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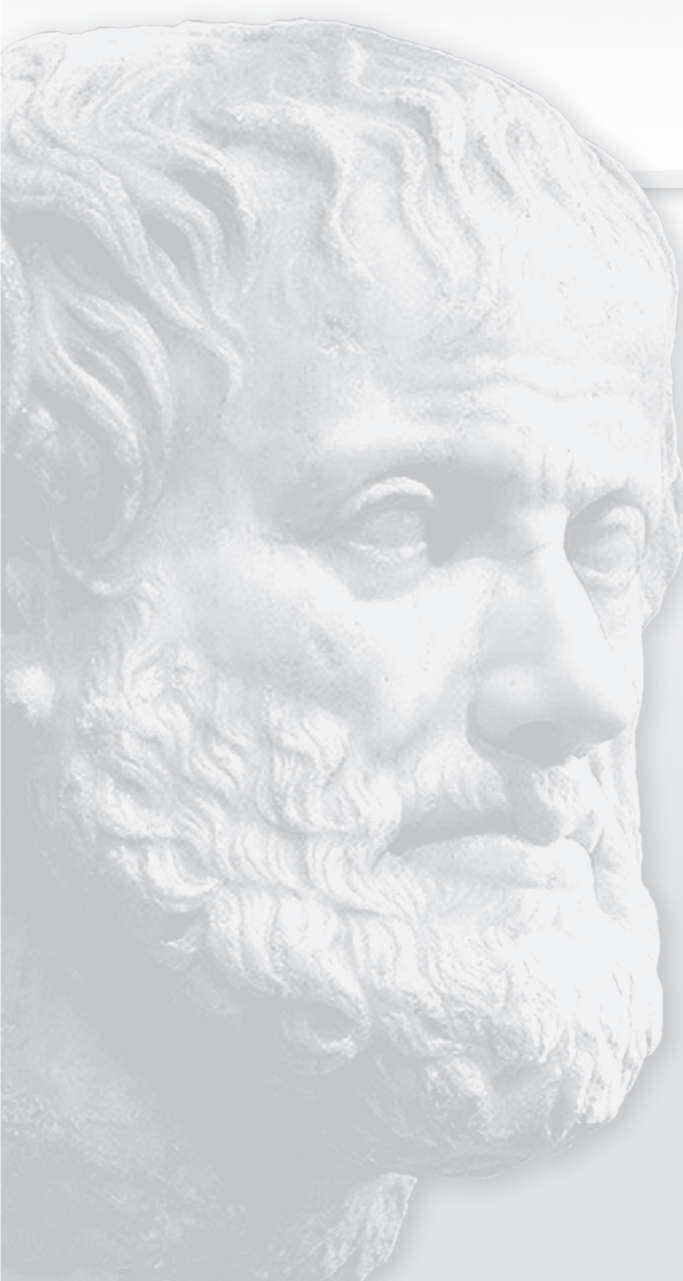
Proceedings of the World Congress

Aristotle

2400 Years

MAY 23-28, 2016

Edited by
Demetra Sfendoni-Mentzou



ARISTOTLE UNIVERSITY
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Proceedings of the World Congress “Aristotle 2400 Years”

Edited by:

Demetra Sfendoni-Mentzou

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Aristotle's Explanations of Bird Migration

WORLD CONGRESS "ARISTOTLE 2400 YEARS" | MAY 23-28, 2016 | ARISTOTLE UNIVERSITY OF THESSALONIKI, ANCIENT STAGEIRA, ANCIENT MIEZA

Introduction

The migrations¹ of birds have attracted the attention and excited the imagination of man since antiquity. The earliest contributions to the study of this phenomenon date back 3,000 years ago, to the times of Hesiod, Homer, Herodotus, Anacreon, and Aristophanes.

However, the first systematic study of birds began in the 4th-century BCE with Aristotle. A search for ornithological material in his zoological or biological writings reveals his attempt to explore the whole field of bird life. The Macedonian philosopher and naturalist displayed specific interest in the morphology, anatomy, physiology, classification and behavior of birds (ὄρνιθες/ὄρνεα/πτηνὰ), and provided explanations of their diet, habitat, migration and reproduction (mating, conception, hatching and generation of young). The principal sources of information on the nature and kinds of birds are the following works: (a) *Historia animalium* (Περὶ τὰ Ζῷα Ἱστορίαι),² (b) *De partibus animalium* (Περὶ Ζῶων Μορίων) and (c) *De generatione animalium* (Περὶ Ζῶων Γενέσεως). Whereas, the most valuable work on the subject of ornithology, is contained in *Historia animalium*, which, according to Ross, "is a preliminary work that aims at recording the main facts of

animal life. The remaining treatises aim at eliciting theory from the recorded facts."³

Aristotle in *Historia animalium* [Book VII(VIII). 12, 596b 20 – 597b 30, and 16, 600a 11-28] writes about bird migration, the mechanism behind the seasonal appearance and disappearance of some species of birds. Peter Berthold asserts that "without doubt the history of bird migration studies started with Aristotle, who 'raised ornithology to the rank of a science', as Stresemann⁴ (1951) confirmed in his *Entwicklung der Ornithologie*⁵ (*Development of Ornithology*)."⁶

Taking into account the previous view, the aim of the present paper is to study Aristotle's explanations of the periodic movement of birds from one geographic location to another and back again and evaluate it under the scope of contemporary avian biology.



