden (1 Mats Rellmar/xeno-canto.org XC139372); Switzerland (10: 9 this study, 1 Thomas Luthi/xeno-canto.org XC247757).

***Muscicapa tyrrhenica* (61)**

M t tyrrhenica (37) – Corsica, France (24: 20 this study, 4 Arnoud van den Berg/The Sound Approach); Italy (13: 4 from Sardinia, 1 from Livorno (coast of Toscana), 7 from Capraia (Tuscan archipelago), 1 from Montecristo (Tuscan archipelago) – all for this study except the one from Montecristo by Giuseppe Gazzoni (in Brichetti & Fracasso 2008).

M t balearica (24) – Balearic Islands, Spain (21 from Mallorca: 19 this study, 2 Mark Constantine/The Sound Approach; 3 from Menorca, this study).

ly with the other feathers. One individual from Sardinia (donated by Crown Prince Rudolph, Hofmuseum, Vienna) resembles the Corsican birds. Range: Corsica and Sardinia. Types: male, 19 May 1910; female, 19 May 1910; pair.'

BREEDING RANGE The published breeding range comprises Sardinia, Corsica, the Tuscan archipelago (nominate *tyrrhenica*) and the Balearic Islands (*balearica*) (Viganò & Corso 2015) (figure 1). In much of its range, this taxon is exceptionally common and prefers less arboreal habitats than *striata*, favouring rocky and sometimes highly urbanized areas (Brichetti & Fracasso 2008, Viganò & Corso 2015; MV pers obs). In some publications, nominate *tyrrhenica* is also reported as breeding along a narrow coastal strip on the western – ie, Tyrrhenian – coast of Italy (Tellini et al 1997, Brichetti & Fracasso 2008). This has recently been confirmed by our personal observations: **1** in May 2015, we observed and sound-recorded singing individuals at Livorno (Tuscan coast); **2** in July 2016, several presumably breeding birds were photographed along the Entella river at Lavagna along the Ligurian coast (Daniele Papi and Andrea Simoncini in litt; the most northerly population currently known); **3** in June–July 2016, breeding birds were observed along the Tiber river at Rome, syntopically with several breeding pairs of *striata* (Andrea Corso & Justin Jansen pers obs). Its presence along the Tyrrhenian coast of Toscana is confirmed by the presence of individuals identified genetically as nominate *tyrrhenica* from the city of Livorno (Pons et al 2016). The presence of nomi-

nate *tyrrhenica* as far inland as Firenze, the locality of the wrongly identified photograph in Shirihai & Svensson (2018), has never been confirmed so far. We have the following data from small islands in the Tyrrhenian Sea, ie, away from its published range in the Tuscan archipelago: **4** in June 2012, several pairs on Marettimo, Egadi islands, Sicily (Giuseppe Speranza in litt); **5** in June 2017, several apparently breeding pairs on Ustica, c 50 km north of Palermo, Sicily (Giuseppe Speranza in litt); **6** in July 2016, several pairs on Ponza, Pontine archipelago, Latium (Giovanni Radaelli in litt); and **7** in June 2018, some possibly breeding birds on Ischia, Campania (Rosario Balestrieri in litt).

MIGRATION At least three were found on migration on 12 September 2015 on Salina, Aeolian islands, Sicily (Davide De Marchi in litt); two on 11 October 2015 on Lampedusa, Pelagie islands, Sicily (pers obs, MISC – Malati di Isolitudine allo Stadio Cronico); and numerous individuals (both adults and juveniles) in mid- to late September 2013–16 on Favignana, Egadi islands, Sicily (AC pers obs). It would be interesting to verify whether, as we suspect, Mediterranean Flycatcher also breeds on Salina and the Egadi islands. The wintering area is still unknown (Viganò & Corso 2015, Pons et al 2016, Viganò et al 2016).

VERNACULAR NAME The English name chosen by the IOC World Bird List is Mediterranean Flycatcher (Gill & Donsker 2019). Since Dutch Birding follows the IOC list for vernacular names, it is also the name used in this paper (Redactie Dutch

Birding 2016). When Mediterranean Flycatcher becomes the name of *tyrrhenica* sensu lato, Tyrrhenian Flycatcher can be used for nominate *M t tyrrhenica* and Balearic Flycatcher for *M t balearica*.

Balearic Flycatcher – M t balearica

Described in German (translated here) by Karl von Jordans (1913). The holotype is stored in ZFMK. The male was collected at Valldemosa, Mallorca, on 19 May 1913 (ZFMK 654) (van den Elzen & Rheinwald 1984). Type description: '*Muscicapa striata balearica* subsp. n. Bird surprisingly pale. Upperhead feathers with broad white edges. Back and underside very bright. Very similar to *M. str. Neumanni* Poche, but brighter, especially the upperhead, remarkably short wings. Wing length male 79,5-81,5, female 76-80 mm (*M. str. striata* 85-89, *M. str. neumanni* 86-90,5 mm). Type in my collection.'

BREEDING RANGE This taxon is only found breeding in the Balearic Islands, where it is very common and often found close to buildings (Gargallo 1993).

MIGRATION Recently, several sightings have been reported for French and Spanish Mediterranean coasts which reveal a regular passage, with a peak in early May (Peignot & le CHR-LR 2011, Gil et al 2016). There are five records outside the Balearic Islands: **1** one ringed in Merzouga, south-eastern Morocco, on 27 April 2013, the first record for Morocco (Bergier et al 2015); **2** one ringed in Malta on 26 April 2011 (Galea & Viganò 2011); **3** one ringed on Antikythera, Greece, on 5 May 2011 and recaptured afterwards on Menorca, Balearic Islands (Garcia-Febrero & Barboutis 2012); **4** 12 individuals trapped on Sardinia between late April and early May, five in Mal di Ventri (from May 1997) and seven from Asinara (May 2013, May 2014, May 2018 and four between late April and early May 2019) (Fozzi et al 2019); **5** one presumed bird photographed near Tagoundaft, 22 km north-east of Tizi n'Test pass, High Atlas, Morocco, on 13 April 2019 (Luca Mazzini et al). Winter range: specimens have been collected in western and south-western Africa (del Hoyo et al 2006). Two collected in Cameroon: see table 1.

VERNACULAR NAME When Mediterranean Flycatcher becomes the name of *tyrrhenica* sensu lato, Tyrrhenian Flycatcher can be used for nominate *M t tyrrhenica* and Balearic Flycatcher for *M t balearica*.

Spotted Flycatcher – various subspecies
Gill & Donsker (2019) list the following subspecies of *striata*:

M s striata, breeds from Europe east across the Ural mountains to western Siberia (Irtysh river), and in north-western Africa from northern Morocco east to northern Tunisia; winters in western, eastern and southern Africa.

M s inexpectata, breeds in Crimea; winters in Africa.

M s neumanni, breeds from islands in the Aegean Sea east to the Caucasus and northern and western Iran, and south to Cyprus and Levant, also in central Siberia (from Irtysh river east to western Transbaikalia); winters in eastern and southern Africa.

M s sarudnyi, breeds from eastern Iran and Turkmenistan east to Tien Shan, Pamirs and northern and western Pakistan; winters probably in eastern and southern Africa.

M s mongola, breeds from south-eastern Altai east to south-eastern Transbaikalia and northern Mongolia; winters probably in eastern and southern Africa.

The same genetic distance measured between the two subspecies of Mediterranean Flycatcher was found between European individuals of Spotted Flycatcher, including *M s neumanni*, and six individuals from Spain and Tunisia (Pons et al 2016). Additional studies are underway to shed light on the taxonomic situation of other populations of Spotted Flycatcher, especially those from Iberia and North Africa which, on the basis of genetic, structural, and plumage differences, may be subspecifically distinct (Jean-Marc Pons & José Luis Copete in litt). Nevertheless, in the absence of data on vocalizations, which proved essential for the other taxa, any further speculation on the systematic relationships of Iberian and North African populations is premature.

Plumage sequences

Interestingly, *Muscicapa* flycatchers have a moult sequence unique among European birds, with primaries moulting ascendantly, from the outermost (p1) to the innermost (p10) (Svensson 1992, Jenni & Winkler 1994, Blasco-Zumeta & Heinze 2015, Demongin 2016). Additionally, moult takes place mostly on the wintering grounds, and primary moult hardly ever in Europe, with very rare exceptions (Jenni & Winkler 1994). Therefore, birds can look very abraded and featureless in summer (plate 402). There is no information available in the literature on moult in Mediterranean Flycatcher, but two adult nominate *tyrrhenica* photographed by



402 Tyrrhenian Flycatcher / Tyrrhense Vliegenvanger *Muscicapa tyrrhenica tyrrhenica*, Sardinia, Italy, 7 August 2012 (Helge Sørensen). This very abraded and faded individual lost most of its warm rusty-drab or beige tinge to both underparts and upperparts; however, note almost invisible streaking and typical structure with shorter primary projection compared with Spotted Flycatcher *M striata*, with impression of longer tail. Abraded birds appear more two-toned than fresh ones, but still look duller overall and more uniform than Spotted. **403** Tyrrhenian Flycatcher / Tyrrhense Vliegenvanger *Muscicapa tyrrhenica tyrrhenica*, Salina, Eolie Islands, Sicily, Italy, 12 September 2015 (Davide de Marchi). On this bird many typical features of nominate *tyrrhenica* are visible: warm brownish colours, weak streaking on head and breast, creamy tinge on throat and weak contrast with ear-coverts, primary projection shorter than tertials length. There is an almost complete lack of information about moult timing of Tyrrhenian but this adult bird seems more advanced in his post-breeding moult than is usually the case in Spotted Flycatcher *M striata*, with newly replaced greater and median coverts, three tertials and, apparently, four inner primaries.

