Ringing & Migration

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tram20

'Tarsus' program: towards a uniform criterion to determine recommended ring sizes for birds in the Aranzadi Ringing Scheme

Juan Arizaga & Diego Villanúa

To cite this article: Juan Arizaga & Diego Villanúa (11 Jul 2024): 'Tarsus' program: towards a uniform criterion to determine recommended ring sizes for birds in the Aranzadi Ringing Scheme, Ringing & Migration, DOI: 10.1080/03078698.2024.2365427

To link to this article: https://doi.org/10.1080/03078698.2024.2365427

Published online: 11 Jul 2024.

https://doi.org/10.1080/03078698.2024.2365427

'Tarsus' program: towards a uniform criterion to determine recommended ring sizes for birds in the Aranzadi Ringing Scheme

Juan Arizaga and Diego Villanúa

Department of Ornithology, Aranzadi Sciences Society, Zorroagagaina 11, 20014 Donostia, Spain

ABSTRACT
Above all, bird ringing must be safe for birds, for ethical reasons but also to ensure that data collection is not biased by marking effects. Bird ringing schemes are responsible for determining the size of the rings used to mark birds individually. This paper critically reviews the recommended ring sizes in the Aranzadi Ringing Scheme and proposes an objective criterion for ringers. A morphological analysis of tarsus width (MTW) and the width of the tibia–tarsus articulation (MAW), over a sample of more than 4000 individuals of 74 species of both passerines and non-passerines captured in Spain, revealed that the mean difference between the internal diameter of the recommended ring (IDR) and MTW was 32% in relation to MTW (sd 15.8%, 95% confidence interval 28–35%). Experience demonstrates that this clearance is adequate, but recommendations for rings with clearances either too narrow (<6%) or too wide (>50–60%) should be reviewed and changed, if possible, to bring them closer to a 32% standard.

ARTICLE HISTORY
Received 12 July 2023
Accepted 15 December 2023

KEYWORDS
bird ringing schemes; bird safety; ring size; tarsus

Ornithological science is to a large extent unviable without individual marking, as many biological processes have an individual basis (Lebreton 2001, Anderson & Green 2009, Sharp 2009). Currently, there are several marking methods used worldwide, including basic metal rings, special marks to be read at distance (such as wing tags, Darvic rings, nasal saddles and collars) and a range of electronic geo-positioning devices including modern GPS that can provide thousands of data points per minute. Of course, each of these methodological approaches has its pros and cons; hence any of them might be suitable for a given project, depending on its scope.

The most modern GPS-based devices allow the gathering of very-fine-scale information on spatial use, survival or behaviour that in most birds would be impossible to obtain with any other method (Cagnacci *et al* 2010). Such devices must necessarily be lightweight; weight constrains the size of the batteries and hence their period of operation, which in small birds can be just a few days (Andueza *et al* 2014) or a few months (Campión *et al* 2020). In addition, their attachment requires specific training (Vandenabeele *et al* 2014) and their costs are still too high for them to be used universally and long term.

Tags to be read at distance offer information on a broader scale than electronic geo-positioning, but still improve many studies because they increase very substantially the number of reports, especially in large birds, such as gulls, flamingos, storks, herons and allies, and several raptor species as well (Zuberogoitia *et al* 2012a, Herrero *et al* 2021, Franks *et al* 2022). However, in some cases these marks, especially wing tags, can impair flight performance (Curk *et al* 2021) or make birds more sensitive to predation (Zuberogoitia *et al* 2012b); a further drawback is that many of these marks tend to wear relatively fast and can detach from the bird, hence limiting their usefulness for long-term monitoring.

Finally, metal rings with a unique alphanumeric code are the oldest and most basic tool used in ornithology for the identification of individuals (Preuss 2001). Compared to the other two main methodological approaches, this less sophisticated tool imposes more constraints to collecting large data sets, but can be used universally, as the metal rings are cheap, relatively easy to attach, last for the entire life of the bird – except in some very long-lived individuals – and are suitable for practically all species. Therefore, classic bird ringing with official metal rings is still appropriate for studies of demography (Lebreton 2001, Ralph & Dunn 2004, Newton 2013), migration (Franks *et al* 2022, Fattorini *et al* 2023) and behaviour (Sharp 2009), allowing long-term comparisons

CONTACT Juan Arizaga jarizaga@aranzadi.eus

(Thorup & Romdal 2022) and with a broad positive impact on bird conservation (Anderson & Green 2009).