Image 1.
[Barn] Swallow
(*Hirundo rustica*).
Drawn from Nature & on
stone by J. & E. Gould
(Plate 54) from Volume II
of John Gould's
The Birds of Europe, 1837.

1. Migration is not just for the birds. Many creatures, like fish, mammals, reptiles, amphibians, and even insects migrate.

2. Cf. Aristotle, *Historia animalium*, II.12, 503b 29 – 504b 13, and 17, 508b 26 – 509a 24; IV.9, 536a 20-32 and 536b 14-19, and 10, 536b 24-32; V.5, 541a 27-31, and 8, 542b 2-28, and 13, 544a 25 – 544b 11; VI.1, 558b 9-10, 564b 14; VII(VIII).3, 592a 29 – 594a 4, and 12, 596b 20 – 597b 30, and 16, 600a 11-28, and 18, 601a 26 – 601b 5; VIII(IX).7, 612b 18-36, and 620b 10.

3. David Ross, *Aristotle*. With an Introduction by John L. Ackrill (London and New York: Routledge, 1995), 118.

4. Erwin Stresemann (1889-1972) was one of the most important ornithologists of the 20th century.

5. Erwin Stresemann, *Die Entwicklung der Ornithologie von Aristoteles bis zur Gegenwart* (Berlin: F.W. Peters, 1951).

6. Peter Berthold, *Bird Migration: A General Survey*, 2nd edition (Oxford - New York: Oxford University Press, 2001), 11.

1. Migration of Birds: Cranes, Pelicans, Cuckoos, Quails, Doves, Swallows, Swans and Geese

The Stageirite philosopher may have been the first person to study “scientifically” bird migration.⁷ He was “the first to discuss migration in anything like the spirit which moves a modern naturalist.”⁸

All animals, says Aristotle, have an innate perception (αἴσθησις σύμφυτος) of the changes of temperature. Some of them find protection in their accustomed locations (συνήθεσι τόποις), while other migrate. Creatures that are able to change their locations spend their winter in warm lands, where food is more abundant, and their summer in cold ones. The philosopher compares bird migration to human behavior asserting, “that wealthier people often change their place of residence seasonally to pursue comfort in more equitable climes, and so do cranes, pelicans, swans, geese, doves and quails.”⁹

πάντα γὰρ τῆς κατὰ τὸ θερμὸν καὶ ψυχρὸν μεταβολῆς αἴσθησιν ἔχει σύμφυτον, καὶ καθάπερ τῶν ἀνθρώπων οἱ μὲν ἐν τοῖς ψυχροῖς χειμάζουσι δ' ἐν τοῖς ἀλεεινοῖς, οὕτω καὶ τῶν ζώων τὰ δυνάμενα μεταβάλλειν τοὺς τόπους. καὶ τὰ μὲν ἐν αὐτοῖς τοῖς συνήθεσι τόποις εὐρίσκεται τὰς βοηθείας, τὰ δ' ἐκτοπίζει, μετὰ μὲν τὴν φθινοπωρινὴν ἰσημερίαν ἐκ τοῦ Πόντου καὶ τῶν ψυχρῶν τόπων φεύγοντα τὸν ἐπιόντα χειμῶνα, μετὰ δὲ τὴν ἑαρινὴν ἐκ τῶν θερμῶν εἰς τοὺς τόπους τοὺς ψυχροὺς φοβούμενα τὰ καύματα, τὰ μὲν ἐκ τῶν ἐγγύς τόπων ποιούμενα τὰς μεταβολάς, τὰ δὲ καὶ ἐκ τῶν ἐσχάτων ὡς εἰπεῖν. (Aristotle, *Historia animalium*, VII(VIII).12, 596b 24 – 597a 4)

Aristotle claims that there are many ὄρνιθες, which migrate south to warm places after the autumnal equinox (φθινοπωρινὴ ἰσημερία) and

7. Gaius Plinius Secundus (23-79 CE), also known as Pliny the Elder, the Roman historian and naturalist displayed scientific interest in the biology, behavior and movements of birds. In his most famed work, the 37-volume *Historia Animalium* (*Natural History*), repeats and discusses much of what Aristotle wrote regarding bird migration.

8. J. H. Gurney, F. Z. S., *Early Annals of Ornithology: With Illustrations from Photographs and Old Prints* (326 High Holborn, London: H. F. & G. Witherby, 1921), 11.

9. Janice M. Hughes, *The Migration of Birds: Seasons on the Wing* (Buffalo, New York - Richmond Hill, Ontario: A Firefly Book Ltd., 2009), 11.

