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TECHNIQUES AND STRATEGIES

Erythrocyte size in birds; an additional data set

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Abstract. Birds have an efficient respiratory system, but in exchange of respiratory gases have the most important role erythrocytes. They transport the oxygen to the cells throughout the body, and it removes waste carbon dioxide from the cells. The size of the red blood cells gives us some idea of the area that is provided to the gas exchange. Although the measurement of length (long diameter) and width (short diameter) is basic morphological data, we can still encounter various data for specific species. In our previous studies, we found that cell size and shape are not species-specific and undergo many changes during the year, depending on many exogenous and endogenous factors. The aim of this work is to provide a basic view of the function and structure of erythrocytes and to point out aspects that potentially affect changes in the size and shape of erythrocytes. Despite these changes, erythrocyte size data provide us with the relative predictive value of the cell size of a particular species. The aim of this work is to supplement the existing data on bird erythrocyte size with published data from works from Eurasia and data from own observation. Given the current knowledge, it is appropriate in the future to supplement the database with additional data (age, sex, number of examined individuals, geographical location, the region, altitude, the annual cycle).

Key words: birds, erythrocyte legnth, erythrocyte width, respiratory system

Introduction

Birds are a unique group of vertebrates, due to their physiology. They are widespread worldwide from lowlands to really high altitudes such as the Andes and Himalayas. As a group of vertebrates adapted for flying, birds inhabit various habitats at all altitudes of the biosphere. During evolution, they adapted to many environmental conditions, including temperature, humidity, and varying degrees of radiation; testifying to the great variability of this group. They have adapted to the different requirements of the environment through their way of life, body structure, and the physiological adaptations of organ systems. Of note is their respiratory system; one of the most complex respiratory systems of all animal groups (Gill 1995). Their lungs receive a constant supply of fresh air during inhalation and expiration, thanks to lung-bags, in which some inhaled air remains and is transferred to the lungs during exhalation (Maina 2006; Laguë 2017). Thus, unlike other classes of vertebrates, gas exchange in the lungs is more efficient, allowing birds to maintain the supply of oxygen even in hypoxia, as peripheral tissues have an increased oxygen diffusion capacity as well as a high aerobic capacity (Scott 2011). Through the process of tissue oxygenation, the most important role is undoubtedly played by the erythrocytes.

Bird red blood cells (RBC), unlike those of mammals, are larger, elliptical in shape, more shape-stable and contain a centrally located nucleus (Mitchell and Johns 2008). They have a shorter lifespan than mammal erythrocytes. Generally, a mature erythrocyte has three main components: the lipid membrane, undermembrane skeleton, and fluid cytoplasm (Ivanov *et al.* 2012).

The red cell membrane contains nearly equal amounts of lipids and proteins and this composition is subject to change during its lifetime (De Oliveira and Saldanha 2010). RBC membrane content is composed of: 19.5 % water, 39.5 % proteins, 35.1 % lipids and 5.8 % carbohydrates (Yawata 2003). Of the lipids, phospholipids are the most represented (60 %), while non-sterified cholesterol represents about 30 % of the lipidic RBC composition, and the last 10 % are glycolipids (Yawata 2003). Changes in lipid composition of erythrocyte membranes resulting in an impairment of deformability may play a role in an altered blood rheological pattern (Bakan *et al.* 2006). Different cells have different shape-shifting capabilities, depending on the specific function of that cell within the organism. RBCs have the ability to deform according to blood flow and thus adapt to the lumen of the capillaries. This shape change is temporary and the return to the original form is ensured by intermediate filaments and the plasma membrane skeleton of erythrocytes. RBC shape is ultimately determined by membrane proteins, particularly the spectrin network, and also by the lipid bilayer content (Yawata 2003).

Molecules of haemoglobin, the most abundant protein in the cytoplasm of erythrocytes (Scanes 2015) are responsible for transporting oxygen and

carbon dioxide to and from tissues. This is the most important role in gas exchange and a specialized feature of RBCs, however, other important processes include nitric oxide transportation and signalling (De Oliveira and Saldanha 2010). Binding between haemoglobin and breathing gases is markedly affected by organic phosphates and thus provides avian haemoglobin a higher affinity for oxygen (Weber 2007). The carrying capacity of blood and oxygen is affected by several factors, including the hematocrit, concentrations of haemoglobin (Hb) (Bouverot 1985) and allosteric modulators of Hb oxygen binding (Storz and Moriyama 2008; West 2012; Laguë 2017). Haemoglobin concentrations in particular have been thoroughly studied, and several factors are known to affect its value, including age (Kostelecka-Myrcha *et al.* 1971), hormonal level (Puerta *et al.* 1995), season (Breuer *et al.* 1995), exposure to hypoxia (Maxwell *et al.* 1990) and interspecies differences in Hb concentrations (Kostelecka-Myrcha 1997). Functional mitochondria are also found in cytoplasm (Stier *et al.* 2013).

The dimensions of erythrocytes offer us an idea of the area that is involved in the exchange of respiratory gases (Hartman and Lessler 1963). The average size varies between species but reaches an approximate length of 12.5 μm, and a width of 6.8 μm (in a mean of 364 or 362 wild birds species respectively; see Scanes 2015) and a thickness of 3.2 μm (Scanes 2015). Large cells represent a lower surface-to-volume ratio, making them inherently less efficient for gas exchange (Gregory *et al.* 2009); therefore, smaller cells more efficient at gas exchange, which can be advantageous for the metabolic demands of flight (Laguë 2017).

In general, there is a directly proportional relationship between erythrocyte size and haemoglobin content (Hawkey *et al.* 1991), and larger erythrocytes contain more haemoglobin. However, this relationship does not apply to post-embryonic development of birds In the , where during their first days the erythrocytes are large but the haemoglobin content is low (Kostelecka-Myrcha and Myrcha 1989; Kostelecká-Myrcha and Jaroszewicz 1993; Kostelecka-Myrcha 1997). Cell size plays a role in body size evolution and environmental adaptations (Czarnoleski 2018). When applying a direct relationship between erythrocyte size and haemoglobin amount, it must also be true that erythrocyte size is subject to change, based on the hypothesis that the level of haemoglobin concentration is subject to many changes of exogenous and endogenous origin. Red blood cells also undergo a change in shape during development (Barrett and Scheinberg 1972).

Our previous studies suggest that changes in size and shape are subject to age, but they also change over the course of the year (Janiga *et al.* 2017). Additionally, the size and shape of erythrocytes are impacted by pollutants. We found that the tendency of erythrocytes to change their shape from ellipsoid to smaller and round increased with an increasing amount of lead in their blood (Janiga and Haas 2019). We also observed different sizes in different populations of geographically separated populations of *Prunella collaris* from the high mountains of Kyrgyzstan, Bulgaria and Slovakia during the mouting period (Haas and Janiga 2020). Based on these factors, additional data should be added to RBC size measurements to form a more complete picture (e.g. sex number of tested samples, location, season).

As indicated, the size and shape of the RBC is subject to many modifications and reflects external environmental conditions as well as the subjective characteristics of each individual. The comparison of published data on erythrocyte measurements of many bird species, provides us with a relative predictive value of the cell size of a particular species. The most extensive is the database list of "Birds erythrocyte sizes" (www.genomesize.com). This dataset is a compilation of pilot studies of erythrocyte size from Guliver (1875), Bartsch *et al.* (1937), and Hartman and Lessler (1963). Due to the localization of the research, these are mainly bird species from the Nearctic and Neotropical regions. Unfortunately, the exact locations, altitudes, seasons of the year, and number of examined birds cannot be derived from these studies. Originally, we sought to supplement this database with data from our research (in Table 1 as "personal data"), however, Table 1 also includes supplementary data from other studies by primarily European and Asian authors (Palomeque *et al.* 1980; Glomski and Pica 2011); including studies of bird species from the Palearctic region (e.g. Irisova 1988; Kostelecka-Myrcha 1997; Kostelecka-Myrcha *et al.* 1993; Dolka *et al.* 2014).