Whatever the method used, bird marking must above all be safe for birds, for ethical reasons but also to ensure that data are not biased by marking effects (Griesser *et al* 2012, Curk *et al* 2021). Metal rings must therefore have a design and dimensions that reduce to zero or at least minimise their impact on birds (Griesser *et al* 2012). Poor ring fit can cause injuries and even death. If the ring is too large, it can block the tibia–tarsus joint (i.e. between the tibiotarsus – upper part of the visible leg, referred to here as the 'tibia' – and the tarsometatarsus – lower leg, the 'tarsus'), which can lead to necrosis of the toes and eventually death (Griesser *et al* 2012), or it can allow the hind toe to become trapped between the ring and the tarsus (Berggren & Low 2004), which could also have an impact on survival. If the ring is too small, the accumulation of dirt between the ring and the tarsus is more frequent, which might cause infections (Sweeney *et al* 1985, Griesser *et al* 2012) or inflammation (Pierce *et al* 2007); this is the reason why a clearance of 6% between the tarsus and the ring has historically been recommended (Blake 1954).

Among other tasks, bird ringing schemes have the responsibility of setting the size of the rings used to mark birds individually; here, we refer to metal rings with the scheme address (for details see e,g, www.euring.org). In many schemes the list of recommended ring size or sizes for each species has generally been set up historically according to the knowledge of skilled ringers with experience in handling it, supported also by evidence from recaptures and recoveries that birds show no ill effects to indicate the ring is excessively small or large. However, it is also true that some ringers prefer ring sizes offering a closer fit to the tarsus, whilst others tend to recommend looser ring sizes.

Founded in 1949, the Aranzadi Ringing Scheme is the oldest one still active in Spain. To mark its 75th anniversary, celebrated in 2024, this paper aims to make a critical review for ringers of recommended ring sizes and propose an objective criterion for setting them. This topic is especially timely given the recent incorporation into the Aranzadi Ringing Scheme of many ringers from southern Spain, the Balearics and the Canary Islands, where previously Aranzadi was barely represented. This involves adding both species and populations for which there had been no officially recommended ring size. These additions arise due to species in these regions that are absent from other parts of Spain (e.g. Barolo Shearwater *Puffinus baroli*, Red-billed Tropicbird *Phaethon aethereus*, Rufous-tailed Scrub Robin *Cercotrichas galactotes*, Western Olivaceous Warbler *Iduna opaca* and Trumpeter Finch *Bucanetes githagineus*), species that are colonising Iberia from northern Africa (e.g. House Bunting *Emberiza sahari* and Common Bulbul *Pycnonotus barbatus*), and morphological differences between populations in northern and southern Spain that might require separate recommendations for ring sizes.

Material and methods

Study area and data collection

Ringers in our ringing scheme were requested to voluntarily submit as many measurements as possible, for as many species as possible, of the following two biometrics of fully grown birds (i.e. nestlings excluded): maximum widths of the tarsus (MTW) and of the tibia–tarsus articulation (MAW). Both variables were recorded in mm, with digital callipers allowing a theoretical accuracy of 0.01 mm – though the real accuracy was assessed to be c. 0.1 mm.

We named this program 'Tarsus'. The data were collected in 2021 and 2022, in Spain, with no geographic, temporal or taxonomic limitation. In general, the data provided were obtained through projects already running, meaning that birds were not captured with the sole objective of providing data for this program.

When compiling the recommended ring sizes of the Aranzadi Ringing Scheme (www.ring.eus/documentos), we considered only the main ring size recommended for each species, i.e. the one used most often (>90%).

Data filter and statistical analyses

Overall, we collected data from 4786 individuals of 188 species. From this database, we selected a subset of species meeting the following three criteria: they have a sample size of 10 or more individuals; ringing is recommended on the tarsus and not on the tibia; and both sexes have the same recommended ring size, there being insubstantial sexual size dimorphism. Applying this filter, we reduced the sample to 74 species (see Appendix).

For each species, we calculated the mean MTW and MAW, pooling the sexes, and then the differences between these two values and the internal diameter of the recommended ring (IDR), calculated as a percentage relative to the smaller measure:

1) Ring diameter relative to tarsus: $100 \times (\text{IDR-MTW})/\text{MTW}$.