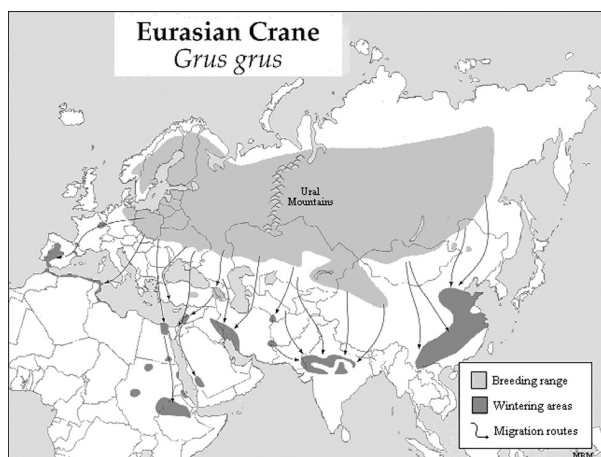


Image 2. Source: Curt D. Meine and George W. Archibald (eds), *The Cranes: Status Survey and Conservation Action Plan* (Gland, Switzerland: International Union for Conservation of Nature and Natural Resources, 1996), 161.

north to cold places after the vernal equinox (ἑαρινὴ ἰσημερία) in search of alternate food sources.

It must be added here that in the springtime after the winter solstice, according to Aristotle, the Ornithiae or Bird-winds (ὀρνιθίαι) blow from the north. These annual winds were called Ornithiae because migratory birds arrived with them in Greece.

ὁμοίως δὲ καὶ μετὰ χειμερινὰς τροπὰς πνέουσιν οἱ ὀρνιθίαι· καὶ γὰρ οὗτοι ἐτησίου εἰσὶν ἀσθενεῖς· ἐλάττους δὲ καὶ ὀψιαιτέροι τῶν ἐτησίων πνέουσιν (Aristotle, *Meteorologica*, II.5, 362a 22-24)

The philosopher notices that cranes (γέρανοι) travel from the steppes of Scythia (near the Black Sea, i.e., Russia) to the marshlands south of Egypt, where the [Blue] Nile River originates, i.e., Central Africa (near Lake Tana in Ethiopia):

μεταβάλλουσι γὰρ ἐκ τῶν Σκυθικῶν πεδίων εἰς τὰ ἔλη τὰ ἄνω τῆς Αἰγύπτου ὅθεν ὁ Νεῖλος ρεῖ· ἔστι δὲ ὁ τόπος οὗτος περὶ ὃν οἱ πυγμαῖοι κατοικοῦσιν· οὐ γὰρ ἔστι τοῦτο μῦθος ἀλλ' ἔστι κατὰ τὴν ἀλήθειαν γένος μικρὸν μὲν ὥσπερ λέγεται, καὶ αὐτοὶ καὶ οἱ ἵπποι, τρωγλοδύται δ' εἰσὶ τὸν βίον. (Aristotle, *Historia animalium*, VII(VIII).12, 597a 5-9)

Among the birds (ὄρνεα) the cranes migrate a long way and fly to a great height:

τῶν μὲν οὖν ὀρνέων αἱ γέρανοι, καθάπερ εἴρηται πρότερον, ἐκτοπίζουσιν εἰς τὰ ἔσχατα ἐκ τῶν ἐσχάτων. πέτονται δὲ πρὸς τὸ πνεῦμα. (Ibid., VII(VIII).12, 597a 30 – 597b 1)



Image 3. Common Crane (*Grus grus*). Drawn by John Gould, Joseph Wolf, H.C.Richter & Wm. Hart; Lithographed by H.C. Hart & Wm. Richter, 1837.



Image 4. Dalmatian Pelican (*Pelecanus crispus*, Feld.). Edward Lear's illustration (Plate 406) from Vol.V of John Gould's *The Birds of Europe*, 1837.

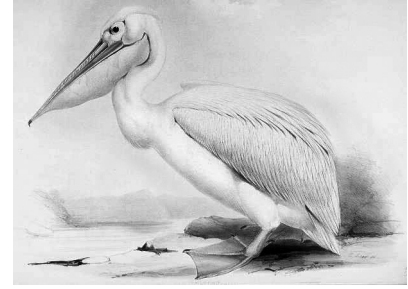


Image 5. White Pelican (*Pelecanus onocrotalus*, Linn.). Edward Lear's illustration (Plate 405) from Vol.V of John Gould's op. cit.

How Aristotle concluded that cranes migrated? (a) *His own observations*: as a naturalist he might have watched cranes flying overhead. (b) *The oral tradition*: he relied upon many oral reports of travelers and bird fanciers who saw cranes on the steppes of Scythia during the summer, and from other travelers who saw cranes in the marshlands of the Nile River during winter. (c) *Written sources*: he obtained data from former writers (such as Homer).