The aim of this paper is to supplement a database (www.genomesize.com) with morphological data of RBCs (length, width) from other studies to extend the basic RBC size data for the species from other geographical areas. In future studies, it would be beneficial to supplement the database with geographical locations, regions, and altitudes, as well as the annual cycle, number of examined individuals, and their sex and age.

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Appendix

A list of bird species with the size of erythrocytes and their nuclei according to literature data and own observations. EL - erythrocyte length, EW - erythrocyte width, NL - nucleus length, NW - nucleus width (all dimensions are given in μm). The taxonomic classification of birds is made according to Kovalik *et al.* 2010.

Order	Family	Species	EL	EW	NL	NW	References
CASUARIIFORMES	Dromaiidae	*Dromaius novaehollandiae*	15.00	8.40			www.genomesize.com 2015
TINAMIFORMES	Tinamidae	*Crypturellus soui*	14.50	7.60			www.genomesize.com 2015
		Rhynchotus rufescens	13.70	7.60	4.80	2.40	www.genomesize.com 2015
ANSERIFORMES	Anatidae	*Dendrocygna viduata*	14.20	7.10			www.genomesize.com 2015
		Dendrocygna arborea	13.20	6.80			www.genomesize.com 2015
		Dendrocygna autumnalis	13.30	6.70			www.genomesize.com 2015
		Cygnus olor	13.90	7.20	6.40	2.30	Dolka *et al.* 2014
		Cygnus atratus	14.10	6.90			www.genomesize.com 2015
		Branta sandvicensis	13.60	6.60			www.genomesize.com 2015
		Branta canadensis	13.80	6.80			Glomski and Pica 2011
		Cereopsis novaehollandiae	14.80	6.90			www.genomesize.com 2015
		Chloephaga picta	13.60	6.60			www.genomesize.com 2015
		Anas penelope	13.60	5.80			www.genomesize.com 2015
		Anas acuta	12.70	6.60			www.genomesize.com 2015
		Anas acuta	10.88	6.44			Irisova 1988
		Anas querquedula	12.60	6.60			www.genomesize.com 2015
		Anas crecca	12.30	5.50			www.genomesize.com 2015
		Anas platyrhynchos	12.50	6.80			Glomski and Pica 2011
		Anas platyrhynchos	11.49	6.82			Irisova 1988
		Anas undulata	12.50	7.40			Glomski and Pica 2011
		Anas erythrorhyncha	12.50	7.50			Glomski and Pica 2011
		Aythya ferina	12.50	6.60			Glomski and Pica 2011
		Oxyura maccoa	12.30	6.20			Glomski and Pica 2011
		Plectropterus gambensis	12.90	7.80			Glomski and Pica 2011
		Aix galericulata	13.10	7.40			www.genomesize.com 2015
		Aix sponsa	12.70	6.20			www.genomesize.com 2015
		Alopochen aegyptiaca	13.60	6.60			www.genomesize.com 2015
		Somateria mollissima	12.70	7.90			www.genomesize.com 2015
GALLIFORMES	Cracidae	*Penelope purpurascens*	13.40	7.00			www.genomesize.com 2015
		Pipile pipile	13.40	7.00			www.genomesize.com 2015
		Chamaepetes unicolor	13.90	7.50	6.50	2.80	www.genomesize.com 2015
		Mitu mitu	12.70	7.30			www.genomesize.com 2015
		Crax rubra	12.70	6.90			www.genomesize.com 2015
	Ondotophoridae	*Colinus virginianus*	11.50	6.40			www.genomesize.com 2015
		Odontophorus guttatus	11.90	6.80	5.20	2.30	www.genomesize.com 2015
	Numididae	*Numida meleagris*	12.40	5.80			www.genomesize.com 2015
	Phasianidae	*Pavo cristatus*	13.80	7.10			www.genomesize.com 2015
		Pavo muticus	13.80	7.10			www.genomesize.com 2015
		Francolinus natalensis	12.50	7.50			Glomski and Pica 2011
		Francolinus afer	12.60	7.60			Glomski and Pica 2011
		Francolinus francolinus	12.10	6.30			www.genomesize.com 2015
		Gallus gallus	12.10	7.30	4.00	3.20	www.genomesize.com 2015

		Coturnix coturnix	11.90	6.70			Kostelecka-Myrcha *et al.* 1993
		Alectoris rufa	13.00	6.00			Glomski and Pica 2011
		Alectoris gracea	11.30	6.40			Glomski and Pica 2011
		Alectoris chukar	10.62	7.18			Irisova 1988
		Tetraogallus caucasicus	13.20	7.30	5.60	2.80	www.genomesize.com 2015
		Tetraogallus himalayensis	12.11	6.97			Irisova 1988
		Perdicula argoondah	10.80	7.30			www.genomesize.com 2015
		Meleagris gallopavo	12.40	7.10			www.genomesize.com 2015
		Lagopus muta	11.00	6.50	5.00	2.40	Glomski and Pica 2011
		Lagopus muta	12.27	6.91			Irisova 1988
		Lagopus lagopus	10.96	6.32			Irisova 1988
		Lyrurus tetrix	10.70	6.80			www.genomesize.com 2015
		Tetrao urogallus	11.30	6.60			www.genomesize.com 2015
		Phasianus colchicus	11.70	7.00	4.50	3.60	www.genomesize.com 2015
		Lophura nycthemera	13.50	7.30	6.40	3.20	www.genomesize.com 2015
		Ammoperdix griseogularis	13.10	7.70	5.60	2.40	www.genomesize.com 2015
		Rhizothera longirostris	12.40	6.70			www.genomesize.com 2015
		Chrysolophus pictus	11.50	7.00			www.genomesize.com 2015
PHOENICOPTERIFORMES	Phoenicopteridae	*Phoenicopterus ruber*	14.50	8.20			Glomski and Pica 2011
		Phoenicopterus roseus	14.50	8.00			Glomski and Pica 2011
		Phoenicopterus chilensis	15.20	8.00			Glomski and Pica 2011
		Phoeniconaias minor	15.10	8.10			Glomski and Pica 2011
PODICIPEDIFORMES	Podicipedidae	*Tachybaptus dominicus*	13.70	8.00	5.70	2.80	www.genomesize.com 2015
		Podilymbus podiceps	14.60	8.20	5.20	2.20	www.genomesize.com 2015
PTEROCLIDIFORMES	Pteroclididae	*Syrrhaptes paradoxus*	10.47	6.59			Irisova 1988
COLUMBIFORMES	Columbidae	*Zenaida aurita*	11.20	7.20			www.genomesize.com 2015
		Geotrygon chiriquensis	12.00	6.90	5.60	2.80	www.genomesize.com 2015
		Geotrygon mystacea	12.10	7.20			www.genomesize.com 2015
		Geotrygon montana	11.30	6.90	4.80	2.10	www.genomesize.com 2015
		Patagioenas leucocephala	11.90	7.00			www.genomesize.com 2015
		Patagioenas corensis	11.60	7.00			www.genomesize.com 2015
		Patagioenas fasciata	12.10	7.70	5.80	2.70	www.genomesize.com 2015
		Streptopelia turtur	12.70	7.50			www.genomesize.com 2015
		Streptopelia turtur	11.42	6.71			Irisova 1988
		Streptopelia decaocto	11.90	7.20			www.genomesize.com 2015
		Streptopelia decaocto	11.04	6.61			Irisova 1988
		Streptopelia capicola	14.30	7.10			Glomski and Pica 2011
		Streptopelia orientalis	12.39	7.05			Irisova 1988
		Spilopelia chinensis	12.20	7.00			www.genomesize.com 2015
		Spilopelia senegalensis	12.50	6.30			Glomski and Pica 2011
		Spilopelia senegalensis	9.94	6.01			Irisova 1988
		Columba livia	12.00	6.80			Kostelecka-Myrcha 1997
		Columba livia	12.43	6.33			Irisova 1988
		Columba livia	12.49	7.11			Irisova 1988
		Columba livia f. domestica					Kostelecka-Myrcha 1997
		Columba rupestris	11.91	6.09			Irisova 1988
		Columba guinea	11.70	6.60			www.genomesize.com 2015
		Columba palumbus	12.90	7.00			www.genomesize.com 2015