Davide de Marchi on Salina, Sicily, on 12 September 2015 (plate 403) showed quite an unusual moult for a European *Muscicapa*, being very advanced – including nearly all greater coverts, tertials, and four primaries – and because the moulted primaries were the inner ones as opposed to the outer ones, as would normally be the case in European *Muscicapa*. Additional studies are sorely needed to shed more light on the moult strategy of the two subspecies of Mediterranean Flycatcher.

Identification

General appearance

Tyrrhenica sensu lato is slightly smaller than *striata*, with a different structure. The wings are shorter and the tail appears longer in the field due to the shorter maximum chord and primary projection. The head looks somewhat larger, as in many Asian flycatchers. The two subspecies can be distinguished on plumage. Nominate *tyrrhenica* gives a rather dark overall impression (especially wings and tail), ‘dirty’, and lacking contrast (plate 404). This is due to lower contrast between the upperparts and underparts, the less-defined streaking on the underparts compared with *striata* and the warmer flanks, often with a buffy hue. The plumage of *balearica* is very pale and clean, both above

and below; the underparts in particular can appear almost pure white from a distance (plate 406). The upperparts are paler than in other taxa in nominate *tyrrhenica* and *striata*, with a beige tint, while the head’s whitish background colour sets off streaking that is better defined and often more ‘orderly’ than in *striata* and especially nominate *tyrrhenica*.

Structure

Table 3 gives the main biometric measurements from our studies of museum skins. Both subspecies of Mediterranean Flycatcher are smaller and more delicate than *striata*: the average maximum chord measured for nominate *tyrrhenica* was 81.6 mm (79-84) and for *balearica* 78.9 mm (76-82), while for 47 *striata* from throughout the WP (but excluding North Africa, see below) the average is 85.5 mm (83-90). We compared our museum measurements with measurements taken on ringed birds in the Balearic Islands (212 *striata*, 229 *balearica*) and can confirm that there is no statistical difference in the mean wing chord length of live birds and museum specimens (t-test for *balearica* gave $t=0.4666$ and $p=0.6412$, for *striata* $t=0.6295$ and $p=0.7878$). In the field, the shorter wing of *tyrrhenica sensu lato* can be detected by looking at primary projection (in relation to tertial length) and the wing-tip/tail-tip ratio. In *tyrrhenica sensu lato*, tertial length

TABLE 3 Important morphometric (mean and range in mm, followed by number of specimens) and plumage measurements derived from museum specimens for the three *Muscicapa* taxa discussed. Values for p2-5 indicate distance (in mm) between second and fifth primary (numbered from outside); positive values indicate that p2 is longer than p5, negative values the opposite. Same for third and fourth primary (p3-4), where p3 is almost always wing-tip in *striata*, while in *tyrrhenica* sensu lato p3 is very often bunched with p4. Plumage streaking intensity was measured for both breast (on scale from 0 to 5, where 0 is least and 5 most streaked) and head (on scale from 0 to 7); see main text under Materials and methods for further details.

	<i>striata</i>	nominate <i>tyrrhenica</i>	<i>balearica</i>
wing chord	85.84 (83-90; 44)	81.59 (79-84; 17)	78.82 (76-82; 17)
tail	55.60 (50-60; 15)	56.36 (54-61; 14)	56.00 (51-58; 17)
p2-5	2.57 (0/5; 44)	-0.59 (-2/1; 14)	-1.94 (-4/0; 17)
p3-4	1.25 (0/3; 44)	0.06 (-1/1; 17)	-0.18 (-1/0; 17)
bill width	4.37 (3.5-4.5; 28)	4.35 (3.5-5; 15)	4.39 (3.5-4.5; 8)
breast streaking	4.04 (3/5; 28)	1.6 (0/3; 15)	0.53 (0/2; 17)
head streaking	3.62 (2/5; 28)	1.33 (0/3; 15)	5.59 (4/7; 17)

is always longer, or at most equal to primary projection (plate 406, 411), while in *striata* the tertial length is always shorter, or at most equal to primary projection (plate 410). When perched and with the wings closed, the wing-tip of *tyrrhenica* sensu lato reaches the base of the tail or c one third of the way down, while in *striata* it reaches at least halfway down the tail. The wing formula also differs between the two: in *tyrrhenica* sensu lato, the wing is rounder with p2 shorter than p5 (numbered from the outside) (plate 407, 409), while the reverse is usually true in *striata* (plate 408). As a consequence, in *tyrrhenica* sensu lato p2 is also clearly shorter than p3 (which forms the wing point), while this difference is less evident in *striata*. Nevertheless, we feel that the p2/p5 ratio is more reliable: this character is easy to use in the hand and on museum skins but can also be seen in the field under ideal conditions or on good photographs (cf plate 410, 413). The best conditions for evaluating this character and obtaining useful images are with birds at eye level or above, and slightly backlit: the primaries will appear translucent, making it easier to assess the position of p2 in relation to p5 (plate 412). Some Iberian breeding individuals from Catalunya measured in the field have p2 equal to p5 in length, or even shorter. The number of studied birds is small (n=25) and mostly they showed p2 longer than p5. Furthermore, from our data there seems to be a slight gradient, with birds from northern, north-eastern and western Europe (Denmark, France, Netherlands, Poland, Sweden) showing a larger distance between p2 and p5 (p2 much longer than p5, mean 3.91 mm, n=8), while birds from central/southern Italy have a less pronounced distance (mean 2.14 mm, so p2 closer to p5 but still longer, n=7); anyway, birds from as south as the Puglia and Calabria regions of Italy (thus breeding south of many Mediterranean

Flycatchers) still show p2 longer than p5, the reverse of most *tyrrhenica* sensu lato. This highlights the need of combining different features for a correct identification. Average tail length is the same in the two species but in light of the wing-tip/tail-tip ratio, *tyrrhenica* sensu lato appears to have a narrower and longer tail compared with *striata*, both in the field and in the hand. We did not find any other meaningful structural differences. In this regard, it is interesting to note that Parrot (1910) reported differences in bill structure for nominate *tyrrhenica*, which he considered to be flatter at the base and more elongated, based on six specimens from Corsica. We have been unable to confirm these differences in bill structure – our measurements from a large series of specimens were similar for all three taxa discussed here – but measurements taken from live birds may shed a different light on the assessment of this character.

Plumage colour

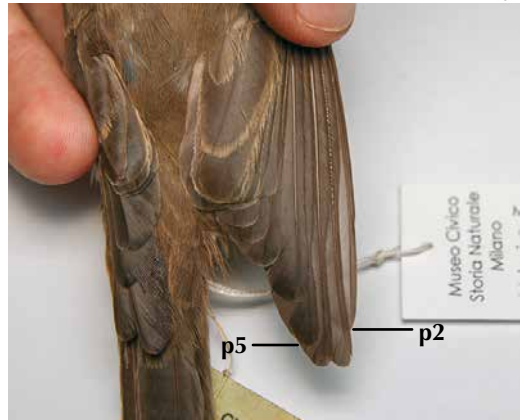
The mantle of *striata* from continental Europe is rather cold brownish-grey, lacking warm tones (plate 405). The rump appears concolorous with the back, or at most slightly warmer. Wings and tail are essentially the same colour, with rather evident pale edges, which wear rapidly and may be nearly invisible as early as May, more commonly mid/late June (wing and tail moult takes place on the wintering grounds in Africa). The underparts are rather pale with evident streaking and contrast visibly with the upperparts. Nominate *tyrrhenica* have clearly warmer plumage tones, brown with a rufous hue (cf plate 404). Although the mantle appears slightly paler in the field, the wings, tail, and head are darker, and this together with darker, less contrasting edgings to the tail and flight-feathers, give nominate *tyrrhenica* a darker overall appearance compared with *striata*; the edges to the wing-