According now to contemporary ornithologists Aristotle's descriptions of cranes' migration refer without doubt to the regular seasonal movements of the Common Crane (*Grus grus*),¹⁰ also known as the Eurasian Crane,¹¹ which is commonly found in Europe (see *Images 2 and 3*). The Common Crane "usually migrates on a narrow front, utilizing two major migration routes (south-west, and south to south-east passages across Europe) and uses regular staging areas (Snow and Perrins 1998)."¹²

Moreover, Aristotle says that pelicans (πελεκᾶνες)¹³ also, migrate and fly from the River Strymon

(in Thrace, it flows south from Bulgaria) to the Ister. Ister is the old Thracian and Greek name of the Danube River all the way from the mouth to the source:

καὶ οἱ πελεκᾶνες δ' ἐκτοπίζουσι, καὶ πέτονται ἀπὸ τοῦ Στρυμόνος ποταμοῦ ἐπὶ τὸν Ἰστρον κάκει τεκνοποιοῦνται ἄθροοι δ' ἀπέρχονται, ἀναμένοντες οἱ πρότεροι τοὺς ὕστερον διὰ τὸ ὅταν ὑπερπῶνται τὸ ὄρος ἀδήλους γίνεσθαι τοὺς ὑστέρους τοῖς πρότεροις. (Aristotle, *Historia animalium*, VII(VIII).12, 597a 9-14)

It is true that Strymon and Danube are two of the most important wetlands in Europe. As the season changes every year, the migrating birds, including pelicans (*Pelecanus phillipensis crispus* and *Pelecanus onocrotalus*), come and go, too (see *Images 4 and 5*).

Aristotle asserts that the cuckoo (κόκκυξ) appear for a short time in summer, and disappears in winter. He considers, correctly enough, that the cuckoo goes away/migrates about the time the Dog Star (Seirios or Sirius)¹⁴ rises, that is, in July. It re-appears from springtime to the rising of the Dog Star. The heliacal rising of Sirius marked the flooding of the Nile in Ancient Egypt and the hot days of summer for the ancient Greeks.

ὁ δὲ κόκκυξ φαίνεται ἐπ' ὀλίγον χρόνον τοῦ θερος, τὸν δὲ χειμῶνα ἀφανίζεται. (Aristotle, *Historia animalium*, VI.7, 563b 18-19)

Μεταβάλλει δὲ καὶ ὁ κόκκυξ τὸ χρῶμα καὶ τῇ φωνῇ οὐ σαφηνίζει, ὅταν μέλλῃ ἀφανίζεσθαι ἀφανίζεται δ' ὑπὸ κύνα, φανερός δὲ γίνεται ἀπὸ τοῦ ἔαρος ἀρξάμενος μέχρι κυνὸς ἐπιτολῆς. (Ibid., VIII(IX). 49B 633a 11-14)

10. See Curt D. Meine and George W. Archibald, eds., *The Cranes: Status Survey and Conservation Action Plan* (Gland, Switzerland: International Union for Conservation of Nature and Natural Resources, 1996), 164-165: Eurasian Crane in "Greece M, X (b) [M = Present during migration (breeding and wintering in other countries / X (b) = Extirpated: (b) as a breeding species]."

11. See Janice M. Hughes, op. cit., 11.

12. Encyclopedia of Life, *Grus grus* <<http://eol.org/pages/1049273/details>>.

13. See William Geoffrey Arnott, *Birds in the Ancient World from A to Z* (London and New York: Routledge, 2007), 172: "In Greece today, two species of Pelican [Πελεκᾶν] survive in the few remaining wetlands of northern Greece: the Dalmatian or Grey (now *Pelecanus phillipensis crispus*) and the White Pelican (*Pelecanus onocrotalus*), but up to the nineteenth century the Dalmatian bred as far south as Attica."

14. Seirios or Sirius (Σείριος) is the brightest star in the night sky. It is also known as the "Dog Star" (*Canicula Stella*).

Image 6.
Common Cuckoo
(*Cuculus canorus*, Linn.). J.
Gould's illustration
(Plate 240) from Vol. III of
John Gould's op. cit.



Image 7.
Common Quail
(*Coturnix coturnix*).
Drawn by John
Gerrard Keulemans, 1873.

Cuckoo is a widespread summer migrant to Europe and Asia and winters in the warmer climates of sub-Saharan Africa. It leaves Africa to breed in the cooler climates of Europe during the spring. The common cuckoo (European cuckoo or *Cuculus canorus*) is a common parasite, which means it relies on others to raise its young.¹⁵ Once the cuckoo leaves its offspring to the care of other birds, by the end of July immediately migrates southward.

The Stageirite describes also cases of *altitudinal avian migration* or a short distance migration, in which birds move from lower elevations to higher elevations and back, in response to weather conditions and food supply. Weakly birds (τὰ ἀσθενῆ τῶν ὀρνέων), he says, migrate downslope in winter for warmth, and in the summer they retreat to higher in the mountains for coolness. Weakly birds are the first to migrate on account of extremes of temperature, either hot or cold. For example, the [common] quails (ὄρνυγες)¹⁶ come down to warmer elevations near the sea level in the month of Boedromion (Βοηδρομιών),¹⁷ while the cranes start their southward journey in the month of Maimakterion (Μαιμακτηριών).¹⁸

καὶ τὰ ἀσθενῆ δὲ τῶν ὀρνέων ἐν μὲν τῷ χειμῶνι καὶ τοῖς πάγοις εἰς τὰ πεδία καταβαίνουσιν εἰς τὰ ὄρη

15. The cuckoos, says Aristotle, do not build nests but lay in other birds' nests. See *Historia Animalium*, VI.7, 563b 29 – 564a 3; VIII(IX).29, 618a 8–31.