		Columbina minuta	12.30	7.40	5.90	2.50	www.genomesize.com 2015
		Columbina talpacoti	11.60	7.00	6.40	2.40	www.genomesize.com 2015
		Phaps chalcoptera	11.50	6.30			www.genomesize.com 2015
		Caloenas nicobarica	11.90	6.90			www.genomesize.com 2015
		Goura cristata	13.00	7.30			www.genomesize.com 2015
		Goura victoria	13.70	8.20			Glomski and Pica 2011
		Ectopistes migratorius	13.30	5.50			www.genomesize.com 2015
		Otidiphaps nobilis	13.50	7.60			Glomski and Pica 2011
		Treron bicincta	13.20	8.00			Glomski and Pica 2011
PODARGIFORMES	Podargidae	*Podargus strigoides*	13.80	7.90			www.genomesize.com 2015
NYCTIBIIFORMES	Nyctibiidae	*Nyctibius griseus*	13.80	8.00	6.40	3.40	www.genomesize.com 2015
CAPRIMULGI-FORMES	Caprimulgi-dae	*Nyctidromus albicollis*	13.60	8.30	6.30	3.30	www.genomesize.com 2015
		Caprimulgus europaeus	9.99	5.79			Irisova 1988
APODIFORMES	Apodidae	*Apus apus*	12.80	6.60	6.40	2.40	www.genomesize.com 2015
		Apus apus	10.22	6.57			Irisova 1988
		Apus apus	13.57	6.91	6.18	2.24	Palomeque *et al.* 1980
		Apus pallidus	10.11	5.85			Irisova 1988
		Apus pallidus	13.80	6.90			Glomski and Pica 2011
		Apus pallidus	13.45	6.83	6.19	2.55	Palomeque *et al.* 1980
		Apus melba	13.81	6.98	6.26	2.39	Palomeque *et al.* 1980
		Tachymarptis melba	13.80	6.90			Glomski and Pica 2011
	Trochilidae	*Glaucis hirsutus*	12.20	6.90	6.20	2.80	www.genomesize.com 2015
		Phaethornis guy	11.80	6.70	4.90	2.10	www.genomesize.com 2015
		Anthrocothorax nigricollis	10.70	6.40	5.20	2.60	www.genomesize.com 2015
		Heliodoxa jacula	12.30	6.30	6.00	2.10	www.genomesize.com 2015
		Archilochus colubris	10.80	5.80			Glomski and Pica 2011
		Selasphorus scintilla	10.70	6.10	5.70	2.50	www.genomesize.com 2015
		Campylopterus hemileucurus	11.10	5.60	5.00	1.80	www.genomesize.com 2015
		Thalurania furcata	11.30	6.40	5.50	2.10	www.genomesize.com 2015
		Amazilia tzacatl	11.20	6.40	5.70	2.60	www.genomesize.com 2015
		Trochilus sp.	9.50	6.40			www.genomesize.com 2015
		Chlorestes julie	10.90	6.10	5.20	2.60	www.genomesize.com 2015
		Saucerottia edward	11.40	6.00	5.70	2.00	www.genomesize.com 2015
OTIDIFORMES	Otididae	*Ardeotis kori*	13.50	7.30			Glomski and Pica 2011
		Otis tarda	14.00	7.90			www.genomesize.com 2015
		Chlamydotis undulata	14.00	7.90			www.genomesize.com 2015
CUCULIFORMES	Cuculidae	*Crotophaga major*	12.00	8.10	5.50	3.40	www.genomesize.com 2015
		Crotophaga ani	12.90	6.90	5.80	2.90	www.genomesize.com 2015
		Piaya cayana	13.70	7.90	6.20	2.90	www.genomesize.com 2015
		Cuculus canorus	12.50	7.10			www.genomesize.com 2015
		Cuculus canorus	11.02	6.55			Irisova 1988
		Cuculus canorus	11.81	6.74			Irisova 1988
		Cuculus canorus	12.02	6.77			Irisova 1988
GRUIFORMES	Psophiidae	*Psophia crepitans*	13.50	7.30			www.genomesize.com 2015
	Gruidae	*Balearica regulorum*	13.70	7.30			www.genomesize.com 2015
		Balearica pavonina	13.70	6.70	6.40	2.60	www.genomesize.com 2015
		Grus virgo	13.50	6.80			www.genomesize.com 2015
		Grus paradisea	13.30	7.20			www.genomesize.com 2015
		Grus japonensis	12.60	9.40			Glomski and Pica 2011
		Grus grus	13.60	7.80			Glomski and Pica 2011

		Grus monacha	12.60	7.10			Glomski and Pica 2011
	Heliornithidae	*Heliornis fulica*	12.60	7.50	5.50	3.00	www.genomesize.com 2015
	Rallidae	*Laterallus albigularis*	12.80	7.20	5.20	3.10	www.genomesize.com 2015
		Rallus longirostris	14.50	7.70	5.70	2.90	www.genomesize.com 2015
		Rallus elegans	14.50	7.70	5.70	2.90	www.genomesize.com 2015
		Aramides cajanea	12.90	7.20	5.50	3.30	www.genomesize.com 2015
		Porzana porzana	12.70	7.10			www.genomesize.com 2015
		Porphyrio porphyrio	15.20	8.30			Glomski and Pica 2011
		Porphyrio martinica	14.20	7.80	6.70	2.90	www.genomesize.com 2015
		Gallinula chlorpus	12.40	6.60			www.genomesize.com 2015
		Fulica atra	13.40	7.90			www.genomesize.com 2015
		Fulica americana	11.40	7.50	4.20	2.30	www.genomesize.com 2015
SPHENICIFORMES	Spheniscidae	*Pygoscelis papua*	14.10	8.20			Glomski and Pica 2011
		Pygoscelis adeliae	13.70	8.50			Glomski and Pica 2011
		Pygoscelis antarcticus	13.40	8.60			Glomski and Pica 2011
	Eudyptula	*Eudyptula minor*	18.80	9.20			Glomski and Pica 2011
PROCELLARIIFORMES	Oceanitidae	*Oceanites oceanicus*	11.80	6.40			Kostelecka-Myrcha *et al.* 1993
CICONIIFORMES	Ciconiidae	*Ciconia nigra*	14.10	7.50			www.genomesize.com 2015
		Leptoptilos crumeniferus	13.70	7.30			www.genomesize.com 2015
SULIFORMES	Sulidae	*Morus bassanus*	12.10	6.80			Glomski and Pica 2011
	Phalacrocoracidae	*Phalacrocorax carbo*	12.70	6.70			www.genomesize.com 2015
		Phalacrocorax auritus	13.60	7.60	5.20	2.60	www.genomesize.com 2015
	Anhingidae	*Anhinga anhinga*	15.10	8.60	6.50	3.00	www.genomesize.com 2015
PELACANIFORMES	Pelecanidae	*Pelecanus ocnocrotalus*	14.30	7.50	7.90	2.60	www.genomesize.com 2015
		Pelecanus occidentalis	14.20	7.80	5.90	2.90	www.genomesize.com 2015
ARDEIFORMES	Threskiornithidae	*Plegadis falcinellus*	14.50	8.30			Glomski and Pica 2011
		Platalea leucorodia	13.70	7.10			www.genomesize.com 2015
	Ardeidae	*Tigrisoma lineatum*	15.80	10.0	7.00	2.90	www.genomesize.com 2015
		Ixobrychus minutus	12.70	6.60			www.genomesize.com 2015
		Nycticorax nycticorax	14.30	7.10			www.genomesize.com 2015
		Bulbucus ibis	14.20	8.40			Glomski and Pica 2011
		Butorides striatus (virescens)	13.00	8.30	6.00	2.90	www.genomesize.com 2015
		Ardea cinerea	13.30	7.30			www.genomesize.com 2015
		Ardea herodias	14.30	7.40	5.80	3.00	www.genomesize.com 2015
		Ardea purpurea	14.50	8.20			Glomski and Pica 2011
		Ardea alba	15.00	7.90	6.70	3.30	www.genomesize.com 2015
		Egretta caerulea	12.80	7.30	6.10	3.00	www.genomesize.com 2015
		Egretta thula	13.10	7.70	5.20	2.60	www.genomesize.com 2015
		Egretta garzetta	13.60	8.30			Glomski and Pica 2011
CHARADRIIFORMES	Burhinidae	*Burhinus oedicnemus*	13.3	6.8			Glomski and Pica 2011
	Charadriidae	*Charadrius dubius*	11.50	6.66			Irisova 1988
		Charadrius wilsonia	12.80	7.30	5.80	2.40	www.genomesize.com 2015
	Pluvialidae	*Pluvialis apricaria*	11.89	6.83			Irisova 1988
	Recurvirostridae	*Himantopus mexicanus*	12.80	6.90	5.80	2.50	www.genomesize.com 2015
	Haematopodidae	*Haematopus ostralegus*	13.40	6.40	7.90	2.80	www.genomesize.com 2015
	Jacanidae	*Jacana spinosa*	13.70	7.50	5.90	3.70	www.genomesize.com 2015