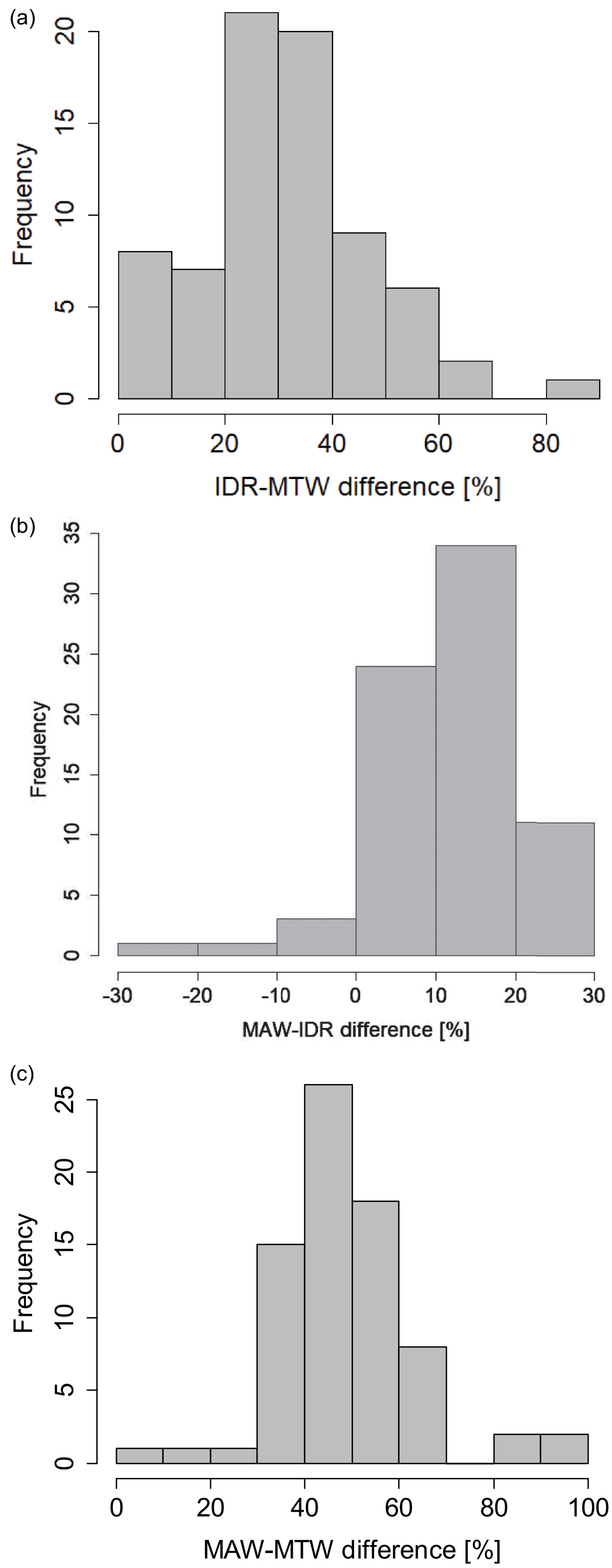

Figure 1. Frequency distribution of number of species against the difference between (a) the inner diameter of the ring (IDR) and the maximum width of the tarsus (MTW), as a percentage of MTW, (b) the maximum width of the tibia–tarsus articulation (MAW) and IDR, as a percentage of IDR, with negative values indicating that the ring is larger than the leg joint, and (c) MAW and MTW, as a percentage of MTW.

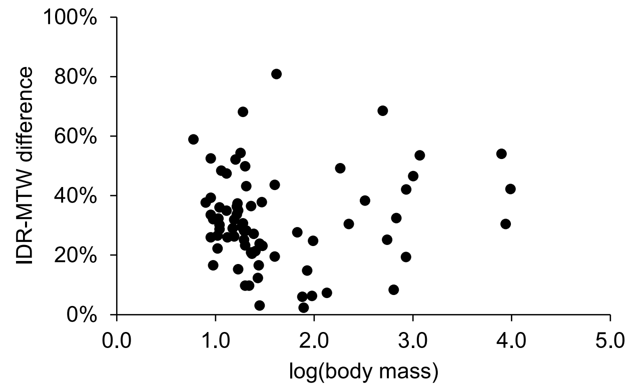

Figure 2. Distribution of the IDR-MTW difference for each species, based on the currently recommended ring size, expressed as a percentage of MTW and plotted against its log-transformed body mass (g)

2) Tibia–tarsus joint relative to ring diameter: 100 × (MAW-IDR)/IDR.
3) Tibia–tarsus joint relative to tarsus: 100 × (MAW-MTW)/MTW.

To test a possible bias towards recommended ring sizes according to size of bird, we used a Pearson correlation test between ring diameter relative to tarsus and log-transformed body mass values, obtained for each species from the *Birds of the World* web site (Billerman *et al* 2022).