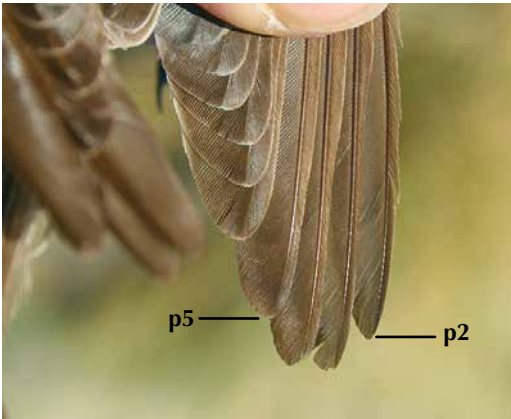
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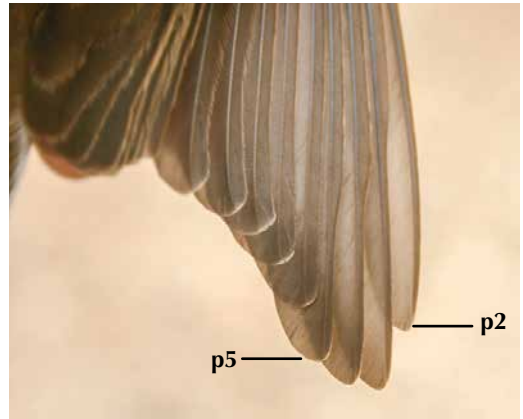
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404 Tyrrhenian Flycatcher / Tyrrhense Vliegenvanger *Muscicapa tyrrenica tyrrenica*, adult, Corsica, France, 6 June 2015 (Michele Viganò). Under field conditions, general impression of individuals from Sardinia, Corsica and Tyrrhenian islands and coasts, Italy, is that of warmer-toned birds than Spotted Flycatcher *M striata*, more uniformly coloured overall, with shorter wings, longer tail and bigger looking head and much less defined streaking on both head and underparts. **405** Spotted Flycatcher / Grauwe Vliegenvanger *Muscicapa striata*, adult, Pantelleria, Sicily, Italy, 15 May 2013 (Michele Viganò). During migration in Mediterranean basin, especially on small islands, it is possible to observe Spotted and Mediterranean Flycatcher *M tyrrenica* together: on side-by-side comparison, it is possible to note longer wings/primary projection of Spotted (wing-tip longer than longest undertail-covert), with primary projection being longer than tertials' length, proportionally shorter tail projection, colder and greyer plumage tone overall, more distinctly streaked underparts and crown, with better defined and well demarked streaks. **406** Balearic Flycatcher / Balearische Vliegenvanger *Muscicapa tyrrenica balearica*, adult, Mallorca, Balearic Islands, Spain, 11 June 2015 (Alex Bos). On Balearic Islands, this subspecies of Mediterranean Flycatcher is very common and widespread, breeding also in urban landscape. Its structure is very similar to that in Tyrrhenian Flycatcher *M t tyrrenica* but plumage is visibly paler, slightly colder, cleaner overall, with stronger contrast between darker upperparts and paler underparts, these being almost clean white. Crown has whiter ground colour than any other of related flycatcher taxa. Compared with Spotted Flycatcher *M striata*, primary projection is shorter (shorter than tertials' length), reaching 1/3 of tail (not 2/3) and in line with longest uppertail-coverts (and often shorter than undertail-coverts), appearing longer tailed; plumage is cleaner, paler, with narrower streaking on breast and crown, often barely visible. **407** Tyrrhenian Flycatcher / Tyrrhense Vliegenvanger *Muscicapa tyrrenica tyrrenica*, adult (collected on Tavolara, Sardinia, Italy, 14 May 1966), Museo Civico di Storia Naturale di Milano, Italy, 20 November 2012 (Michele Viganò). All over distribution range of Mediterranean Flycatcher (ie, both subspecies), wing is shorter than in Spotted Flycatcher *M striata*, with shorter second primary (p2) shorter or equal to p5. Furthermore, p3 and p4 appear closer to each other, being in most cases of same length.



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408 Spotted Flycatcher / Grauwe Vliegenvanger *Muscicapa striata*, adult, Falsterbo, Skåne, Sweden, 22 August 2015 (*Marc Illa*). In *striata*, p2 is (almost) always longer than p5. **409** Balearic Flycatcher / Balearische Vliegenvanger *Muscicapa tyrrhenica balearica*, adult, Illa de l'Aire, Menorca, Balearic Islands, Spain, 5 May 2015 (*Marc Illa*). Wing formula in *balearica* is similar to that in Tyrrhenian Flycatcher *M t tyrrhenica*, or sometimes with even shorter p2. **410** Spotted Flycatcher / Grauwe Vliegenvanger *Muscicapa striata*, adult, Ventotene island, Lazio, Italy, 24 April 2011 (*Michele Viganò*). Note extremely long primary projection, longer than tertials, and uppertail-coverts, reaching more than 2/3 of tail. In rare opportunity like this, when p2 is displaced, longer length compared with Mediterranean Flycatcher *M tyrrhenica* is obvious. **411** Tyrrhenian Flycatcher / Tyrreense Vliegenvanger *Muscicapa tyrrhenica tyrrhenica*, adult, Sardinia, Italy, 20 May 2012 (*Francesco Deluca*). Streaking on breast (and often belly) is weak and often appearing as dull spotting/marbling (almost as in Thrush Nightingale *Luscinia luscinia*), less well marked and obvious than in Spotted Flycatcher *M striata*. Head is overall dull with rather dull ground colour, streaking consequentially being barely visible. Throat is tinged creamy or tawny-drab, almost concolorous with ear-coverts (unlike Balearic Flycatcher *M t balearica*). Often, it is throat where dark markings are more visible. Flanks are in most birds tinged creamy or drab-tawny as well, more often than in Spotted (and of course than in Balearic).

coverts are also more fulvous and therefore less contrasting. In nominate *tyrrhenica*, the rump shows the warmest, rustiest tones of the entire body and slightly contrasts with the mantle and the tail (plate 411). The underparts look rather dirty, including the flanks and underwing, and contrast with the upperparts is limited. Additionally, the underparts, especially the throat and upper chest,

show a pale cream wash that is lacking in the other taxa (plate 417). *Balearica* share with nominate *tyrrhenica* the warm tones on the mantle, wings and tail but the ground colour is visibly paler and less reddish than in nominate *tyrrhenica*; sandy tones prevail over reddish ones (plate 406, 415). Additionally, some individuals may have a greyer and colder plumage, with reduced warm tones

Identification of Mediterranean Flycatcher



412 Tyrrhenian Flycatcher / Tyrreense Vliegenvanger *Muscicapa tyrrenica tyrrenica*, juvenile, Sardinia, Italy, 29 July 2013 (Claudio Crespi). All flycatchers, when perched, often have wings slightly open: in such position, it is possible to study wing-formula in detailed and close up photographs – note rather short p2, ‘bunched’ p3-p4 and shadow of p5, longer than p2.

413 Balearic Flycatcher / Balearische Vliegenvanger *Muscicapa tyrrenica balearica*, adult, Mallorca, Balearic Islands, Spain, 24 May 2016 (Michele Viganò). When preening, it may be possible to ‘read’ wing formula: look for rather short p2 with much longer p5 (in Spotted Flycatcher *M striata* this would have almost equal length of p5 or shorter and not visible). Note also typically clean white underwing-coverts of *balearica*, and almost unmarked white underparts, including breast. Crown is very pale with ‘ghostly’ streaking. Throat is very white, contrasting strikingly with ear-coverts, more than in Spotted and Tyrrhenian Flycatcher *M t tyrrenica*.





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414 Spotted Flycatcher / Grauwe Vliegenvanger *Muscicapa striata*, adult, Losone, Ticino, Switzerland, 12 June 2014 (Riccardo Caretoni). Streaking on both underparts and head more pronounced, visible and regularly defined compared with Mediterranean Flycatcher *M tyrrhenica*; furthermore, border between dark ear-coverts and pale throat is more abrupt than in Mediterranean, which usually shows creamy tinge in throat, lowering contrast between upper- and underparts. **415** Balearic Flycatcher / Balearische Vliegenvanger *Muscicapa tyrrhenica balearica*, adult, Mallorca, Balearic Islands, Spain, 5 May 2015 (Juan Sagardía). Plumage of *balearica* is surely most characteristic among related Western Palearctic *Muscicapa* flycatchers: underparts are almost unmarked white (sometimes only barely tinged creamy), fine, pencil-like dark streaking barely detectable, ground colour of crown is rather whitish, with darker streaking showing off pretty well, upperparts are drab-tawny, rusty ear-coverts often appear as isolated patch (surrounded by pale). **416** Balearic Flycatcher / Balearische Vliegenvanger *Muscicapa tyrrhenica balearica*, adult (left) and Spotted Flycatcher / Grauwe Vliegenvanger *M striata* (right), Illa de l'Aire, Menorca, Balearic Islands, Spain, 8 May 2012 (Marc Illa). When compared directly, whiter ground colour of crown of *balearica* is strikingly visible. In Tyrrhenian Flycatcher *M t tyrrhenica*, colour would be pretty similar to *striata*, but dark streaking much less well marked. **417** Tyrrhenian Flycatcher / Tyrrhense Vliegenvanger *Muscicapa tyrrhenica tyrrhenica*, adult (left) and Spotted Flycatcher / Grauwe Vliegenvanger *M striata* (right), Sardinia, Italy, 22 May 2018 (Ilaria Fozzi). When directly compared, it is easy to note differences in colours and contrasts between them: right bird has more numerous, clearer and browner streaks on underparts, while left bird shows fainter streaking and distinctive creamy wash to throat.



418 Spotted Flycatcher / Grauwe Vliegenvanger *Muscicapa striata*, adult, Falsterbo, Skåne, Sweden, 22 August 2015 (*Marc Illa*). Note cold plumage tone in this post-breeding adult, with very well marked dark streaking on crown and throat/breast, and very long wing and primary projection. **419** Balearic Flycatcher / Balearische Vliegenvanger *Muscicapa tyrrenica balearica*, adult, Illa de l'Aire, Menorca, Balearic Islands, Spain, 5 May 2015 (*Marc Illa*). Being easiest Mediterranean Flycatcher *M tyrrenica* to identify, *balearica* shows most characteristic plumage pattern: almost white ground colour of crown with well visible streaking, pencil-like streaking over breast, white throat which is often unmarked, isolated rusty ear-coverts patch, clean and bright underparts, uniformly tawny-drab or 'beige' upperparts, and often rather pale rump. In hand examination will reveal biometrical characters that are diagnostic for Mediterranean (ie, both nominate *tyrrenica* and *balearica*).