16. Ὀρνυξ is the [Common] Quail, *Coturnix coturnix* or *Coturnix communis*. It is a small, round game bird and belongs to the family of Phasianidae (including chicken, quail, partridges, pheasants, turkeys, peafowl and grouse). It is the only migratory Galliforme (an order of heavy-bodied ground-feeding birds), but many are all year-round residents of Greece.

17. Boedromion = a part of August and September.

18. Maimakterion = a part of October – November.

ἄνω διὰ τὰ καύματα. ποιεῖται δ' αἰεὶ τὰ ἀσθενέστερα πρῶτα τὴν μετάστασιν καθ' ἑκατέραν τὴν ὑπερβολήν, οἷον οἱ μὲν σκόμβροι τῶν θύννων οἱ δ' ὄρνυγες τῶν γεράνων· τὰ μὲν γὰρ μεταβάλλει τοῦ Βοηδρομιώνος τὰ δὲ τοῦ Μαιμακτηριώνος. (Aristotle, *Historia Animalium*, VII(VIII).12, 597a 18–24)

Furthermore, of birds those who migrate and never winter at the same place are the following species: (a) ring doves or cushats (φάτται), which are the common wood pigeons (*Columba palumbus*), (b) stock doves (πελειάδες) or wild pigeons (*Columba oenas*), (c) swallows (χελιδόνες) or [barn] swallows (*Hirundo rustica*),¹⁹ (d) turtle doves (τρυγόνες) or European turtle doves (*Streptopelia turtur*), (e) swans (κύκνοι), which are the mute (*Cygnus olor* or *mansuetus*) and the whooper (*Cygnus cygnus*) swans,²⁰ and (f) the small goose (ὁ μικρὸς χήν) or white-fronted goose (*Anser albifrons*).²¹

19. See Thomas East, Lones, "On the Identification of Some of the Birds Mentioned by Aristotle," *The Zoologist*, A Monthly Journal of Natural History, No. 745 (July 1903): 245: "Whether the House-Martin and the Crag-Martin, if that bird were known separately by Aristotle, should also be included under *chelidon*, is difficult to decide," due to insufficient data.

20. See William Geoffrey Arnott, op. cit., 182: "Kyknos was the Greek word in regular use for Swan, of which two species then as now were found in the Balkan peninsula and Turkey: the Mute Swan (*Cygnus olor*), breeding today as a totally wild bird in eastern Thrace and parts of Turkey, but reaching as far south as Attica up to the beginning of the twentieth century, with a locally common influx of winter visitors; and the Whooper (*C. cygnus*), now an uncommon passage migrant and winter visitor to the Evros delta and Turkish wetlands. In ancient times the two species were probably much commoner and more widespread, but not yet sufficiently distinguished from each other to warrant separate names."

21. See Thomas East Lones, *Aristotle's Researches in Natural Science: With Illustrative Drawings* (London: West, Newman & Co., Hatton Garden, 1912), 253.

Image 8.
Wood pigeon
(*Columba palumbus*, Linn.).
E. Lear's illustration (Plate 243)
from Vol. IV
of John Gould's
op. cit.

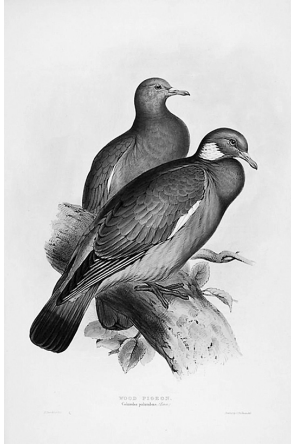


Image 9. Turtle Dove (*Columba turtur*, Linn.). Drawn by J. & E. Gould
(Plate 246) from Vol. IV of John
Gould's op. cit.



Image 10.
Stock Dove
(*Columba oenas*,
Linn.). Drawn by
J. & E. Gould
(Plate 244)
from Vol. IV
of John Gould's
op. cit.



ἀπαίρουσι δὲ καὶ αἱ φάτται καὶ αἱ πελειάδες καὶ οὐ χειμάζουσι, καὶ αἱ χελιδόνες καὶ αἱ τρυγόνες. (Aristotle, *Historia animalium*, VII(VIII).12, 597b 3-4)

ἀγελαῖοι δὲ τῶν ὀρνίθων εἰςὶ γέρανος κύκνος πελεκὰν χῆν ὁ μικρός. (Ibid., VII(VIII).12, 597b 29-30)

However, the philosopher at 593a 16-18 says that the common wood pigeon (*Columba palumbus*) appear at all seasons, whereas the turtle dove (*Streptopelia turtur*) only in summer, for in winter it goes into hiding/hibernates and is never seen.

φᾶψ μὲν οὖν καὶ περιστερὰ αἰε φαίνονται, τρυγῶν δὲ τοῦ θέρους· τοῦ γὰρ χειμῶνος ἀφανίζεται· φωλεύει γάρ. (Ibid., VII(VIII).3, 593a 16-18)

But at 600a 24-26 he says that some common wood pigeons hide/hibernate, while others migrate at the same time as the swallows.