Results

Descriptive statistics

The mean of the IDR-MTW difference was 31.6% of MTW (sd 15.8%; Pearson coefficient of variation

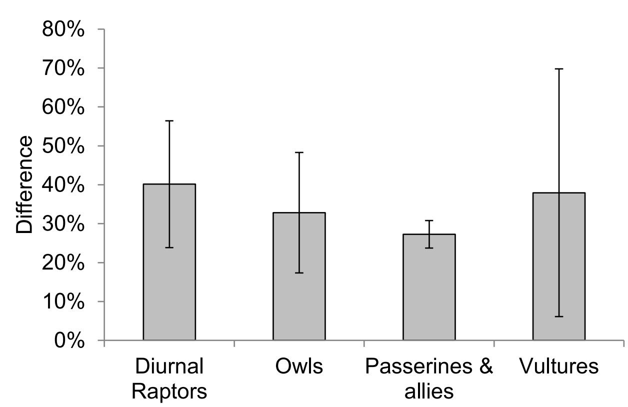

Figure 3. Mean and 95% confidence interval for the IDR-MTW difference, based on the currently recommended ring size and expressed as a percentage of MTW, amongst the four taxonomic groups that provided sample sizes of more than five species: diurnal raptors, n = 12; owls, n = 7; passerines and allies, n = 115; vultures, n = 6.

49.8%, 95% confidence interval 28–35%; Figure 1). Three species (Song Thrush *Turdus philomelos,* House Sparrow *Passer domesticus* and European Nightjar *Caprimulgus europaeus*), showed an IDR-MTW value of less than 6% of tarsus width, using the historically recommended ring size.

We did not detect a significant linear relationship of ring fit with log-transformed body mass ($r^2 = 0.006$, $P > 0.05$; Figure 2). When calculated separately for the richer taxonomic subgroups in the sample, those with more than five species, we found a great overlap between 95% confidence intervals, indicating a lack of significant differences among means (Figure 3). Percentiles 10 and 90 of ring diameter relative to tarsus were, respectively, 10.5% and 52.4%.

The mean of the MAW-MTW difference was 48.4% of MTW (sd 14.5%; Pearson coefficient of variation 30%, 95% confidence interval 45–52%; Figure 1). The mean of the MAW-IDR difference was 11.1% of IDR (sd 8.6%; Pearson coefficient of variation 77.6%, 95% confidence interval 9.2–13.1%; Figure 1). Three species (Kingfisher *Alcedo atthis*, Common Swift *Apus apus* and Firecrest *Regulus ignicapilla*) had an IDR clearly larger than the tibia–tarsus articulation.

Rings that need revision

According to the statistics above, we can establish the following equation as a recommendation of the optimal ring size: $IDR = 1.32 \times MTW$. Applying the range given by the 95% confidence interval associated with the estimation of mean MTW values, we can obtain a theoretical range of 1.28–1.35 for this conversion factor.

Using the factor and its confidence interval, we found that in 59.2% (48.6–64.5%) of the species, the currently recommended ring sizes did not fit with the size that ought to be used. This method identifies 11 out of the 12 species that lay outside percentiles 10 and 90 of ring diameter relative to tarsus.

Discussion

The critical revision of all recommendations surrounding ringing activity is necessary to promote more ethical practices and make ringing safer for birds (Griesser *et al* 2012). In this context, our exercise may be one of the few cases where the list of recommended ring sizes has been examined in order to establish an objective recommendation for the ring size of a bird.

Overall, we determined that the gap between the tarsus and the internal diameter of a ring (IDR) was on average 32% of the maximum tarsus width (MTW), and that this mean was consistent and was independent of both body mass and taxonomy. This slack is very similar to the value of 35–40% proposed by Splittgerber & Clarke (2006) to ensure safe marking in Australian passerines, and much higher than the 6% proposed by Blake (1954), which has traditionally been accepted and applied in many bird ringing schemes. This much smaller value is shown to be appropriate for many species, but there are documented cases of injury, such as those found by Griesser *et al* (2012) with the Purple-crowned Fairy-wren (*Malurus coronatus*). These authors found severe inflammation of the feet associated with the combined use of plastic and metal rings with a clearance of 6%, whereas no lesions were found when larger rings, with 18% clearance, were used.

If we use this 32% criterion to establish optimal ring sizes, we found that, surprisingly, almost 60% of the species had an optimal ring size different from that currently recommended, with in most cases the rings used being smaller than what we theoretically should use. We attribute this bias towards using close-fitting rings mainly to the following two considerations. First, the mean distance between the maximum width of the tibia–tarsus articulation (MAW) and the MTW was 48% of the MTW, putting IDR much closer to the MAW than to the MTW. Hence there is little scope for increasing ring size before IDR exceeds the size of the MAW, with the consequent risk of blocking the joint and causing permanent injury to the leg. Second, we must also mention that the step change from one ring size to the next, even if just a few millimetres, can make a big difference for small birds. Thus a larger ring might fit the tarsus well, using 1.32×MTW as the criterion, but might easily be too large relative to the tibia–tarsus articulation. In this context we suggest the decision tree presented in Figure 4.