(caused by wear and individual, seasonal and age-related variation). The underparts are quite clean, almost pure white; the flanks are white, at most with a slight brownish wash, and the underwing is milky-white with a very slight hint of pale fulvous or cinnamon, which is often altogether lacking. When assessing field records of *balearica* in a vagrancy context, and especially when the documentation is poor, photographs of the underwing might be highly relevant to ensure the identification.

Chest and head streaking

As already noted by Schiebel (1910), underpart streaking is different in *striata* and *tyrrhenica* sensu lato. In *striata*, streaking is an evident plumage feature (plate 414, 418), hence its scientific name. Streaking is heavy and dense on the chest and neck sides, and quite well defined, contrasting strongly with the whitish ground colour of the underparts; streaking is more diffuse on flanks and axillaries. Some *striata*, especially breeding birds

in southern Europe (eg, several birds in north-eastern Spain) can show reduced chest streaking and white background, resembling *balearica* to some extent, but still have brown underwing and flanks. In *tyrrhenica* sensu lato, the underparts are visibly less marked, with some individuals showing virtually no real streaking: markings on the underparts are much less well defined and extensive than in *striata*, and they are rather warm in coloration (plate 411); in some individuals, especially from a distance, it is hard to discern any sort of patterns on the underparts except for a warm wash on the chest. Underpart streaking in *balearica* is limited, very fine, and of a warm yet quite pale colour (plate 415). Important differences from an identification standpoint can also be seen in head streaking (especially crown and forehead). Nominate *tyrrhenica* is the least marked of all, and since the ground colour of the head feathers is darker and warmer compared with the other taxa, the head streaking is less evident. In *balearica*, the ground colour of the head feathers, especially the fore-

TABLE 4 Summary of identification criteria for the three *Muscicapa* taxa discussed

	<i>striata</i>	nominate <i>tyrrhenica</i>	<i>balearica</i>
general structure	slender and elongated	short wings, long tail, large head	short wings, long tail, large head
general appearance	contrast between upperparts and underparts	dark and dirty, rather uniform	pale and clean, contrast between upperparts and underparts
primary projection	longer than tertials	shorter than tertials	shorter than tertials
wing formula	p2>p5 p3>p4	p2<p5 p3≈p4	p2<p5 p3≈p4
general colour	brownish-grey, generally cold plumage tones	dark brown with evident warm plumage tones	pale brown with evident warm plumage tones
rump	same colour as back	warmer than back	warmer than back
chest	strongly streaked	spotted or marbled, often indistinct as in Thrush Nightingale <i>Luscinia luscinia</i>	thin, well-defined streaking, sometimes nearly invisible
flank and underwing	dark	dark or dirty	pale and clean
head streaking	well-defined	poorly defined (dark ground colour of head)	very well-defined (ground colour of head very pale, often milky white)
ear-coverts	well demarcated from underparts but not from upperparts	blending with spotting on underparts	appearing isolated from rest of face (masked appearance)
song	maximum frequency 2 kHz, almost always below 10/11 kHz	electric tones in song, maximum frequency 18-20 kHz	electric tones in song, to human ear sounds very similar to <i>tyrrhenica</i> , but lower maximum frequency (13-15kHz)

Identification of Mediterranean Flycatcher



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420 From left to right: two Balearic Flycatchers / Balearische Vliegenvangers *Muscicapa tyrrhenica balearica*, adults, Ibiza, Balearic Islands, Spain, 11 May 1930; one Tyrrhenian Flycatcher / Tyrreense Vliegenvanger *M t tyrrhenica*, adult, Strait of Bonifacio, Sardinia, Italy, 1 April 1899; two Spotted Flycatchers / Grauwe Vliegenvangers *M striata*, adults, Uppsala, Sweden, 17 June 1950 and Texel, Netherlands, 5 June 1930, respectively; two flycatchers / vliegenvangers *Muscicapa*, Moyen Atlas, Morocco, 28 and 9 July 1919, respectively; Natural History Museum Tring, England, 21 March 2016 (*Michele Viganò*). Same specimens as in plate 421. Note differences in plumage tone and pattern between Tyrrhenian, Balearic and Spotted Flycatchers: warmer and darker in *tyrrhenica*, warm but paler in *balearica*, and colder in *striata* (with certain amount of variability). Crown weakly streaked in *tyrrhenica*, visibly streaked and contrasting in *balearica*, and well streaked in *striata*. Right specimen of *striata* represents warmest and rustiest extreme of coloration spectrum, while left one is typical example. North African specimens appear as in-between link or mix among both species in plumage colour/pattern and measurements, though closer to Tyrrhenian.

421 From left to right: two Balearic Flycatchers / Balearische Vliegenvangers *Muscicapa tyrrhenica balearica*, adults, Ibiza, Balearic Islands, Spain, 11 May 1930; one Tyrrhenian Flycatcher / Tyrreense Vliegenvanger *M t tyrrhenica*, adult, Strait of Bonifacio, Sardinia, Italy, 1 April 1899; two Spotted Flycatchers / Grauwe Vliegenvangers *M striata*, adults, Uppsala, Uppsala län, Sweden, 17 June 1950 and Texel, Noord-Holland, Netherlands, 5 June 1930, respectively; two flycatchers / vliegenvangers *Muscicapa*, Moyen Atlas, Morocco, 28 and 9 July 1919, respectively; Natural History Museum Tring, England, 21 March 2016 (*Michele Viganò*). Same specimens as in plate 420. Note that *balearica* is cleanest and least patterned; nominate *tyrrhenica* is pretty dull below (rusty-drab or dull beige tinged) with pretty dull and marked throat and almost spotted pattern; *striata* shows clean throat with well-marked streaks on malar area, breast with obvious and defined dark streaking. North African birds appearing as taxon with mixed features, though closer to Tyrrhenian.

head, is extremely pale, almost whitish, which clearly and strongly contrasts with the dark streaking (plate 416). In *striata*, this pattern is intermediate, more contrasting than in nominate *tyrrhenica* but never as well defined as in *balearica* (table 4). In summer (July-August), the contour feathers, which by this time are 7-8 months old, are quite worn, and the pale margins that make the head of *balearica* look so contrasting, can wear off to the point that the head looks more uniform, while the underpart streaking in *striata* can look much thinner and subtle differences in plumage contrasts can easily disappear due to wear in nominate *tyrrhenica* too (plate 402).

Face pattern

In combination with underparts and chest streaking, the face pattern is of great use in identifying flycatchers in the Mediterranean basin. Once again, the face pattern in nominate *tyrrhenica* is the least well defined of all three taxa in question. In particular, the streaking/spotting on the chest and chin is so poorly-defined and blurry as to blend in with the ear-coverts; in most individuals, there is no clear demarcation between ear-coverts and the underparts, the ground colour of which is closer to cream than to white (plate 417). In *striata*, instead, the streaking on the underparts is not only thin and well-defined, it is also less messy than in nominate *tyrrhenica*, and running parallel to the malar stripes. This implies that a pale area is present between the dark malar stripe and the dark ear-coverts on *striata*, so that the ear-coverts are always clearly set off from the underparts. This is

true in *balearica* as well, although it is not quite as obvious due to the paler ground colour of ear-coverts. Nevertheless, *balearica* shows another important characteristic as a result of the sum of all the field marks listed above. The ear-coverts, together with the lores, look like an isolated dark mask surrounded by paler areas. In most individuals, the pale areas on the sides of the neck are so extensive that it almost looks like a half-collar that reaches all the way around the ear-coverts, further setting off the dark ear-coverts mask (plate 415, 419).

Vocalizations

In late spring and summer 2015, we carried out a study of *Muscicapa* songs. Our aim was to compare the songs of *striata* from continental Europe with those of nominate *tyrrhenica* from throughout their range: Corsica, Sardinia, the Tuscan archipelago and the Tyrrhenian coast. Our results showed that these two species could always be told apart by their songs, both in the field and through analysis of spectrograms, so that the song is a diagnostic identification character. The overall structure of the song of nominate *tyrrhenica* (figure 3) is very similar to that of *striata* (figure 5) but there is one character that allows for the immediate identification of these two species: nominate *tyrrhenica* emits some notes of extremely high frequency, much higher than the 6-8 kHz of their normal notes. They give the song a very distinctive tone, unique among European passerines (although at times Common Nightingale *Luscinia megarhynchos* and Lesser Whitethroat *S curruca* can give brief snatches of song that sound some-

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422 Flycatchers / vliegenvangers *Muscicapa*, adults, Museu de Ciències Naturals de Barcelona, Spain, 18 May 2016 (Michele Viganò). Four left birds: Hauta Kasdir, north-western Morocco, 7-18 July 1932; three right birds: Cubelles, Catalunya, Spain, 6 June 1952. Same specimens as in plate 423. Note that four skins to left appear much rustier and warmer than three right ones. Ibero-maghreb population deserves more study: genetically (see Pons et al 2016), they should represent compact group well differentiated from European Spotted Flycatchers *M striata*; looking at specimens and birds in field it would be hard to think that they belong to same 'population' or taxon. Study of vocalizations will surely help in better understanding of this conundrum. Nearest breeding area of Tyrrhenian Flycatcher *M t tyrrhenica* to Tunisian populations is no more than 150 km, raising question whether it could also be nesting in North Africa.