	Scolopacidae	*Numenius phaeopus*	13.80	5.70			www.genomesize.com 2015
		Limosa limosa	13.10	7.80			www.genomesize.com 2015
		Gallinago stenura	11.09	6.80			Irisova 1988
		Gallinago gallinago	10.81	6.55			Irisova 1988
		Gallinago gallinago	11.70	7.00			www.genomesize.com 2015
		Actitis hypoleucos	11.01	6.53			Irisova 1988
		Actitis hypoleucos	10.45	6.40			Irisova 1988
		Actitis hypoleucos	11.43	6.58			Irisova 1988
		Actitis hypoleucos	10.75	6.27			Irisova 1988
		Tringa ochropus	11.04	6.52			Irisova 1988
		Tringa brevipes	11.27	6.69			Irisova 1988
		Tringa glareola	10.53	6.01			Irisova 1988
		Tringa glareola	10.80	6.74			Irisova 1988
		Calidris pugnax	10.58	6.66			Irisova 1988
	Stercorariidae	*Stercorarius maccormicki*	11.80	6.60			Glomski and Pica 2011
	Alcidae	*Alle alle*	12.80	6.80			Kostelecka-Myrcha *et al.* 1993
	Laridae	*Chlidonias leucopterus*	10.66	6.15			Irisova 1988
		Sterna paradisaea	12.70	6.60			Kostelecka-Myrcha *et al.* 1993
		Sterna paradisaea	12.11	6.76			Irisova 1988
		Sterna vittata	12.10	6.60			Kostelecka-Myrcha *et al.* 1993
		Chroicocephalus ridibundus	12.10	6.40			www.genomesize.com 2015
		Hydrocoloeus minutus	12.54	6.09			Irisova 1988
		Larus canus	12.90	6.60	7.10	2.40	www.genomesize.com 2015
		Larus dominicanus	12.60	6.60			Glomski and Pica 2011
		Larus marinus	12.40	7.10			Glomski and Pica 2011
		Larus argentatus	11.80	7.64			Irisova 1988
		Larus argentatus	11.90	6.80			Glomski and Pica 2011
CATHARTIFORMES	Cathartidae	*Cathartes aura*	14.00	7.50	6.00	2.40	www.genomesize.com 2015
		Coragyps atratus	14.00	7.70	6.30	2.60	www.genomesize.com 2015
		Sarcorhamphus papa	14.30	8.10	6.50	3.20	www.genomesize.com 2015
		Vultur gryphus	14.40	6.50			www.genomesize.com 2015
ACCIPITROFORMES	Sagitariidae	*Sagittarius serpentarius*	14.80	7.70			www.genomesize.com 2015
	Accipitridae	*Gypohierax angolensis*	15.10	8.00			www.genomesize.com 2015
		Gypaetus barbatus	13.30	7.40			www.genomesize.com 2015
		Torgos tracheliotus	13.80	7.30	6.40	2.40	www.genomesize.com 2015
		Gyps fulvus	13.90	7.50			www.genomesize.com 2015
		Gyps coprotheres	14.20	7.60			www.genomesize.com 2015
		Terathopius ecaudatus	13.40	7.30			www.genomesize.com 2015
		Aquila rapax	14.30	7.70			Glomski and Pica 2011
		Aquila adalberti	14.90	8.00			Glomski and Pica 2011
		Aquila chrysaetos	14.00	6.60			www.genomesize.com 2015
		Aquila audax	13.70	7.30			www.genomesize.com 2015
		Circus aeruginosus	13.80	8.00			Glomski and Pica 2011
		Accipiter nisus	12.70	7.10	7.90	2.80	www.genomesize.com 2015
		Accipiter cooperii	14.30	8.10	6.20	2.40	www.genomesize.com 2015
		Accipiter gentilis	12.50	6.20			Glomski and Pica 2011
		Milvus milvus	13.20	6.90			www.genomesize.com 2015
		Milvus migrans	14.20	8.00			Glomski and Pica 2011

		Haliaeetus albicilla	13.90	7.50			www.genomesize.com 2015
		Haliaeetus leucocephalus	13.30	7.50			www.genomesize.com 2015
		Geranoaetus melanoleucus	14.10	7.10			www.genomesize.com 2015
		Buteo platypterus	13.60	7.70	5.90	2.70	www.genomesize.com 2015
		Buteo swainsonii	13.70	6.90			www.genomesize.com 2015
		Buteo jamaicensis	13.50	6.60	5.90	2.50	www.genomesize.com 2015
		Buteo buteo	14.30	7.50			Glomski and Pica 2011
		Buteo lagopus	13.70	6.90			www.genomesize.com 2015
STRIGIFORMES	Tytonidae	*Tyto alba pratincola*	14.10	7.80	6.30	2.50	www.genomesize.com 2015
		Tyto capensis	12.60	7.60			Glomski and Pica 2011
	Strigidae	*Athene noctua*	13.42	6.55			Irisova 1988
		Athene cunicularia	14.10	7.80	6.30	2.70	www.genomesize.com 2015
		Glaucidium passerinum	13.50	7.10			www.genomesize.com 2015
		Otus scops	13.90	7.50			www.genomesize.com 2015
		Pseudoscops clamator	13.70	7.70	5.90	3.00	www.genomesize.com 2015
		Megascops choliba	13.30	7.40	5.50	2.80	www.genomesize.com 2015
		Megascops atricapillus	14.80	7.10			www.genomesize.com 2015
		Strix nebulosa	13.40	7.90			www.genomesize.com 2015
		Strix aluco	13.20	6.70			www.genomesize.com 2015
		Strix varia	13.70	7.60	5.70	2.50	www.genomesize.com 2015
		Bubo scandiaca	16.30	6.30	7.90	2.40	www.genomesize.com 2015
		Bubo virginianus	13.80	6.40			www.genomesize.com 2015
		Bubo africanus	12.50	10.0			Glomski and Pica 2011
		Asio flammeus	13.50	6.80	6.40	2.40	www.genomesize.com 2015
TROGONIFORMES	Trogonidae	*Pharomachrus mocino*	12.20	7.00	5.80	2.70	www.genomesize.com 2015
		Trogon collaris	13.60	7.70	6.80	2.90	www.genomesize.com 2015
		Trogon massena	13.60	7.60	6.30	2.60	www.genomesize.com 2015
BUCEROTIFORMES	Upupidae	*Upupa epops*	11.24	6.41			Irisova 1988
	Bucerotidae	*Tockus leucomelas*	12.70	7.90			www.genomesize.com 2015
		Buceros rhinoceros	15.00	7.90			www.genomesize.com 2015
CORACIIFORMES	Meropidae	*Merops apiaster*	10.41	6.31			Irisova 1988
	Coraciidae	*Coracias garrulus*	12.70	7.30			www.genomesize.com 2015
	Alcedinidae	*Dacelo novaeguineae*	12.00	7.10			www.genomesize.com 2015
		Alcedo atthis	12.00	6.90			www.genomesize.com 2015
		Chloroceryle aenea	12.60	6.70	6.50	2.90	www.genomesize.com 2015
		Chloroceryle amazona	13.90	7.80	6.50	2.90	www.genomesize.com 2015
PICIFORMES	Bucconidae	*Notharchus macrorhynchos*	13.10	7.60	6.20	2.90	www.genomesize.com 2015
	Ramphastidae	*Aulacorhynchus prasinus*	12.80	8.00	7.20	2.90	www.genomesize.com 2015
		Pteroglossus torquatus	13.90	8.00	6.60	2.70	www.genomesize.com 2015
		Ramphastos ambiguus (swainsonii)	13.30	7.70	5.80	2.30	www.genomesize.com 2015
	Picidae	*Campephilus guatemalensis*	13.80	7.20	6.00	2.50	www.genomesize.com 2015
		Melanerpes erythrocephalus	14.10	7.30	6.50	2.30	www.genomesize.com 2015
		Melanerpes formicivorus	12.40	6.60	6.40	2.80	www.genomesize.com 2015
		Melanerpes chrysauchen	11.70	7.30	6.10	2.10	www.genomesize.com 2015
		Melanerpes rubricapillus	13.70	7.30	6.10	2.40	www.genomesize.com 2015
		Melanerpes carolinus	13.60	6.80	6.40	2.30	www.genomesize.com 2015
		Dryobates pubescens	12.70	5.80	6.00	2.30	www.genomesize.com 2015