τῶν δὲ φασσῶν ἔναι μὲν φωλοῦσιν, ἔναι δ' οὐ φωλοῦσιν ἀπέρχονται δ' ἅμα ταῖς χελιδόσιν. (Ibid., VII(VIII).16, 600a 24-26)

Finally, at 633a 5-9 Aristotle notices that the wood pigeon utters no sound in the winter except when there is fine weather.

ἐπεὶ καὶ ἡ φάττα τοῦ μὲν χειμῶνος οὐ φθέγγεται (πλὴν ἥδη ποτὲ εὐδίας ἐκ χειμῶνος σφοδροῦ γενομένης ἐφθέγγατο καὶ ἐθαυμαστώθη ὑπὸ τῶν ἐμπείρων), ἀλλ' ὅταν ἔαρ γένηται, τότε ἄρχεται φωνεῖν. (Ibid., VIII(IX).36, 633a 5-9)

Why do the previous reports on the appearance or migration of the wood pigeons and the turtle doves through the winter show such differences / are so

inconsistent? D. M. Balme believes that "these reports suggest independent sources; factually, they can all be reconciled with partial migration."²²

Partial migration is a phenomenon in which some individuals of a population migrate from the breeding range while others remain resident. It is found in a variety of animal groups, including birds, fish, amphibians, insects and mammals. Three main hypotheses have been proposed to explain *partial migration*: (a) the "Behavioral Dominance hypothesis" suggests that subordinate individuals in a population migrate farther from the breeding grounds because of competition with dominant individuals (Ketterson and Nolan 1976, Gauthreaux 1978, Myers 1981),²³ (b) the "Arrival Time hypothesis" states that if individuals (adult males) experience more intense competition for breeding resources than the other, then these individuals should benefit by a more rapid return to the breeding grounds (Ketterson & Nolan 1976)²⁴ and (c) the "Body-Size hypothesis" states that larger and healthier individuals are less likely to migrate or, if they migrate, to migrate shorter distances because of their ability to withstand colder

22. Aristotle, *Historia animalium*. Books 7-10, Loeb Classical Library, 1991, 135.

23. See E. D. Ketterson and V. Nolan, Jr, "Geographic Variation and its Climatic Correlates in the Sex Ratio of Eastern-Wintering dark-eyed Juncos (*Junco hyemalis hyemalis*)," *Ecology* 57 (1976): 679-693; S. A. Gauthreaux, Jr, "The Ecological Significance of Behavioral Dominance," in *Perspectives in Ethology*, volume 3, eds. P. P. G. Bateson and P. H. Klopfer (New York: Plenum Press, 1978), 17-54; J. P. Myers, "A Test of Three Hypotheses for Latitudinal Segregation of the Sexes in Wintering Birds," *Canadian Journal of Zoology* 59 (1981): 1527-1534.

24. See E. D. Ketterson and V. Nolan, Jr, op. cit.: 679-693.

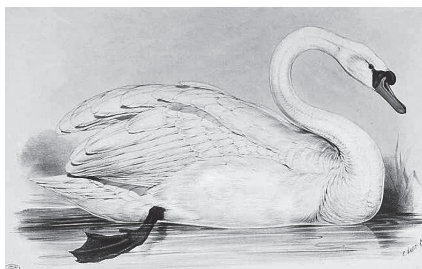


Image 11. Mute Swan (*Cygnus olor* or *mansuetus*, Gmel.). E. Lear's illustration (Plate 354) from Vol. V of John Gould's op. cit.



Image 12. Whistling Swan, or Whooper (*Cygnus cygnus*, Linn., *Cygnus ferus*, Ray). E. Lear's illustration (Plate 355) from Vol. V of John Gould's op. cit.

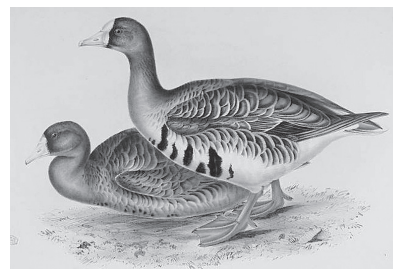


Image 13. White-fronted Goose (*Anser albifrons*, Steph.). Drawn by J. & E. Gould (Plate 349) from Vol. V of John Gould's op. cit.

temperatures and food shortages (Ketterson & Nolan 1976).²⁵

Aristotle was probably the first to write that birds are fatter before they migrate south in autumn than when they return from migration the following spring.²⁶

ἔστι δὲ πότερα πάντα ὅταν ἐκ τῶν ψυχρῶν τόπων μεταβάλλῃ ἢ ὅταν ἐκ τῶν θερμῶν, οἷον καὶ οἱ ὄρνυγες τοῦ φθινοπώρου μᾶλλον ἢ τοῦ ἔαρος. (Aristotle, *Historia animalium*, VII(VIII).12, 597a 24-27)

It took more than 2,300 years before scientists elaborated much on Aristotle's observation about *avian flight metabolism*. Today it is given that birds must feast before long-distance flights on high-energy foods to build fat stores for the journey ahead. During migration some birds lose as much

as one fourth to one half of their entire body weight, so it is necessary to store up enough fat for energy (see *Figure 1*).