423 Flycatchers / vliegenvangers *Muscicapa*, adults, Museu de Ciències Naturals de Barcelona, Spain, 18 May 2016 (Michele Viganò). Four left birds: Hauta Kasdir, north-western Morocco, 7-18 July 1932; three right birds: Cubelles, Catalunya, Spain, 6 June 1952. Same specimens as in plate 422. Note that underparts colour and markings in North African specimens are similar to those in Mediterranean Flycatcher *M tyrrhenica*, while these are more like Spotted Flycatcher *M striata* in Iberian ones.

what similar), which might be described as 'electric' due to the very brief notes emitted in a rapid sequence, and their dry, strident, and high-pitched tone falling between 12 and 19 kHz. A practical way to describe this tone would be to liken it to a rusty bicycle wheel or to the sounds that can sometimes be heard near power lines. On a sonagram (figure 3), the shape of these high-frequency notes is very distinctive and visible, since they occupy a portion of the sonagram—above 12 kHz—that no other European bird exploits. The notes look like a thin, well-defined, uninterrupted line that begins at about 16 kHz then rises to 18-19 kHz—the highest frequency reached by the song—then drops precipitously to c 10-11 kHz or lower in the space of 0.02 seconds (Viganò 2015); similar results were recently found by Comolet-Tirman (2017). It should be stressed that these diagnostic high-pitched notes are very conspicuous and numerous in highly excited songs (eg, during interactions within the members of a couple—fast song, figure 3A and 3B), while in less excited song (eg, on a lazy session of territorial song from a high elevated perch—slow song, figure 3C) they can be much less frequent and thus the song sounds more similar to *striata*. In our experience anyway, even in the slowest song, some diagnostic high-pitched notes are always uttered.

In spring 2016, we recorded numerous individuals of *balearica* on Mallorca and Menorca, allowing us to present some general remarks on the song of this taxon: in the field, the general structure sounds extremely similar to that of the song of nominate *tyrrhenica*, including the diagnostic high-pitched elements that give it its distinctive electric tone. Looking at sonagrams (figure 4), it is evident that the maximum frequency reached by *balearica* is not quite as high as in nominate *tyr-*

rhenica, generally remaining below 15 kHz. We disagree with Comolet-Tirman (2018) about some recordings of *balearica* he analysed in his paper: he obtained similar results to ours but concludes that, even though generally higher pitched, the song of *balearica* does not have the short, strident, high-pitched notes of nominate *tyrrhenica*. Even though high-pitched notes of *balearica* have a maximum frequency usually between 12 and 15 kHz, they share the same structure and strident tone with the ones of nominate *tyrrhenica* and to our ears they sound extremely similar, just a tad less extreme and electric. The same considerations about the different number of high-pitched notes given for nominate *tyrrhenica* applies for fast (figure 4A) and slow songs (figure 4B and 4C) of *balearica*. In light of the above, it should be possible to differentiate between the songs of *striata* and *tyrrhenica* *sensu lato* by ear in the field at all times, and to distinguish the two subspecies of Mediterranean Flycatcher using sonagrams.

The song of *striata* and *tyrrhenica* *sensu lato* falls into the category of 'endless songs', namely vocalizations that are not organized into strophes repeated at regular intervals, but rather comprise improvised notes with no discernible pattern, uttered for a variable length of time. The notes included in these songs are very disparate: from low-frequency warbled notes reminiscent of certain parts of the song of Common Blackbird *Turdus merula* to very high-frequency notes around 10 kHz, which only a very few European species—such as Common Firecrest *Regulus ignicapilla*—reach; as stated, in *tyrrhenica* *sensu lato*, the highest frequency reached is even higher. The volume is always quite low, making it one of the least conspicuous European passerine songs.

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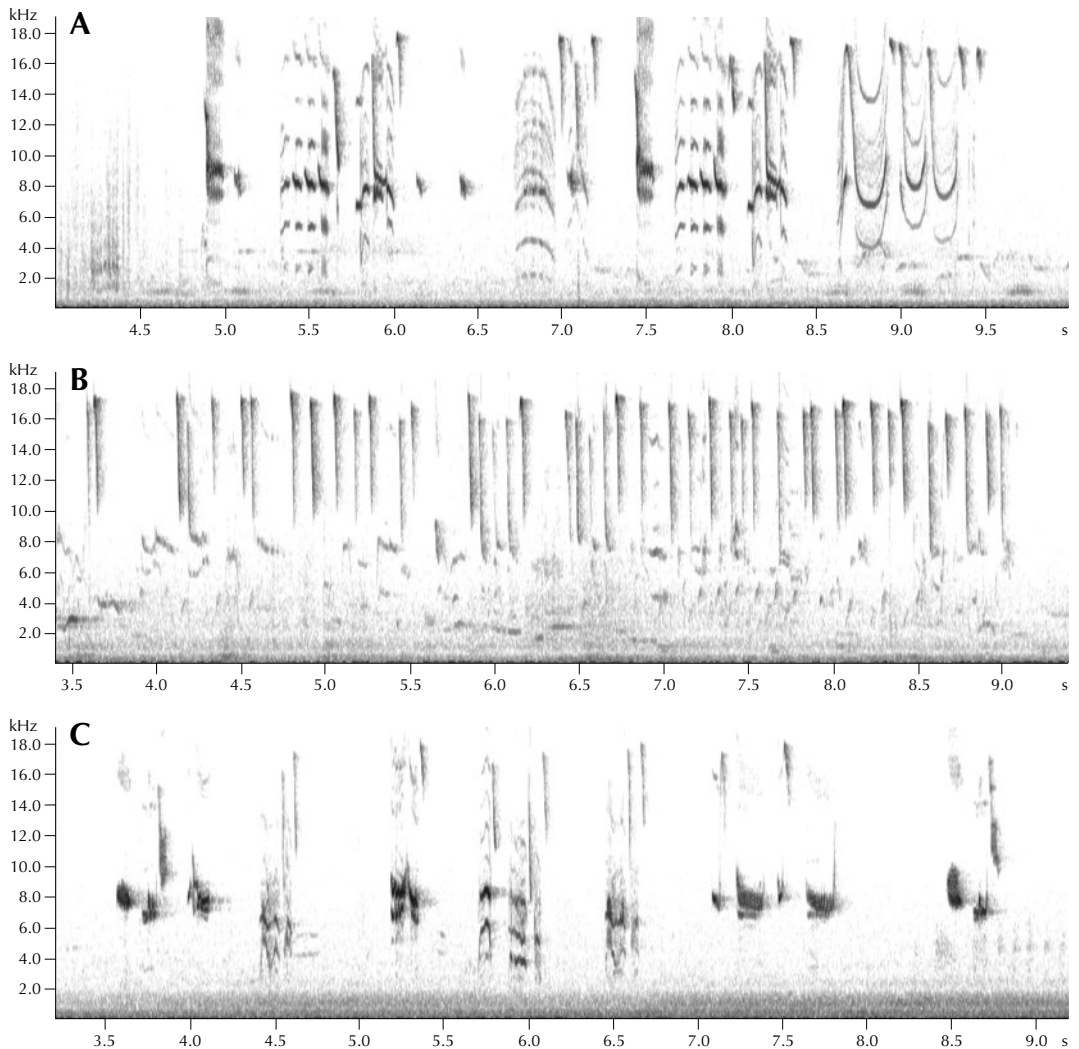


FIGURE 3 Tyrrhenian Flycatcher / Tyrrhense Vliegenvanger *Muscicapa tyrrenica tyrrenica*, song. **A** Sardinia, Italy, 8 June 2015; **B** Corsica, France, 5 June 2015; **C** Capraia Island, Tuscan archipelago, Italy, 28 May 2015 (*Michele Viganò*). Song is, in all European *Muscicapa*, without fixed scheme and uttered erratically and suddenly; however, some differences can be seen in sonagrams (and by ear once learned): both nominate *tyrrhenica* and Balearic Flycatcher *M t balearica* always include some notes of very high frequencies, unique among European passerines, giving song rather 'electric' quality (vertical lines on upper part of sonagram). In nominate *tyrrhenica*, these reach 17-19 kHz.