		Dendrocopos minor	11.70	6.50			www.genomesize.com 2015
		Dendrocopos minor	10.46	6.13			Irisova 1988
		Dendrocopos leucopterus	12.17	6.73			Irisova 1988
		Dendrocopos major	10.71	6.00			Irisova 1988
		Dendrocopos major	10.34	5.38			Irisova 1988
		Leuconotopicus villosus	12.40	6.30	6.20	2.20	www.genomesize.com 2015
		Dryocopus lineatus	14.30	7.60	6.40	3.10	www.genomesize.com 2015
FALCONIFORMES	Falconidae	*Caracara plancus*	14.10	8.70	6.40	2.70	www.genomesize.com 2015
		Falco rupicoloides	13.10	7.40			Glomski and Pica 2011
		Falco tinnunculus	13.40	7.30			www.genomesize.com 2015
		Falco sparverius	11.80	7.30	5.80	2.10	www.genomesize.com 2015
		Falco subbuteo	13.90	7.20			www.genomesize.com 2015
		Falco subbuteo	11.97	7.03			Irisova 1988
		Falco peregrinus	13.30	6.60			www.genomesize.com 2015
		Falco rusticolus	14.80	7.20			Glomski and Pica 2011
		Falco biarmicus	12.80	7.80			Glomski and Pica 2011
PSITTACIFORMES	Cacatuidae	*Nymphicus hollandicus*	11.80	6.10			www.genomesize.com 2015
		Calyptorhynchus funereus	14.60	7.70			Glomski and Pica 2011
		Probosciger aterrimus	14.50	7.90			Glomski and Pica 2011
		Cacatua haematuropygia	12.90	6.30			www.genomesize.com 2015
		Cacatua sulphurea	11.50	7.50			www. genomesize.com 2015
		Cacatua galerita	13.50	7.10			www.genomesize.com 2015
		Cacatua alba	13.80	7.50			Glomski and Pica 2011
	Psittacidae	*Coracopsis vasa*	12.40	6.50			www.genomesize.com 2015
		Coracopsis nigra	11.90	6.50			www.genomesize.com 2015
		Psittacus erithacus	13.40	6.40			www.genomesize.com 2015
		Myiopsitta monachus	11.90	6.30			www.genomesize.com 2015
		Brotogeris jugularis	12.10	7.70	6.00	2.90	www.genomesize.com 2015
		Pionus menstruus	12.00	6.90			www.genomesize.com 2015
		Pionus senilis	13.00	7.60	5.80	2.30	www.genomesize.com 2015
		Graydidascalus brachyurus	12.50	6.10			www.genomesize.com 2015
		Amazona leucocephala	12.40	6.80			www.genomesize.com 2015
		Amazona albifrons	13.20	6.90			www.genomesize.com 2015
		Amazona autumnalis	13.60	7.70	6.20	3.00	www.genomesize.com 2015
		Amazona dufresniana	11.20	7.50			www.genomesize.com 2015
		Amazona festiva	13.10	7.60			Glomski and Pica 2011
		Amazona aestiva	13.50	8.10			Glomski and Pica 2011
		Amazona ochrocephala	13.80	7.60			Glomski and Pica 2011
		Amazona amazonica	14.10	6.60			www.genomesize.com 2015
		Amazona imperialis	12.20	7.00			www.genomesize.com 2015
		Anodorhynchus hyacinthinus	14.00	7.40			Glomski and Pica 2011
		Pionites melanocephalus	12.70	6.50			www.genomesize.com 2015
		Pyrrhura hoffmanni	13.20	7.20	6.10	2.30	www.genomesize.com 2015
		Cyanoliseus patagonus	11.80	6.40			www.genomesize.com 2015
		Enicognathus leptorhynchus	12.30	6.50			www.genomesize.com 2015
		Aratinga solstitialis	11.90	6.40			www.genomesize.com 2015
		Ara ararauna	13.00	6.20			www.genomesize.com 2015
		Ara militaris	13.50	7.20			Glomski and Pica 2011
		Ara macao	13.40	5.30			www.genomesize.com 2015
		Ara chloropterus	12.70	7.80			Glomski and Pica 2011

		Ara severus	11.70	6.70			www.genomesize.com 2015
		Alisterus amboinensis	12.40	6.10			www.genomesize.com 2015
		Alisterus scapularis	12.70	6.30			www.genomesize.com 2015
		Tanygnathus megalorhynchos	12.10	6.60			www.genomesize.com 2015
		Psittacula krameri	11.70	6.50			www.genomesize.com 2015
		Psittacula cyanocephala	11.20	6.40			www.genomesize.com 2015
		Psittacula alexandri	12.00	6.50			www.genomesize.com 2015
		Cyanoramphus novaezelandiae	12.00	6.10			www.genomesize.com 2015
		Platycercus caledonicus	12.00	6.50			www.genomesize.com 2015
		Platycercus elegans	12.10	6.50			www.genomesize.com 2015
		Platycercus eximius	11.60	6.50			www.genomesize.com 2015
		Agapornis canus	12.10	6.10			www.genomesize.com 2015
		Agapornis pullarius	12.10	6.10			www.genomesize.com 2015
		Lorius domicella	12.10	6.10			www.genomesize.com 2015
		Eos bornea	14.10	7.70			Glomski and Pica 2011
		Trichoglossus haematodus	11.50	6.50			www.genomesize.com 2015
PASSERIFORMES	Pittidae	*Pitta sordida*	10.80	6.10			www.genomesize.com 2015
	Thamnophilidae	*Taraba major*	13.60	7.60	6.60	2.80	www.genomesize.com 2015
	Furnariidae	*Sittasomus griseicapillus*	12.00	6.40	5.40	2.00	www.genomesize.com 2015
		Dendrocincla homochroa	11.80	6.70	5.40	2.30	www.genomesize.com 2015
		Xiphorhynchus guttatus	12.30	7.30	6.00	2.80	www.genomesize.com 2015
		Xiphorhynchus erythropygius	12.20	6.40	5.70	2.40	www.genomesize.com 2015
		Lepidocolaptes affinis	11.20	6.60	6.00	2.60	www.genomesize.com 2015
		Anabacerthia striaticollis	11.90	6.10	5.40	2.10	www.genomesize.com 2015
		Synallaxis brachyura	11.10	6.10	5.60	2.10	www.genomesize.com 2015
	Pipridae	*Corapipo leucorrhoa*	11.10	6.10	5.10	2.30	www.genomesize.com 2015
		Manacus manacus	12.00	6.70	5.90	2.90	www.genomesize.com 2015
	Cotingidae	*Cotinga ridgwayi*	12.20	6.70	6.20	2.10	www.genomesize.com 2015
	Tyrannidae	*Todirostrum cinereum*	11.90	6.40	5.70	2.30	www.genomesize.com 2015
		Lophotriccus pileatus	11.50	6.40	4.70	2.20	www.genomesize.com 2015
		Attila spadiceus	12.30	6.60	5.70	1.90	www.genomesize.com 2015
		Myiarchus crinitus	11.30	6.70	5.20	2.30	www.genomesize.com 2015
		Myiozetetes cayenensis	10.70	6.30	5.20	2.50	www.genomesize.com 2015
		Sayornis phoebe	10.80	5.80	5.00	2.20	www.genomesize.com 2015
		Tityra semifasciata	11.70	6.80	5.60	2.70	www.genomesize.com 2015
		Mitrephanes phaeocercus	11.10	6.40	5.60	2.10	www.genomesize.com 2015
		Contopus virens	11.90	6.80	6.00	2.50	www.genomesize.com 2015
		Empidonax flaviventris	12.00	5.90	5.70	2.10	www.genomesize.com 2015
	Cracticidae	*Gymnorhina tibicen*	12.00	6.50			www.genomesize.com 2015
	Vireonidae	*Vireo flavifrons*	11.20	6.30	5.30	2.20	www.genomesize.com 2015
		Vireo solitarious	11.20	6.10	5.20	2.30	www.genomesize.com 2015
		Vireo olivaceus	11.00	6.60	5.90	2.60	www.genomesize.com 2015
		Cyclarhis gujanensis	11.80	6.60	5.90	2.60	www.genomesize.com 2015
	Oriolidae	*Oriolus oriolus*	10.21	6.15			Irisova 1988
		Oriolus oriolus	11.00	6.44			Irisova 1988
	Pachycephalidae	*Pachycephala cinerea*	11.70	6.10			www.genomesize.com 2015
	Laniidae	*Lanius collurio*	11.40	6.50			www.genomesize.com 2015