We found only three species out of 74 for which the clearance of the recommended ring with respect to the thickness of the tarsus was 6% or even less: these are Song Thrush, House Sparrow and European Nightjar. Despite the fact that to date no injuries or deaths have been reported as associated with the use of these ring sizes, it is worth suggesting an IDR increase in order to reduce possible risks. The replacement of the current ring size by the next largest option currently available to our scheme would allow the clearance for these species to reach values of 8.5%, 15.4% and 21.1% respectively.

Regarding the potential for accidents due to rings being too large (Berggren & Low 2004), the average gap of 32% we found between the ring and the tarsus

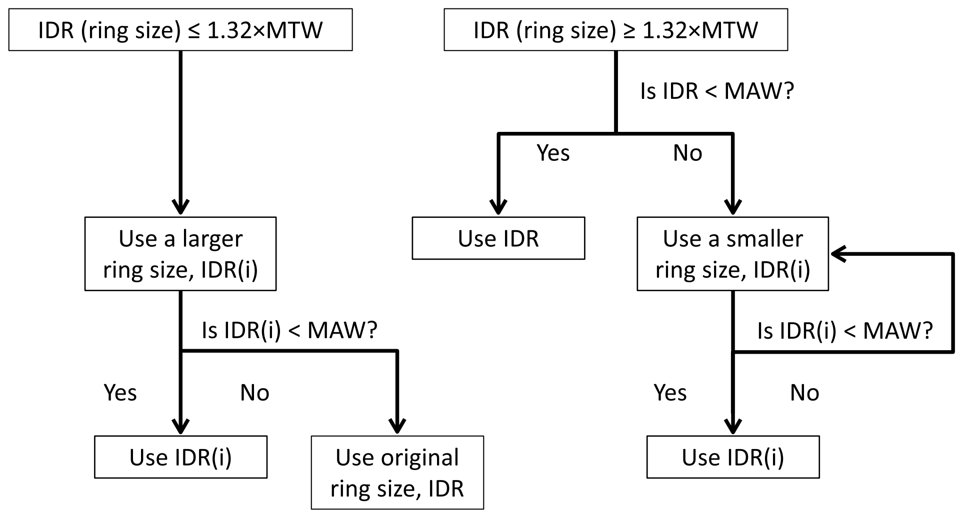

Figure 4. Proposed decision tree to select a ring size for a species (IDR), given the mean maximum widths of its tarsus and tibia–tarsus articulation (MTW, MAW).

is so much lower than the average 48% between the tarsus and the MAW that, a priori, there should be no risk that the rings could slip over the tibia–tarsus joint and cause injuries. In only the Kingfisher, Common Swift and Firecrest, however, the IDR was greater than the MAW, which means that the ring could block this joint. Kingfishers have very unusual anatomical traits in their legs and feet, and there is still some debate about how they should be ringed, including whether rings should be rolled around the tarsus or, alternatively, the tibia. Our results bring data to reopen this discussion. The difference between the MTW and the MAW is so small (2.4 mm and 2.7 mm) that it is impossible to propose an IDR larger than the MTW but not exceeding the MAW. To date, we have found no injured birds after working with a very large data set of recaptures of tarsus-ringed Kingfishers in one of their main ringing stations in Spain (Arizaga *et al* 2010). Other ringing teams associated with our ringing scheme have had similar experiences and, in this scenario and given the great value of these ringed birds and their recaptures, their continued ringing should be recommended. Common Swift is another species with a very peculiar anatomy, often subject to debate on its suitability for ringing and the appropriate ring size (e.g. www.commonswift.org). The difference between the MTW at 1.9 mm and the MAW at 2.7 mm is large enough to be able to find an IDR of, for example, 2.3 mm, that provides a 21% clearance with respect to the MTW but without reaching the MAW. Finally, the case of the Firecrest must follow from the size of this species, one of the very smallest in Europe, taking us to the physical limit for producing a metal ring on which a unique alphanumeric code and an address can be legibly inscribed. Even so, its anatomy may leave some margin for improvement in ring sizing; with a MTW of 1.3 mm, a new ring size with an IDR of 1.6 mm, rather than the 2.0 mm of the current smallest available ring, would allow a clearance of 23% with respect to MTW.

In conclusion, a morphological analysis of MTW and MAW over a sample of more than 4000 individuals of 74 species of both passerines and non-passerines captured in Spain revealed a mean IDR-MTW value of 32% in relation to MTW. Experience demonstrates that this clearance is adequate, but the current recommendations for rings too small (<6%) or too large (>50–60%) should be revised and changed, if possible. Therefore, we recommend a review of all these outlying ring clearances to examine how they could be moved closer towards our 32% criterion.