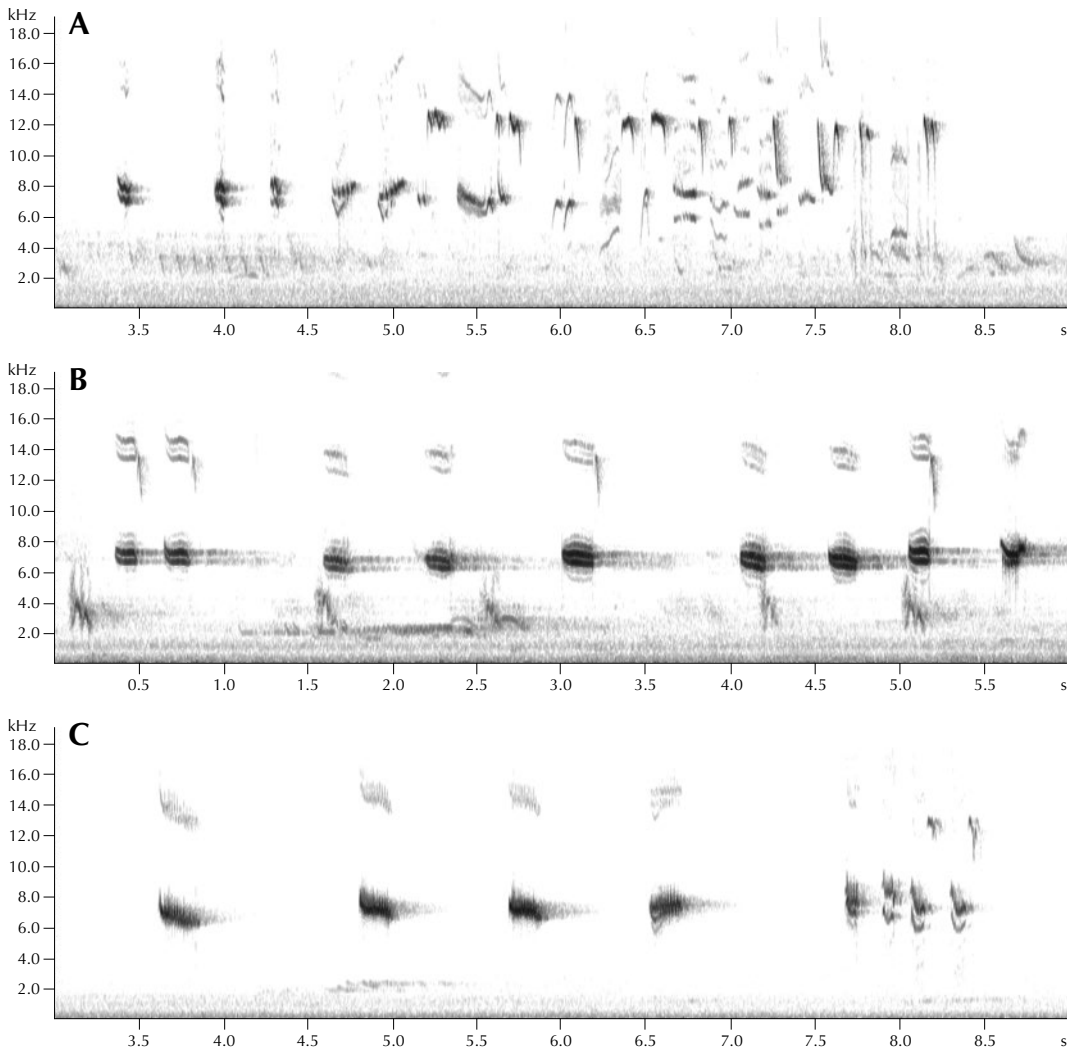


FIGURE 4 Balearic Flycatcher / Balearische Vliegenvanger *Muscicapa tyrrenica balearica*, song. **A** Mallorca, Balearic Islands, Spain, 24 May 2016; **B** Mallorca, Balearic Islands, Spain, 27 May 2016; **C** Menorca, Balearic Islands, Spain, 28 May 2016 (Michele Viganò). ‘Electric’ quality and notes typical of Tyrrhenian Flycatcher *M t tyrrenica* can be heard also in *balearica*, although highest frequencies are slightly lower in *balearica*, being around 13/14 kHz (still much higher than in Spotted Flycatcher *M striata*, and sounding very differently). In slower songs (B and C), the diagnostic high-pitched notes are less frequent than in faster songs (A).

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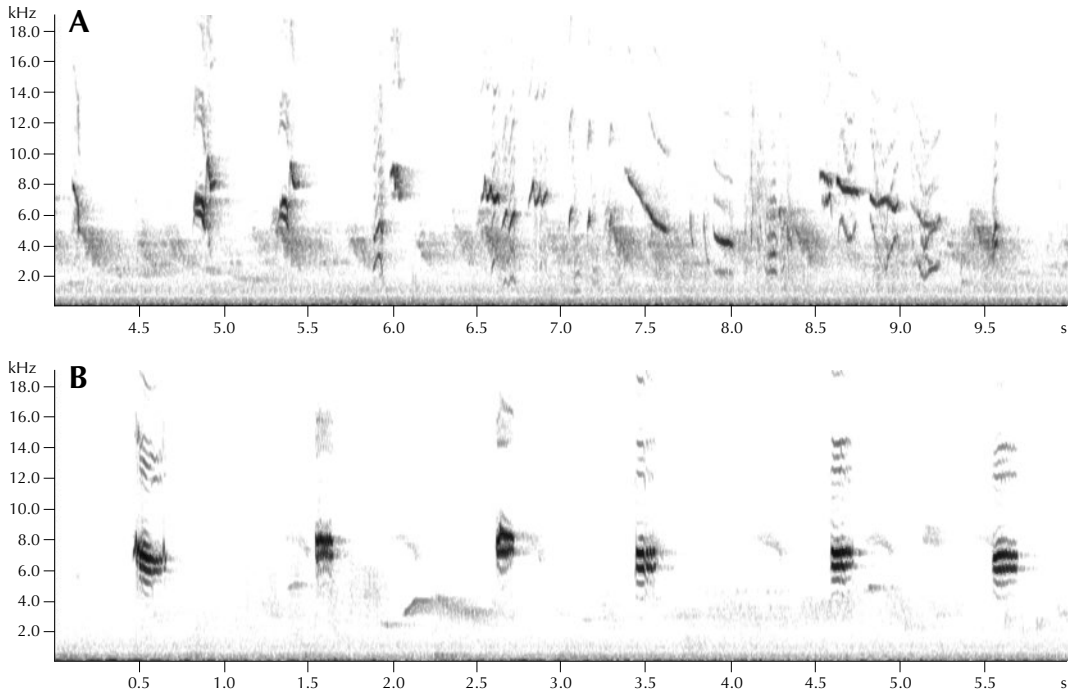


FIGURE 5 Spotted Flycatcher / Grauwe Vliegenvanger *Muscicapa striata*, song. **A** Sarigo, Varese, northern Italy, 18 May 2015; **B** Cadero-Veddasca, northern Italy, 26 May 2015 (*Michele Viganò*). Song of Spotted is always very subdued and continuously improvised, heard mostly around sunrise and sunset: it alternates some slow-pace parts (B) with other much faster ones (A); during latter, it is easier to hear typical difference between this species and Mediterranean Flycatcher *M tyrrhenica*. As can be seen in these sonagrams, ‘electric’ high-pitched notes are missing in Spotted.

Conclusions and further research

Striata has a very large breeding range, and our studies did not comprehensively sample all populations. For instance, the easternmost taxa *sarudnyi* and *mongola* are not well represented in European museum collections. Nevertheless, the specimens we were able to analyse convinced us that further studies are needed: given their plumage characteristics and morphometrics, these eastern taxa may prove to be identifiable in the field in a European context, where autumn vagrancy is possible. While *neumannii* does not appear to be much different from *striata*, taxa from further east (*inexpectata*, *sarudnyi*, *mongola*) generally appear paler and less well-marked than European birds, with a variable degree of streaking on the underparts and crown, and plumage patterns that can sometimes be very similar to those of *balearica* or even nominate *tyrrhenica*. Some individuals seem to have an overall brownish wash, and in some cases the ground colour of the crown is whitish. Primary projection is

generally longer than in nominate *tyrrhenica* and *balearica*, with a wing-tip/tail-tip ratio as in nominate *striata*, although p2 in *sarudnyi* can be shorter than or equal to p5. Crown streaking is generally heavy and well defined. Vocalizations are in need of further study.

The populations that require, however, the most urgent study are undoubtedly those from Iberia and North Africa. According to genetic analyses of Spanish and Tunisian individuals, they form a distinct group that is genetically different from all other *striata* analysed (from Europe and central Russia), and differentiated from them at about the same time as the split between the two subspecies of Mediterranean Flycatcher (Pons et al 2016). Once again, few specimens exist in museum collections but the ones we were able to study suggest that the situation is even more complicated. The Barcelona museum collection is of particular interest, as it provides the possibility to directly compare specimens taken during the breeding season

(June-July) in Spain and Morocco. Clear plumage and structural differences exist between specimens from these two countries: it is hard to believe that the individuals in plate 422-423 belong to the same taxon. In terms of biometrics, some – but not all! – of these North African individuals look very similar to *tyrrhenica* sensu lato. North Africa is as ecologically varied as the rest of the Mediterranean basin, and it could well host more than one taxon from the *striata* complex, as is the case with the Italian peninsula, where nominate *tyrrhenica* has recently been found along the Tyrrhenian coast of central Italy and on small islands off Sicily less than 150 km from the Tunisian coast. Studies on the Iberian-North African populations will shed more light on the evolutionary history of the *striata* complex in the Mediterranean, and we suspect that once again vocalizations will prove to be of crucial importance. For all taxa it would also be worthwhile to investigate more vocalizations than only song, such as contact calls (which are of more use for identifying out-of-range individuals). Mediterranean Flycatchers (especially *balearica*) are seen with some regularity along the Mediterranean coast of France and Spain in spring, probably due to overshooting. Therefore, spring is probably the best time to look for vagrants in central and northern Europe, a pattern matched by other species that share a similar breeding distribution, such as Moltoni's Warbler and Balearic Woodchat Shrike *Lanius senator badius*. Any putative claims of Mediterranean Flycatcher from central and northern Europe should be scrutinized very closely and ideally be assessed on the basis of: **1** very high-quality photographs showing the wing formula; **2** sound recordings; **3** primary projection and wing/tail ratio; and **4** precise plumage observations. In particular, in the absence of **1** and **2**, reports of vagrants should not be accepted far away from the breeding range.