Migratory birds store up fat in thick layers "especially under the skin, and in well-defined deposits within the wishbone (tracheal pit) and around the gut."²⁷ Fat is indispensable as a fuel for migratory flight. "At least 15 distinct fat depots have been described in passerines (King & Farner 1965). Just before departure, the subcutaneous fat layer in some long-distance passerine migrants can be so extensive that most of the body appears to be clad in a thick layer of pale-yellow fat, only the central part of the breast muscle remaining uncovered. This subcutaneous fat is relatively soft, even at body temperature."²⁸

2. Transmutation and Hibernation of Birds

As we have already discussed, the accuracy of many of Aristotle's observations and conclusions on the periodic movement of birds from one geographic location to another, has been confirmed in contemporary times. Despite this fact, he is credited with two "unusual" explanations for small birds disappearing in winter: birds either hibernated, or turned into other species.

Aristotle was the originator of the *theory of transmutation* — a theory that survived in various forms until Charles Darwin's time: the belief that birds change species with the season. He noticed that when the summer redstarts (φοινίκουροι)²⁹

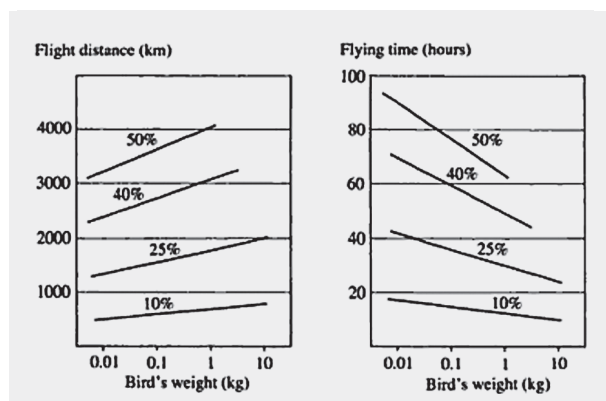


Figure 1. Flight distance (km) and flying time (hours) in still weather for migratory birds which begin their journey with different amounts of fat reserves and which fly until the fat runs out. Source: Thomas Alerstam, David A. Christie (Translator), *Bird Migration* (Verlag: Cambridge University Press, 1993), 285.

25. See *ibid.*

26. See Janice M. Hughes, *op. cit.*, 11.

27. Ian Newton, *The Migration Ecology of Birds* (London, U.K.: Elsevier Ltd., 2008), 97.

28. *Ibid.*, 97.

29. The [Common] Redstart (*Phoenicurus phoenicurus*) is a



Image 14. Redstart (*Phoenicurus phoenicurus*, formerly *Phoenicurus ruticilla*, Swains). Drawn by J. & E. Gould (Plate 95) from Vol. II of John Gould's op. cit.



Image 15. Robin (*Erithacus rubecula*, Swains). Drawn by J. & E. Gould (Plate 98) from Vol. II of John Gould's op. cit.



Image 16. Garden Warbler (*Sylvia borin* Boddaert). Drawn by Wilhelm von Wright (1810-1887).



Image 17. Black-Cap Warbler (*Sylvia atricapilla*). Drawn by J. & E. Gould (Plate 120) from Vol. II of John Gould's op. cit.

disappeared as fall turned to winter, the red-breasted robins (ἐρίθακοι)³⁰ showed up. It was obvious to him that redstarts (*Phoenicurus phoenicurus*) became/transformed or transmuted themselves into robins (*Erithacus rubecula*) in winter. Likewise, garden warblers (συκαλίδες)³¹ changed into black-cap warblers (μελαγκόρυφοι)³² at the end of autumn.

Μεταβάλλουσι δὲ καὶ οἱ ἐρίθακοι καὶ οἱ καλούμενοι φοινίκουροι ἐξ ἀλλήλων· ἔστι δ' ὁ μὲν ἐρίθακος χειμερινόν, οἱ δὲ φοινίκουροι θερινοί, διαφέρουσι δ' ἀλλήλων οὐθὲν ὡς εἰπεῖν ἀλλ' ἢ τῇ χροῇ μόνον. Ὡσαύτως δὲ καὶ αἱ συκαλίδες καὶ οἱ μελαγκόρυφοι καὶ γὰρ οὗτοι μεταβάλλουσιν εἰς ἀλλήλους. Γίνεται δ' ἢ μὲν συκαλὶς περὶ τὴν ὁπώραν, ὁ δὲ μελαγκόρυφος εὐθέως μετὰ τὸ φθινόπωρον. Διαφέρουσι δὲ καὶ οὗτοι ἀλλήλων πλὴν τῇ χροῇ καὶ τῇ φωνῇ. (Aristotle, *Historia animalium*, VIII(IX).49B 632b 27 – 633a 2)

small passerine bird. It is also known as the Eurasian or European redstart, the white-fronted redstart or simply as the redstart. It is identifiable by its bright orange-red tail. It migrates north to breed in Europe and western Asia and returns to winter in sub-Saharan Africa.