Acknowledgements

We are grateful to the ringers who collaborated with the 'Tarsus' initiative and provided the measurements used in this work. The Aranzadi Ringing Scheme is supported by the Basque Government, the Regional Councils (Diputaciones) of Álava, Bizkaia and Gipuzkoa, and our own resources within the Aranzadi Sciences Society.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Juan Arizaga http://orcid.org/0000-0003-1911-4078

References

Anderson, G.Q.A. & Green, R.E. (2009) The value of ringing for bird conservation. *Ringing & Migration* **24**, 205–212.

Andueza, M., Arizaga, J., Barba, E. & Tamayo-Uria, I. (2014) Spatial distribution and habitat use of reed warblers *Acrocephalus scirpaceus* during the autumn migration period. *Behaviour* **151**, 799–817.

Arizaga, J., Mendiburu, A., Alonso, D., Cuadrado, J.E., Jauregi, J.I. & Sanchez, J.M. (2010) Common Kingfishers *Alcedo atthis* along the coast of northern Iberia during the autumn migration period. *Ardea* **98**, 161–167.

Berggren, A. & Low, M. (2004) Leg problems and banding-associated leg injuries in a closely monitored population of North Island robin (*Petroica longipes*). *Wildlife Research* **31**, 535–541.

Billerman, S.M., Keeney, B.K., Rodewald, P.G. & Schulenberg, T.S. (2022) *Birds of the World*. Cornell Laboratory of Ornithology, Ithaca, NY, USA. www.birdsoftheworld.org

Blake, C.H. (1954) Leg sizes and band sizes; first report. *Bird-Banding* **25**, 11–16.

Cagnacci, F., Boitani, L., Powell, R.A. & Boyce, M.S. (2010) Animal ecology meets GPS-based radiotelemetry: a perfect storm of opportunities and challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences* **365**, 2157–2162.

Campión, D., Pardo, I., Elósegui, M.M. & Villanúa, D. (2020) GPS telemetry and home range of the White-backed Woodpecker *Dendrocopos leucotos*: results of the first experience. *Acta Ornithologica* **55**, 77–87.

Curk, T., Scacco, M., Safi, K., Wikelski, M., Fiedler, W., Kemp, R. & Wolter, K. (2021) Wing tags severely impair movement in African Cape Vultures. *Animal Biotelemetry* **9**, 1–13.

Fattorini, N., Costanzo, A., Romano, A., Rubolini, D., Baillie, S., Bairlein, F., Spina, F. & Ambrosini, R. (2023) Eco-evolutionary drivers of avian migratory connectivity. *Ecology Letters* **26**, 1095–1107.

Franks, S., Fiedler, W., Arizaga, J., Jiguet, F., Nikolov, B., van der Jeugd, H., Ambrosini, R., Aizpurua, O., Bairlein, F., Clark, J., Fattorini, N., Hammond, M., Higgins, D., Levering, H., Skellorn, W., Spina, F., Thorup, K., Walker, J., Woodward, I. & Baillie, S.R. (2022) *Online Atlas of the Movements of Eurasian–African Bird Populations*. EURING/CMS. https://migrationatlas.org

Gill, F., Donsker, D. & Rasmussen, P. (2023) *IOC World Bird List* (v 13.1). doi: 10.14344/IOC.ML.13.1

Griesser, M., Schneider, N.A., Collis, M.-A., Overs, A., Guppy, M., Guppy, S., Takeuchi, N., Collins, P., Peters, A. & Hall, M.L. (2012) Causes of ring-related leg injuries in birds – evidence and recommendations from four field studies. *PLoS One* **7**, e51891.

Herrero, A., Damian-Picollet, S., Domec, D., Valiente, A., Aldalur, A., Alzaga, A., Galarza, A. & Arizaga, J. (2021) The origins and temporal and spatial distribution pattern of non-local gulls in the Bay of Biscay. *Ringing & Migration* **36**, 1–8.

Lebreton, J.-D. (2001) The use of bird rings in the study of survival. *Ardea* **89** (special issue), 85–100.

Newton, I. (2013) *Bird Populations*. Collins New Naturalist Library, London.

Pierce, A.J., Stevens, D.K., Mulder, R. & Salewski, V. (2007) Plastic colour rings and the incidence of leg injury in flycatchers (Muscicapidae, Monarchidae). *Ringing & Migration* **23**, 205–210.

Preuss, N.O. (2001) Hans Christian Cornelius Mortensen: aspects of his life and of the history of bird ringing. *Ardea* **89** (special issue), 1–6.

Ralph, C.J. & Dunn, E.H. (2004) *Monitoring bird populations using mist nets*. Studies in Avian Biology **29**. Cooper Ornithological Society.