In the next years, the distribution of *striata* and nominate *tyrrhenica* in continental Italy will be studied to assess sympatry. When contact areas are found, it will be possible to study the interactions between these taxa.

As said before, until recently information on identification of these *Muscicapa* taxa was treated in only a few publications (Gargallo 1993, van Duivendijk 2011, Viganò & Corso 2015), and at first differences between nominate *tyrrhenica* and *balearica* were not shown. That explains why all extralimital Mediterranean Flycatchers are from recent dates.

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Samenvatting

HERKENNING VAN BALEARISCHE VLIEGENVANGER Recent onderzoek naar *Muscicapa*-populaties in het centrale Middellandse Zeegebied laat zien dat deze de status van soort verdienen, Balearische Vliegenvanger *M tyrrhenica*. Na onderzoek aan morfologie en morfometrie kwamen er studies aan vocalisaties en genetica. Er bleken constante verschillen te zijn in zang en in nucleair en mitochondriaal DNA tussen continentale Grauwe Vliegenvanger *M striata* en de eilandpopulaties van Balearische. Twee ondersoorten van Balearische worden momenteel erkend: nominaat *M t tyrrhenica* broedt in Sardinië, Corsica, de Toscaanse archipel en delen van de Tyrrheense kust in Italië; de ondersoort *M t balearica* broedt op de Balearen. Voor beide ondersoorten is zeer weinig informatie over migratieroutes of overwinteringsgebieden beschikbaar. Structureel zijn beide onderling

vergelijkbaar en ze verschillen van Grauwe in kortere vleugellengte (*striata*: 85,5 mm, nominaat *tyrrhenica*: 81,6 mm, *balearica*: 78,9 mm). Anders dan bij Grauwe is daardoor de handpenprojectie van Balearische korter dan de lengte van de tertials. De vleugelvorm van Balearische is meer afgerond (p2 is gelijk of korter dan p5; handpennen van buiten naar binnen geteld). Hoewel de staart van Balearische even lang is als die van Grauwe, lijkt deze door de kortere vleugels in verhouding langer. De twee ondersoorten van Balearische verschillen onderling in verenkleed. Nominaat *tyrrhenica* heeft meestal een warme kleur van het verenkleed (bijna roodachtig), minder contrast tussen boven- en onderdelen, minder kruinstreping, uitgebreide maar slecht gedefinieerde streping op de onderdelen, goed gemarkeerde flanken en ondervleugels, en een subtiele maar karakteristieke roomkleurige tint op de keel. *Balearica* vertoont meer beige bovendelen, een sterk contrast tussen boven- en onderdelen, zeer goed gemarkeerde kruinstreping (zelfs meer dan bij *striata*), en zuiver witte onderdelen, flanken en ondervleugel met zeer kleine, dunne, en bleke streping beperkt tot bovenborst en keel. De algemene structuur van de zang van Balearische is vergelijkbaar met die van Grauwe: een schijnbaar willekeurige mix van lage en hoge tonen op laag volume en gedurende een variabele tijdsduur. De zang van Balearische verschilt echter van die van Grauwe door de aanwezigheid van veel hogere tonen (18-20 kHz in nominate *tyrrhenica*, 13-15 kHz in *balearica*). Deze zijn zowel in het veld als in sonogrammen detecteerbaar en diagnostisch. De zang van Balearische heeft daardoor een elektrische en schelle kwaliteit. De kennis over deze *Muscicapa*-soorten dient nog verder te worden onderzocht, met name op het Iberisch Schiereiland en in Noord-Afrika.

References

- Bergier, P, Franchimont, J & the CHM 2015. Les oiseaux rares du Maroc. Rapport de la Commission d'Homologation Marocaine numéro 20 (2014). Go-South Bull 12: 1-23.
- Blasco-Zumeta, J & Heinze, G-M 2015. Identification atlas of birds of Aragon – Spotted Flycatcher. Website: <https://tinyurl.com/yxe3qbfx>. [Accessed 17 May 2018.]
- Brambilla, M, Janni, O, Guidali, F & Sorace, A 2008a. Song perception among incipient species as a mechanism for reproductive isolation. *J Evol Biol* 21: 651-657.
- Brambilla, M, Vitulano, S, Spina, F, Baccetti, N, Gargallo, G, Fabbri, E & Randi, E 2008b. A molecular phylogeny of the *Sylvia cantillans* complex: cryptic species within the Mediterranean basin. *Mol Phylogenet Evol* 48: 461-472.
- Brichetti, P & Fracasso, G 2008. *Ornitologia italiana* 5 – Turdidae-Cisticolidae. Bologna.
- Comolet-Tirman, J 2017. Les vocalisations du Gobe-mouche gris *Muscicapa striata tyrrhenica* en Corse: perspectives pour les décisions relatives à son statut taxonomique. *Alauda* 85: 295-306.
- Comolet-Tirman, J 2018. Note sur le chant nuptial du Gobe-mouche des Baléares *Muscicapa tyrrhenica balearica* à Majorque. *Alauda* 86: 235-236.
- Cracraft, J 1983. Species concepts and speciation analysis. In: Johnston, R F (editor), *Current Ornithology* 1, Boston, p 159-187.
- Cracraft, J 1997. Species concepts in systematics and conservation biology: an ornithological viewpoint. In: Claridge, M F, Dawah, H A & Wilson, M R (editors), *Species, the units of biodiversity*, Systematics Association special volume 54, London, p 325-339.
- Demongin, L 2016. Identification guide to birds in the hand. Beauregard-Vendon.
- van Duivendijk, N 2011. *Advanced bird ID handbook – the Western Palearctic*. London.
- van den Elzen, R & Rheinwald, G 1984. Die Wirbeltiersammlungen des Museums Alexander Koenig. II. Vögel. *Bonn Zool Monogr* 19: 49-150.
- Förschler, M I & Kalko, E K 2007. Geographical differentiation, acoustic adaptation and species boundaries in mainland citril finches and insular Corsican finches, superspecies *Carduelis [citrinella]*. *J Biogeogr* 34: 1591-1600.
- Förschler, M I, Senar, J C, Perret, P & Björklund, M 2009. The species status of the Corsican finch *Carduelis corsicana* assessed by three genetic markers with different rates of evolution. *Mol Phylogenet Evol* 52: 234-240.
- Fozzi, I, Pisu, D, Piras, S, Carta, P, Zucca, C & Nissardi, S 2019. Prime segnalazioni di Pigiamaosche *Muscicapa striata balearica* in Italia attraverso dati di inanellamento scientifico. Poster, XX CIO 2019, Napoli.
- Galea, R & Viganò, M 2011. Segnalazioni da Malta. *Quad di Birdwatching* XIII (6): 40-41.
- Garcia-Febrero, O & Barboutis, C 2012. Primera cita de Menjamosques Balear (*Muscicapa striata balearica*) (Jordans, 1913) a l'illa d'Anticitera (Illes Jòniques, Grècia). *An Ornitol de Les Balears* 2012 (27): 43-48.
- Gargallo, G 1993. Identificació de la subspècie balear de Menjamosques (*Muscicapa striata balearica*). *An Ornitol de Les Balears* 1993: 21-30.
- van der Geer, A, Lyras, G, de Vos, J & Dermitzakis, M 2010. Evolution of island mammals. Malaysia.
- Gil, M, Burgas, A, García, M, Illa, M, Larruy, X, Ollé, À & Franch, M 2016. Ocells rars a Catalunya. Informe del Comitè Avifaunístic de Catalunya 2012, 2013 i 2014. *Butl del CAC* 1: 32-43.
- Gill, F & Donsker, D (editors) 2019. IOC world bird list (version 9.2). Website: www.worldbirdnames.org.
- del Hoyo, J, Elliott, A & Christie, D A (editors) 2006. *Handbook of the birds of the world* 11. Barcelona.
- Jenni, L & Winkler, R 1994. *Moult and ageing of European passerines*. London.
- von Jordans, K 1913. Vorläufige kurze Beschreibung neuer Formen von den Balearen. *Falco* 3: 43-44.
- Kvist, L, Viiri, K, Dias, P C, Rytkönen, S & Orell, M 2004. Glacial history and colonization of Europe by the blue tit *Parus caeruleus*. *J Avian Biol* 35: 352-359.
- Olioso, J, Thibault, J-C, Piacentini, J & Pons, J-M 2019. Le Gobe-mouche tyrrhénien: nouvel endémique des îles de Méditerranée occidentale. *Ornithos* 26: 67-77.
- Parrot, C 1910. Neue Vogelformen aus dem mediterranen Gebiet. *Ornithol Monatsber* 18: 153-156.
- Peignot, C & le CHN-LR 2011. Les oiseaux rares en Languedoc Roussillon en 2010. 3e rapport du Comité