		Lanius collurio	8.94	5.45			Irisova 1988
		Lanius collurio	10.52	5.90			Irisova 1988
		Lanius minor	10.65	6.15			Irisova 1988
		Lanius excubitor	12.80	4.80			www.genomesize.com 2015
	Corvidae	*Pyrrhocorax pyrrhocorax*	10.57	5.35			Irisova 1988
		Pyrrhocorax graculus	12.10	5.60			www.genomesize.com 2015
		Pyrrhocorax graculus	11.10	5.74			Irisova 1988
		Cyanocitta cristata	13.70	7.80	5.80	2.60	www.genomesize.com 2015
		Perisoreus infaustus	11.47	6.10			Irisova 1988
		Perisoreus infaustus	11.05	6.08			Irisova 1988
		Cyanocorax cristatellus	11.90	6.30			www.genomesize.com 2015
		Cyanocorax chrysops	12.40	6.10			www.genomesize.com 2015
		Pica pica	13.00	7.50	6.00	2.30	www.genomesize.com 2015
		Pica pica	10.13	6.26			Irisova 1988
		Pica pica	9.96	6.27			Irisova 1988
		Garrulus glandarius	12.30	6.50	6.40	2.40	www.genomesize.com 2015
		Garrulus glandarius	11.43	6.57			Irisova 1988
		Nucifraga caryocatactes	13.50	6.10			www.genomesize.com 2015
		Nucifraga caryocatactes	11.36	6.23			Irisova 1988
		Nucifraga caryocatactes	11.56	6.61			Irisova 1988
		Coloeus monedula	11.30	6.10	6.40	2.40	www.genomesize.com 2015
		Corvus brachyrhynchos	11.40	6.60			Glomski and Pica 2011
		Corvus tristis	12.70	6.10			www.genomesize.com 2015
		Corvus frugilegus	13.40	7.90	5.60	2.80	www.genomesize.com 2015
		Corvus corax	13.00	6.40			www.genomesize.com 2015
		Corvus albus	12.50	6.90			Glomski and Pica 2011
	Remizidae	*Remiz pendulinus*	11.4	5.41			Irisova 1988
	Paridae	*Cyanistes caeruleus*	11.00	6.20			www.genomesize.com 2015
		Cyanistes caeruleus	10.80	6.00			Kostelecka-Myrcha *et al.* 1993
		Cyanistes flavipectus	10.34	5.40			Irisova 1988
		Parus major	11.50	6.40			Kostelecka-Myrcha *et al.* 1993
		Parus major	9.65	5.74			Irisova 1988
		Baelophus (Parus) bicolor	10.70	5.90	5.30	2.00	www.genomesize.com 2015
		Periparus rufonuchalis	10.31	5.57			Irisova 1988
		Poecile montanus	11.20	5.90			Kostelecka-Myrcha *et al.* 1993
		Poecile carolinensis	10.40	5.60	4.90	1.90	www.genomesize.com 2015
		Eremophila alpestris	10.68	5.46			Irisova 1988
	Alaudidae	*Eremophila alpestris*	10.72	5.52			Irisova 1988
		Alauda arvensis	12.00	6.20	6.40	2.10	www.genomesize.com 2015
		Alauda arvensis	10.04	5.89			Irisova 1988
	Hirundinidae	*Progne chalybea*	12.70	7.10	5.50	2.70	www.genomesize.com 2015
		Stelgidopteryx ruficollis	12.20	6.60	5.90	2.10	www.genomesize.com 2015
		Hirundo rustica	11.90	6.40	5.60	3.20	www.genomesize.com 2015
		Hirundo rustica	10.80	5.90			Irisova 1988
		Delichon urbicum	11.70	6.40			www.genomesize.com 2015
		Delichon urbicum	10.82	5.82			Irisova 1988
		Cecropis daurica	10.82	6.01			Irisova 1988
		Pygohelidon cyanoleuca	11.70	6.40	5.40	2.10	www.genomesize.com 2015
	Accrocephalidae	*Acrocephalus schoenobaenus*	12.70	7.20			www.genomesize.com 2015