Sharp, S.P. (2009) Bird ringing as a tool for behavioural studies. *Ringing & Migration* **24**, 213–219.

Splittgerber, K. & Clarke, M.F. (2006) Band-related leg injuries in an Australian passerine and their possible causes. *Journal of Field Ornithology* **77**, 195–206.

Sweeney, T.M., Fraser, J.D. & Coleman, J.S. (1985) Further evaluation of marking methods for Black and Turkey Vultures. *Journal of Field Ornithology* **56**, 251–257.

Thorup, K. & Romdal, T. (2022) *EURING Eurasian–African Bird Migration Project. Report to the CMS on historical changes in migration patterns*. Copenhagen Bird Ringing Centre, Natural History Museum of Denmark, University of Copenhagen, Copenhagen.

Vandenabeele, S.P., Grundy, E., Friswell, M.I., Grogan, A., Votier, S.C. & Wilson, R.P. (2014) Excess baggage for birds: inappropriate placement of tags on Gannets changes flight patterns. *PLoS One* **9**, e92657.

Zuberogoitia, I., González-Oreja, J.A., Martínez, J.E., Zabala, J., Gómez, I. & López-López, P. (2012a) Foraging movements of Eurasian griffon vultures (*Gyps fulvus*): implications for supplementary feeding management. *European Journal of Wildlife Research* **59**, 421–429.

Zuberogoitia, I., Arroyo, B., O'Donoghue, B., Zabala, J., Martínez, J.A., Martínez, J.E., & Murphy, S.G. (2012b) Standing out from the crowd: are patagial wing tags a potential predator attraction for harriers (*Circus* spp.)? *Journal of Ornithology* **153**, 985–989.

Appendix. List of the species studied and their sample sizes (n), mean internal diameter of recommended ring (IDR), mean widths of tarsus and tibia–tarsus articulation (MTW, MAW), and the percentage differences between the IDR and MTW in relation to MTW, and between the MAW and IDR in relation to IDR (see Methods). Species are listed taxonomically (Gill *et al* 2023).

Species	n (MTW, MAW)	IDR (mm)	MTW (mm)	MAW (mm)	IDR-MTW	MAW-IDR
Caprimulgus europaeus	25, 12	3.5	3.30	4.06	6.0%	13.8%
Apus apus	14, 14	3.5	1.94	2.71	80.8%	-29.4%
Streptopelia turtur	39, 25	5.0	4.66	5.48	7.3%	8.8%
Larus michahellis	26, 27	11.0	7.51	12.27	46.5%	10.3%
Calonectris diomedea	38, 36	8.0	7.39	9.92	8.3%	19.4%
Gyps rueppelli	12, 12	26.0	16.88	25.97	54.0%	-0.1%
Gyps fulvus	38, 39	26.0	19.94	29.60	30.4%	12.2%
Aegypius monachus	23, 24	26.0	18.29	29.44	42.2%	11.7%

(*Continued*)

Continued.

Species	n (MTW, MAW)	IDR (mm)	MTW (mm)	MAW (mm)	IDR-MTW	MAW-IDR
Circus aeruginosus	17, 17	11.0	8.31	12.14	32.4%	9.4%
Milvus milvus	32, 31	11.0	7.17	13.08	53.5%	15.9%
Milvus migrans	17, 16	11.0	7.75	12.91	42.0%	14.8%
Buteo buteo	34, 33	11.0	9.22	14.03	19.3%	21.6%
Tyto alba	21, 22	8.0	6.39	10.25	25.1%	21.9%
Athene noctua	12, 12	6.5	4.36	8.53	49.2%	23.8%
Otus scops	32, 26	5.0	4.01	5.80	24.8%	13.8%
Asio otus	14, 13	8.0	5.79	9.76	38.3%	18.0%
Strix aluco	24, 21	11.0	6.53	10.98	68.5%	-0.2%
Upupa epops	27, 19	4.0	3.13	4.13	27.6%	3.2%
Alcedo atthis	42, 41	3.0	2.44	2.65	23.0%	-13.1%
Jynx torquilla	20, 18	3.3	2.30	3.50	43.6%	5.7%
Falco tinnunculus	68, 67	6.5	4.98	7.99	30.4%	18.7%
Lanius collurio	41, 40	3.3	2.67	3.55	23.8%	7.0%
Lanius senator	28, 16	3.3	2.76	3.66	19.5%	9.9%
Periparus ater	38, 36	2.0	1.72	2.51	16.6%	20.2%
Poecile palustris	18, 17	2.3	1.55	2.44	48.4%	5.6%
Cyanistes caeruleus	41, 41	2.3	1.79	2.56	28.7%	10.0%
Parus major	107, 87	2.5	2.17	2.93	15.2%	14.8%
Panurus biarmicus	32, 26	2.5	1.64	2.75	52.1%	9.2%
Calandrella brachydactyla	17, 17	2.3	2.10	3.09	9.7%	25.5%
Alaudala rufescens	21, 19	2.3	1.91	2.94	20.4%	21.8%
Hirundo rustica	26, 29	2.3	1.54	2.30	49.8%	0.1%
Cettia cetti	91, 92	2.3	1.83	2.59	26.0%	11.2%
Aegithalos caudatus	49, 48	2.0	1.45	2.12	37.6%	5.6%
Phylloscopus bonelli	53, 24	2.0	1.51	2.15	32.1%	6.9%
Phylloscopus trochilus	358, 64	2.0	1.58	2.22	26.5%	9.7%
Phylloscopus collybita	61, 36	2.0	1.31	2.02	52.5%	0.9%
Phylloscopus ibericus	63, 61	2.0	1.50	2.17	33.5%	7.7%
Acrocephalus schoenobaenus	17, 15	2.3	1.56	2.44	47.4%	5.7%
Acrocephalus scirpaceus	98, 92	2.3	1.74	2.63	32.3%	12.6%
Hippolais polyglotta	98, 70	2.3	1.77	2.46	30.1%	6.6%
Sylvia atricapilla	291, 235	2.5	2.03	2.79	23.3%	10.4%
Sylvia borin	44, 30	2.5	1.91	2.87	30.7%	12.8%
Curruca hortensis	24, 18	2.5	2.28	3.16	9.7%	20.8%