- d'Homologation Régional du Languedoc-Roussillon. Website: <https://tinyurl.com/y36jabxk>. [Accessed 17 May 2018.]
- Pons, J-M, Thibault, J-C, Aymí, R, Grussu, M, Muntaner, J, Olioso, G, Sunyer, J R, Touirhi, M & Fuchs, J 2016. The role of western Mediterranean islands in the evolutionary diversification of the Spotted Flycatcher (*Muscicapa striata*). *J Avian Biol* 46: 1-13.
- Redactie Dutch Birding 2016. Naamgeving van taxa in Dutch Birding. *Dutch Birding* 38: 97-101.
- Schiebel, G 1910. Neue Vogelformen aus Corsica. *Ornithol Jahresber* 21: 102-103.
- Shirihai, H, Gargallo, G, Helbig, A J, Harris, A & Cottridge, D 2001. *Sylvia* warblers. Identification, taxonomy and phylogeny of the genus *Sylvia*. London.
- Shirihai, H & Svensson, L 2018. Handbook of Western Palearctic birds 2 – Passerines: flycatchers to buntings. London.
- Svensson, L 1992. Identification guide to European passerines. Fourth edition. Stockholm.
- Svensson, L 2013. A taxonomic revision of the Subalpine Warbler *Sylvia cantillans*. *Bull Br Ornithol Club* 133: 240-248.
- Tellini, F G, Baccetti, N, Arcamone, E, Meschini, A & Sposimo, P 1997. Atlante degli uccelli nidificanti e svernanti in Toscana (1982-1992). Provincia di Livorno e Centro Ornitologico Italiano. Quaderni del Museo Provinciale di Storia Naturale di Livorno. Monografie 1.
- Viganò, M 2015. Indagini genetiche e bioacustiche sui Pigliamosche (*Muscicapa striata*) del bacino del Mediterraneo. Thesis Pavia University. Pavia.
- Viganò, M & Corso, A 2015. Morphological differences between two subspecies of Spotted Flycatcher *Muscicapa striata* (Pallas, 1764) (Passeriformes, Muscicapidae). *Biodiv J* 6: 271-284.
- Viganò, M, Corso, A & Janni, O (MISC) 2016. Identificazione del Pigliamosche tirrenico. *Quaderni di Birdwatching* 20: 58-70.
- Weiss, S & Ferrand, N 2007. Phylogeography of southern European refugia. Dordrecht.
- Wroza, S 2019. Le Gobemouche tyrrhénien *M. tyrrhenica*: un exemple de vocalisation extrême. *Ornithos* 26: 78-82.

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Shirihai & Svensson (2018):

GEOGRAPHICAL VARIATION & RANGE As many as 11 races have been described, and within the treated region six (e.g. in H&M 4). However, across most of the range variation is mostly slight and clinal, or too subtle to make separation practicable. There is a cline running from W Europe towards east, with dark and well-streaked birds in W Europe (*striata*), gradually becoming paler and less clearly streaked in the east (*neumanni*). The variation between the two is gradual and can only be appreciated with long series of breeding birds for comparison (birds on migration are mostly inseparable). Hence we found only reason to recognise the following four subspecies.

M. s. striata (Pallas, 1764) (Europe east to W Siberia and south to N Africa, but not on Balearics, and eastern limit partly unclear—see below; winters tropical Africa including in the south). Described above and compared to eastern paler and slightly plainer populations best characterised by being dull grey-brown to brownish-grey above, with forehead and forecrown sullied darker (fringed predominantly pale brownish-grey and indistinctly intermixed with white); dark streaks not so contrasting, being rather broad and diffuse. Underparts washed cream, lower throat, breast and flanks streaked on grey-buff suffusion. Birds with such characteristics generally occur in W & C Europe, but variation is inconsistent and mostly clinal. For example, birds from C & S England, but especially in the SE corner of the country, are particularly dark and brown, less grey above, and are dirty-looking below with broader streaking; they also tend to be slightly shorter-winged (W 81–86 mm, n 15, m 84.0), hence might warrant subspecific recognition, but here treated as a minor local variation within *striata* in want of a more comprehensive examination. Birds from N England, Scotland and especially in coastal continental Europe from Holland south to N Portugal are intermediate between classic *striata* (S Sweden) and these darker S English birds. – The situation is similarly unclear in the east. Vaurie (1959) and BWP extend the range of *striata* to just east of the Urals or to W Siberia. This may be practical, and is followed here, but it should be noted that, already from E Europe, birds gradually become paler, approaching *neumanni*, or appear intermediate; breeders in Levant and E Mediterranean are also to some degree intermediate and difficult to assign to one of the two races. – Breeders in Crimea ('*inexpectata*') were described from only four specimens and said to be distinctly darker than other forms, being browner above and more heavily streaked below than *striata*, but of similar size; such birds have never been examined by modern authors, nor have such birds ever been recorded on migration, and the evidence seems insufficient. Also, Hartert & Steinbacher (1933–38) cites Stegmann in stating that 'birds from Crimea do not differ from typical *striata*.' (Syn. *inexpectata*; *papamoscas*.)

M. s. balearica von Jordans, 1913 (Balearics; winters W & SW Africa). Highly distinctive by combination of being paler and drabber, rather cream grey-brown above with (almost diagnostic) whitish crown, strongly enhancing dark streaking, and conversely has the poorest dark breast streaking (diffuse and pale, sometimes restricted to breast-sides, or appears almost washed out). Furthermore, it is distinctly smaller than surrounding populations (smallest of all races), has a proportionately broader but flatter bill, is rather long-tailed and has a more rounded wing. W 77–82.5 mm (n 22, m 80.1); T 55–62 mm (n 22, m 58.3); T/W m 72.7; B 14.7–18.2 mm (n 22, m 16.8); BD 3.5–3.9 mm (n 6,

m 3.7); BW 5.3–6.5 mm (n 22, m 5.9); Ts 14.9–16.2 mm (n 6, m 15.4). Wing formula: $p1 > pc$ 1–5.5 mm, $< p2$ 38–43.5 mm; $p2 < wt$ 2.5–6 mm, = 5 or 5/6 (100%); $pp3-4$ longest; $p5 < wt$ 1.5–3.5 mm; $p6 < wt$ 7.5–10 mm; $p7 < wt$ 12.5–14 mm; $p10 < wt$ 18–21 mm; $s1 < wt$ 20–23 mm.

○ *M. s. tyrrhenica* Schiebel, 1910 (Corsica, Sardinia, Elba, Italian west coast south to Campania; winters probably

W Africa). Very close to *striata*, differing only by subtly smaller size (much overlap!) and being a little warmer brown above (but not as pale as *balearica*). Tentatively accepted, though certainly a weak race. The streaking of throat and breast is often rather diffuse and blotchy, and the chest can appear almost unpatterned, but many are inseparable from *striata* on this character alone. Wing shape intermediate between *striata* and *balearica*. Many migrant *striata* can be eliminated by long primary projection and more greyish-tinged upperparts. *W* 82–87 mm (n 13, m 83.1); *T* 58.5–65 mm; *T/W* m 73.1; *B* 14.7–16.9 mm (n 12, m 16.1); *BD* 3.7–4.3 mm (n 12, m 4.0); *BW* 5.0–6.0 mm (n 12, m 5.4); *Ts* 14.5–15.8 mm. Wing formula: $p1 > pc$ 0–3.5 mm, $< p2$ 41–46.5 mm; $p2 < wt$ 2–4.5 mm, $=4/5$ or 5 (rarely =5/6); $pp3-4$ longest; $p5 < wt$ 2.5–4 mm; $p6 < wt$ 9–11.5 mm; $p7 < wt$ 14–16 mm; $p10 < wt$ 22.5–24 mm; $s1 < wt$ 22–26.5 mm.

M. s. neumanni Poche, 1904 (*W & C Siberia east to N Mongolia and W Transbaikalia, Near East, and perhaps at least part of SE Europe and Levant, or intergrades with striata, further Turkey, Caucasus, Transcaucasia south to SW Iran; winters E & S Africa*). Compared to *striata* decidedly paler and greyer above, and has on average paler forehead and crown (forehead admixed with more off-white) with dark streaks being sharper and more contrasting. Pale fringes to wing-feathers tend to be broader and purer in fresh plumage, adding to the paler impression. Underparts also generally paler, with limited light greyish-brown wash and paler and more ill-defined streaks that barely extend to lower chest and flanks. Averages marginally larger. *W* 83–92 mm (n 31, m 87.0); *T* 55–70 mm (n 31, m 62.2); *T/W* m 71.5; *B* 15.8–18.8 mm (n 31, m 17.2); *BD* 4.0–4.3 mm (n 11, m 4.1); *BW* 5.0–6.3 mm (n 31, m 5.7); *Ts* 14.5–15.5 mm (n 11, m 15.0). Wing formula: $p10 < wt$ 21.5–25.5 mm; $s1 < wt$ 24.5–28 mm. – Breeders in E Iran, Transcaspiya, Kazakhstan to Tien Shan, Pamir and N & W Pakistan ('sarudnyi') seem to fit into normal variation of *neumanni*, being only very subtly paler and sandier on upperparts, and perhaps a shade whiter on underparts, but far from consistent and hence best included here. – Breeders in SW Altai, N Mongolia and SE Transbaikalia ('mongola') have been separated on account of paler colours, perhaps similar to 'sarudnyi' but greyer, less buff-tinged; the few birds examined from this region were inseparable from other paler *neumanni*. (Syn. *mongola*; *sarudnyi*.)