		Acrocephalus arundinaceus	9.53	5.68			Irisova 1988
	Pycnonotidae	*Pycnonotus barbatus*	12.50	6.90			Glomski and Pica 2011
	Aegithalidae	*Aegithalos caudatus*	11.90	5.60	5.30	2.40	www.genomesize.com 2015
		Aegithalos caudatus	12.20	6.40			Kostelecka-Myrcha *et al.* 1993
	Phylloscopidae	*Phylloscopus sibilatrix*	11.00	5.90			personal data
		Phylloscopus fuscatus	10.66	5.89			Irisova 1988
		Phylloscopus trochillus	11.20	5.90			personal data
		Phylloscopus collybita	10.70	5.90			personal data
		Phylloscopus collybita	9.74	6.84			Irisova 1988
		Phylloscopus nitidus	10.15	5.55			Irisova 1988
	Sylviidae	*Sylvia borin*	10.22	5.99			Irisova 1988
		Sylvia atricapilla	11.50	6.80			Kostelecka-Myrcha *et al.* 1993
	Leiothrichidae	*Garrulax canorus*	11.00	6.50			www.genomesize.com 2015
	Certhiidae	*Certhia familiaris*	11.00	6.40			www.genomesize.com 2015
		Certhia familiaris	11.00	6.20			Kostelecka-Myrcha *et al.* 1993
	Sittidae	*Sitta europaea*	11.50	6.10	5.60	2.30	www.genomesize.com 2015
		Sitta carolinensis	11.30	5.80	5.20	2.10	www.genomesize.com 2015
	Polioptilidae	*Polioptila caerulea*	10.00	6.30	4.50	2.10	www.genomesize.com 2015
	Troglodytidae	*Troglodytes troglodytes*	10.80	6.10			www.genomesize.com 2015
		Troglodytes troglodytes	11.20	6.30			Kostelecka-Myrcha *et al.* 1993
		Troglodytes aedon	11.10	6.50	5.40	2.20	www.genomesize.com 2015
		Thryothorus ludovicianus	11.20	5.60	5.20	1.80	www.genomesize.com 2015
		Cantorchilus modestus	10.80	6.50	5.60	2.60	www.genomesize.com 2015
		Pheugopedius fasciatoventris	12.10	6.90	5.50	2.90	www.genomesize.com 2015
	Regulidae	*Regulus regulus*	11.10	6.10			www.genomesize.com 2015
		Regulus regulus	10.70	6.10			Kostelecka-Myrcha *et al.* 1993
		Regulus satrapa	9.80	5.00	4.70	2.00	www.genomesize.com 2015
		Regulus calendula	10.20	5.30	4.80	2.30	www.genomesize.com 2015
	Bombycillidae	*Bombycilla garrulus*	11.90	6.40			www.genomesize.com 2015
		Bombycilla cedrorum	12.20	6.30	5.70	2.30	www.genomesize.com 2015
	Mimidae	*Toxostoma rufum*	11.40	7.00			www.genomesize.com 2015
		Mimus polyglottos	11.00	6.20	4.90	2.10	www.genomesize.com 2015
	Sturnidae	*Gracula religiosa*	12.20	6.10			www.genomesize.com 2015
		Sturnus vulgaris	12.00	6.50	6.70	2.20	www.genomesize.com 2015
		Sturnus vulgaris	10.41	6.01			Irisova 1988
		Sturnus vulgaris	10.26	6.11			Irisova 1988
		Pastor roseus	12.10	5.50			www.genomesize.com 2015
		Pastor roseus	10.14	6.08			Irisova 1988
		Acridotheres tristis	11.06	6.50			Irisova 1988
		Acridotheres tristis	12.90	6.90			Glomski and Pica 2011
		Spodiopsar sericeus	11.90	5.60			www.genomesize.com 2015
	Cinclidae	*Cinclus cinclus*	10.71	5.64			Irisova 1988
	Turdidae	*Catharus guttatus*	11.90	5.60	5.70	2.10	www.genomesize.com 2015
		Turdus torquatus	11.70	6.20			personal data
		Turdus merula	12.20	7.00			Kostelecka-Myrcha *et al.* 1993
		Turdus merula	12.10	6.00	4.80	2.80	www.genomesize.com 2015
		Turdus ruficollis	11.25	6.01			Irisova 1988

		Turdus atrogularis	11.60	6.31			Irisova 1988
		Turdus naumanni	12.44	6.96			Irisova 1988
		Turdus pilaris	11.71	6.21			Irisova 1988
		Turdus philomelos	12.50	7.10			Kostelecka-Myrcha *et al.* 1993
		Turdus philomelos	11.50	6.10	6.40	2.60	www.genomesize.com 2015
		Turdus viscivorus	11.30	6.40			www.genomesize.com 2015
		Turdus viscivorus	11.15	6.06			Irisova 1988
		Turdus plebejus	11.80	7.30	5.50	2.80	www.genomesize.com 2015
		Turdus grayi	12.10	6.70	5.40	2.00	www.genomesize.com 2015
		Turdus migratorius	11.10	6.10	5.60	2.20	www.genomesize.com 2015
	Muscicapidae	*Muscicapa striata*	11.52	6.27			Irisova 1988
		Muscicapa striata	11.47	6.85			Irisova 1988
		Erithacus rubecula	11.00	6.10			www.genomesize.com 2015
		Erithacus rubecula	12.50	7.00			Kostelecka-Myrcha *et al.* 1993
		Luscinia svecica	10.58	6.29			Irisova 1988
		Luscinia svecica	10.74	6.06			Irisova 1988
		Luscinia megarhynchos	11.35	5.99			Irisova 1988
		Luscinia megarhynchos	13.40	5.80	6.40	2.10	www.genomesize.com 2015
		Tarsiger cyanurus	10.71	5.75			Irisova 1988
		Myophonus caeruleus	11.12	6.14			Irisova 1988
		Phoenicurus caeruleocephala	10.52	5.88			Irisova 1988
		Phoenicurus ochruros	11.50	6.00			personal data
		Phoenicurus phoenicurus	9.78	5.16			Irisova 1988
		Phoenicurus erythrogastrus	10.52	5.53			Irisova 1988
		Monticola saxatilis	10.46	6.29			Irisova 1988
		Monticola saxatilis	11.10	5.42			Irisova 1988
		Saxicola rubicola	10.02	5.34			Irisova 1988
		Oenanthe isabellina	10.66	5.82			Irisova 1988
		Oenanthe deserti	10.05	6.02			Irisova 1988
		Oenanthe pleschanka	10.71	5.89			Irisova 1988
	Prunellidae	*Prunella collaris* (SK)	11.40	6.00	6.30	3.10	personal data
		Prunella collaris (KG)	11.09	5.66	5.48	2.58	personal data
		Prunella collaris (BG)	11.12	6.39	5.58	2.69	personal data
		Prunella himalayana	10.45	5.26			Irisova 1988
		Prunella himalayana	10.78	5.66			Irisova 1988
		Prunella fulvescens	11.66	6.09	5.47	2.71	personal data
		Prunella fulvescens	10.96	5.58			Irisova 1988
		Prunella fulvescens	10.48	5.50			Irisova 1988
		Prunella atrogularis	11.46	5.78	5.64	2.56	personal data
		Prunella modularis	12.10	6.50	4.10	2.10	personal data
		Prunella modularis	11.90	6.80			Kostelecka-Myrcha *et al.* 1993
	Ploceidae	*Ploceus hypoxanthus*	11.10	6.90			www.genomesize.com 2015
	Viduidae	*Vidua paradisaea*	12.70	6.80			www.genomesize.com 2015
	Estrildidae	*Lonchura punctulata*	11.30	8.30			Glomski and Pica 2011
		Lonchura malacca	10.80	6.10			www.genomesize.com 2015
		Amandava amandava	11.30	5.30			www.genomesize.com 2015
		Amadina fasciata	12.70	5.80			www.genomesize.com 2015
		Amadina erythrocephala	11.60	6.80			Glomski and Pica 2011
		Estrilda astrild	11.20	5.40			www.genomesize.com 2015

Passeridae	*Montifringilla nivalis*	10.95	6.16			Irisova 1988
	Montifringilla nivalis	10.87	5.06			Irisova 1988
	Petronia petronia	10.79	6.18			Irisova 1988
	Petronia petronia	11.64	5.65			Irisova 1988
	Passer domesticus	11.30	5.60	5.40	2.30	www.genomesize.com 2015
	Passer domesticus	10.46	6.39			Irisova 1988
	Passer domesticus	11.60	6.10			Kostelecka-Myrcha *et al.* 1993
	Passer melanurus	11.30	5.30			Glomski and Pica 2011
	Passer montanus	11.50	6.10			Kostelecka-Myrcha *et al.* 1993
	Passer montanus	10.63	5.60			Irisova 1988
	Passer montanus	10.51	6.00			Irisova 1988
	Passer montanus	10.74	6.07			Irisova 1988
Motacillidae	*Motacilla flava*	9.63	5.78			Irisova 1988
	Motacilla cinera	10.82	5.49			Irisova 1988
	Motacilla cinera	10.02	5.45			Irisova 1988
	Motacilla alba	11.60	7.10	6.40	2.40	www.genomesize.com 2015
	Motacilla alba	10.36	5.58			Irisova 1988
	Motacilla alba	10.03	5.73			Irisova 1988
	Motacilla alba	10.64	5.72			Irisova 1988
	Motacilla alba	10.11	5.96			Irisova 1988
	Anthus trivialis	10.48	5.50			Irisova 1988
	Anthus trivialis	10.26	5.78			Irisova 1988
	Anthus trivialis	10.88	6.15			Irisova 1988
	Anthus spinoletta	11.20	5.80			personal data
	Anthus spinoletta	10.78	5.66			Irisova 1988
Fringillidae	*Fringilla coelebs*	11.10	5.70			personal data
	Fringilla coelebs	10.22	6.10			Irisova 1988
	Fringilla coelebs	11.90	6.80			Kostelecka-Myrcha *et al.* 1993
	Mycerobas carnipes	10.66	6.07			Irisova 1988
	Coccothraustes coccothraustes	12.40	6.70	5.60	2.40	www.genomesize.com 2015
	Coccothraustes coccothraustes	10.81	5.97			Irisova 1988
	Pinicola enucleator	11.30	6.20			www.genomesize.com 2015
	Pinicola enucleator	9.75	7.05			Irisova 1988
	Pinicola enucleator	9.75	7.05			Irisova 1988
	Pyrrhula pyrrhula	10.90	6.10			Kostelecka-Myrcha *et al.* 1993
	Pyrrhula pyrrhula	10.22	6.10			Irisova 1988
	Leucosticte brandti	10.35	5.54			Irisova 1988
	Carpodacus erythrinus	10.97	5.76			Irisova 1988
	Carpodacus erythrinus	10.03	5.69			Irisova 1988
	Carpodacus erythrinus	10.59	5.92			Irisova 1988
	Carpodacus rubicilla	10.85	5.76			Irisova 1988
	Carpodacus roseus	11.16	5.05			Irisova 1988
	Carpodacus purpureus	11.40	5.10			Glomski and Pica 2011
	Rhodopechys sanguineus	10.52	6.16			Irisova 1988
	Loxia curvirostra	10.70	6.40			www.genomesize.com 2015
	Serinus canaria	11.40	7.10			www.genomesize.com 2015
	Serinus pusillus	11.28	5.91			Irisova 1988
	Serinus pusillus	10.72	5.52			Irisova 1988
	Chloris chloris	11.40	7.10			www.genomesize.com 2015
	Spinus spinus	11.90	6.40			www.genomesize.com 2015