(Continued)

Continued.

Species	n (MTW, MAW)	IDR (mm)	MTW (mm)	MAW (mm)	IDR-MTW	MAW-IDR
Curruca melanocephala	90, 28	2.3	1.78	2.45	29.6%	6.2%
Curruca iberiae	69, 24	2.0	1.64	2.29	22.2%	12.8%
Curruca communis	70, 52	2.5	1.98	2.69	26.2%	7.1%
Regulus ignicapilla	52, 46	2.0	1.26	1.94	58.9%	-3.0%
Troglodytes troglodytes	36, 33	2.0	1.59	2.26	25.9%	11.6%
Certhia brachydactyla	33, 34	2.0	1.44	2.18	39.2%	8.2%
Sturnus unicolor	14, 14	4.0	3.48	4.84	14.8%	17.4%
Turdus philomelos	54, 48	3.3	3.23	4.65	2.3%	29.0%
Turdus merula	229, 133	4.0	3.76	5.03	6.3%	20.4%
Muscicapa striata	95, 26	2.3	1.69	2.31	36.3%	0.3%
Erithacus rubecula	283, 261	2.3	1.84	2.79	25.2%	17.5%
Luscinia megarhynchos	90, 63	2.5	2.14	3.09	16.6%	19.0%
Ficedula hypoleuca	40, 23	2.0	1.52	2.32	31.9%	13.7%
Phoenicurus phoenicurus	78, 15	2.3	1.70	2.57	35.0%	10.4%
Saxicola rubicola	20, 23	2.3	1.78	2.70	28.9%	14.7%
Oenanthe hispanica	13, 5	2.5	1.87	2.80	33.6%	10.7%
Passer domesticus	125, 63	2.5	2.43	3.21	3.1%	22.1%
Prunella modularis	82, 79	2.5	1.95	2.84	28.2%	12.1%
Anthus pratensis	14, 11	2.3	1.49	2.74	54.3%	15.9%
Anthus trivialis	19, 14	2.3	2.05	3.04	12.3%	24.3%
Fringilla coelebs	54, 46	2.5	1.83	2.78	36.4%	9.9%
Pyrrhula pyrrhula	32, 29	2.5	1.81	2.70	37.8%	7.3%
Bucanetes githagineus	46, 46	2.5	1.75	2.69	43.1%	7.2%
Chloris chloris	75, 60	2.5	2.06	2.97	21.3%	15.7%
Linaria cannabina	48, 41	2.3	1.79	2.58	28.2%	10.9%
Carduelis carduelis	36, 25	2.3	1.67	2.49	37.4%	7.5%
Carduelis citrinella	11, 10	2.0	1.48	2.29	34.9%	12.8%
Serinus serinus	34, 32	2.0	1.47	2.23	36.0%	10.4%
Emberiza cia	18, 20	2.5	2.07	2.90	20.9%	13.7%
Emberiza cirlus	22, 21	2.5	1.97	2.78	27.1%	10.1%
Emberiza schoeniclus	12, 12	2.3	1.37	2.62	68.1%	12.2%