		Spinus spinus	10.90	5.90			Kostelecka-Myrcha *et al.* 1993
		Acanthis flammea	11.10	5.60			www.genomesize.com 2015
		Acanthis flammea	10.45	5.78			Irisova 1988
		Acanthis cabaret	11.18	5.39			Irisova 1988
		Carduelis carduelis	11.30	5.30			www.genomesize.com 2015
		Carduelis caniceps	10.34	5.30			Irisova 1988
		Carduelis cannabina	10.90	6.70			www.genomesize.com 2015
	Parulidae	*Seiurus aurocapilla*	11.70	5.50	5.30	2.50	www.genomesize.com 2015
		Helmitheros vermivorus	11.30	6.10	5.40	2.30	www.genomesize.com 2015
		Parkesia motacilla	11.70	6.00	5.60	2.40	www.genomesize.com 2015
		Mniotilta varia	11.20	6.10	4.90	2.30	www.genomesize.com 2015
		Oreothlypis gutturalis	11.10	7.20	5.60	2.90	www.genomesize.com 2015
		Geothlypis aequinoctialis	11.90	5.90	5.30	2.00	www.genomesize.com 2015
		Wilsonia citrina	11.80	6.70	5.90	2.60	www.genomesize.com 2015
		Wilsonia pusilla	11.70	5.80	5.60	2.30	www.genomesize.com 2015
		Dendroica pensylvanica	11.70	6.50	5.90	2.20	www.genomesize.com 2015
		Dendroica fusca	11.40	5.60	5.10	2.40	www.genomesize.com 2015
		Dendroica magnolia	10.90	6.30	5.20	2.40	www.genomesize.com 2015
		Dendroica caerulescens	11.30	6.30	5.40	2.60	www.genomesize.com 2015
		Dendroica coronata	11.00	6.00	5.30	2.40	www.genomesize.com 2015
		Dendroica virens	10.90	6.30	5.00	2.40	www.genomesize.com 2015
		Dendroica dominica	11.10	6.10	5.30	2.40	www.genomesize.com 2015
		Dendroica discolor	10.80	6.30	4.90	2.10	www.genomesize.com 2015
		Dendroica pinus	9.70	5.90	4.80	2.50	www.genomesize.com 2015
		Basileuterus rufifrons	11.50	6.00	5.60	2.60	www.genomesize.com 2015
		Myioborus miniatus	11.60	6.10	5.10	2.30	www.genomesize.com 2015
	Calcariidae	*Plectrophenax nivalis*	11.90	5.40			www.genomesize.com 2015
	Icteridae	*Dolichonyx oryzivorus*	10.60	6.10			www.genomesize.com 2015
		Amblycercus holosericeus	11.60	6.50	5.70	3.00	www.genomesize.com 2015
		Quiscalus quiscula	10.70	6.20	4.70	2.30	www.genomesize.com 2015
		Psarcolius wagleri	11.00	6.70	4.90	2.20	www.genomesize.com 2015
		Icterus mesomelas	13.10	6.90	5.70	2.80	www.genomesize.com 2015
		Icterus galbula	12.00	6.30	5.30	2.20	www.genomesize.com 2015
	Emberizidae	*Emberiza citrinella*	11.40	6.40			Kostelecka-Myrcha *et al.* 1993
		Emberiza citrinella	11.10	6.40	6.40	2.10	www.genomesize.com 2015
		Emberiza leucocephalos	10.20	6.03			Irisova 1988
		Emberiza leucocephalos	10.40	6.02			Irisova 1988
		Emberiza cia	10.52	5.70			Irisova 1988
		Emberita stewarti	11.65	5.83			Irisova 1988
		Emberiza buchanani	12.35	6.05	5.84	2.79	personal data
		Emberiza hortulana	10.34	5.79			Irisova 1988
		Emberiza pusilla	11.38	6.33			Irisova 1988
		Emberiza aureola	10.64	5.69			Irisova 1988
		Emberiza pallasi	11.46	6.47			Irisova 1988
		Emberiza pallasi	10.70	4.97			Irisova 1988
	Passerellidae	*Chlorospingus pileatus*	11.40	6.70	5.90	2.70	www.genomesize.com 2015
		Arremonops conirostris	11.40	6.20	5.50	2.20	www.genomesize.com 2015
		Spizella passerina	10.10	6.00	5.00	2.30	www.genomesize.com 2015
		Spizella pusilla	11.30	5.90	5.30	2.2	www.genomesize.com 2015
		Spizella arborea	10.20	5.30	5.10	2.00	www.genomesize.com 2015

		Passerella iliaca	11.30	6.20	5.70	2.20	www.genomesize.com 2015
		Junco hyemalis	11.70	5.90	5.50	2.30	www.genomesize.com 2015
		Zonotrichia capensis	11.40	6.10	4.80	2.10	www.genomesize.com 2015
		Zonotrichia albicollis	11.70	5.10	5.50	2.10	www.genomesize.com 2015
		Melospiza melodia	11.10	6.10	5.30	2.30	www.genomesize.com 2015
		Melospiza georgiana	10.90	5.90	5.10	2.40	www.genomesize.com 2015
		Pipilo erythrophthalmus	11.40	6.10	5.20	2.40	www.genomesize.com 2015
	Cardinalidae	*Piranga olivacea*	11.90	6.20	5.10	2.40	www.genomesize.com 2015
		Cardinalis cardinalis	11.90	6.00	5.60	2.10	www.genomesize.com 2015
		Pheucticus tibialis	11.70	6.50	5.30	2.70	www.genomesize.com 2015
		Passerina caerulea	11.10	6.80			www.genomesize.com 2015
	Thraupidae	*Saltator albicollis*	12.10	7.20	5.20	3.00	www.genomesize.com 2015
		Saltator atriceps	12.50	7.50	5.30	2.90	www.genomesize.com 2015
		Tiaris olivaceus	11.30	6.90	4.90	2.40	www.genomesize.com 2015
		Tangara icterocephala	11.40	6.30	5.10	2.40	www.genomesize.com 2015
		Thraupis episcopus	11.40	7.00	5.40	2.30	www.genomesize.com 2015
		Dacnis venusta	11.20	6.00	4.80	2.10	www.genomesize.com 2015
		Dacnis cayana	12.50	7.40	6.20	3.20	www.genomesize.com 2015
		Ramphocelus passerinii	12.00	6.60	4.80	2.40	www.genomesize.com 2015