30. The European Robin (*Erithacus rubecula*) is a small insectivorous passerine bird. It is also known as robin redbreast because of the distinctive orange breast of both sexes. It lives in Europe and the United Kingdom. Birds living in the northern parts of the habitat migrate southwards in winter.

31. The Garden Warbler - Beccafico (*Sylvia borin*) is a small bird that breeds in most of Europe and in western Asia.

32. The Eurasian black-cap (*Sylvia atricapilla*) is a common warbler. The black-cap is named for the male's distinctive black cap. It breeds in Europe, western Asia and northwestern Africa.

Aristotle claimed to have seen these birds “in mid-‘transformation’ — when their plumage coloration displayed the attributes of both species.”³³

Ὅτι δ' ὁ αὐτός ἐστιν ὄρνις, ἤδη ὥπται περὶ τὴν μεταβολὴν ἐκάτερον τὸ γένος τοῦτο, οὐπω δὲ τελῶς μεταβεβληκότα οὐδ' ἐν θατέρῳ εἶδει ὄντα. (Ibid., VIII(IX).49B 633a 2-4)

The philosopher probably saw these birds in the middle of prebasic molt, in other words when many avian species in the late summer and early fall change their bright breeding plumage for more dull winter colours. Anyone who has tried to identify birds when they are experiencing the “fall molt” (the periodic replacement of feathers by shedding old feathers while producing new ones / feathers fall out or break off and numerous patterns evolve) can understand then Aristotle's misidentification.

Aristotle's “transmuting” birds could also have been misidentified because of similarities in their behaviours.³⁴ For example, the Redstart (*Phoenicurus phoenicurus*) “has many behaviours that resemble those of the European robin (*Erithacus rubecula*). It has the same body carriage, the same chat-like behaviour, and is the same size as the robin, although its body is slimmer.”³⁵

33. Janice M. Hughes, *The Migration of Birds: Seasons on the Wing* (Buffalo, New York - Richmond Hill, Ontario: A Firefly Book Ltd., 2009), 12.

34. See *ibid.*, 12.

35. GrrlScientist, “Mystery Bird: Common Redstart, *Phoenicurus phoenicurus*,” *Science/The Guardian* (Tuesday 30 August, 2011): <<https://www.theguardian.com/science/punctuated-equilibrium/2011/aug/30/4>>.



Image 18. Common House Martin (*Delichon urbicum* or *Hirundo urbicum*, Linn.). Drawn by J. & E. Gould (Plate 57) from Vol. II of John Gould's op. cit.



Image 19. Red-rumped Swallow (*Cecropis daurica* or *Hirundo rufula*, Temm.). Drawn by J. & E. Gould (Plate 55) from Vol. II of John Gould's op. cit.



Image 20. Eurasian Crag Martin or Rock Martin (*Ptyonoprogne rupestris* or *Hirundo rupestris*, Linn.). Drawn by J. & E. Gould (Plate 56) from Vol. II of John Gould's op. cit.



Image 21. Sand Martin (*Riparia riparia* or *Hirundo riparia*, Linn.). Drawn by J. & E. Gould (Plate 58) from Vol. II of John Gould's op. cit.



Image 22. Red Kite (*Milvus milvus*, *Milvus vulgaris*, Flem.). E. Lear's illustration (Plate 28) from Vol. II of John Gould's op. cit.



Image 23. Black Kite (*Milvus migrans* or *Milvus ater*). E. Lear's illustration (Plate 29) from Volume II of John Gould's op. cit.



Image 24. White Stork (*Ciconia alba*, Bellon). E. Lear's illustration (Plate 283) from Volume IV of John Gould's op. cit.



Image 25. Black Stork (*Ciconia nigra*, Bellon). E. Lear's illustration (Plate 284) from Volume IV of John Gould's op. cit.



Image 26. Blackbird (*Turdus merula*, Linn. *Merula vulgaris*, Ray). Drawn by J. & E. Gould (Plate 72) from Vol. II of John Gould's op. cit.



Image 27. Crested Lark (*Alauda cristata*, Linn.). Drawn by J. & E. Gould (Plate 165) from Vol. III of John Gould's op. cit.



Image 28. Common or Eurasian Sky Lark (*Alauda arvensis*, Linn.). Drawn by J. & E. Gould (Plate 166) from Vol. III of John Gould's op. cit.



Image 29. Mistle Thrush (*Turdus viscivorus*, Linn.). Drawn by J. & E. Gould (Plate 77) from Vol. II of John Gould's op. cit.



Image 30. Song Thrush (*Turdus musicus*, Linn. or *Turdus philomelos*, Brehm) & Redwing (*Turdus iliacus*, Linn.). Drawn by J. & E. Gould (Plate 78) from Vol. II of John Gould's op. cit.



Image 31. Field-fare (*Turdus pilaris*, Linn.). Drawn by J. & E. Gould (Plate 76) from Vol. II of John Gould's op. cit.



Image 32. Starling (*Sturnus vulgaris*, Linn.). Drawn by J. & E. Gould (Plate 210) from Vol. III of John Gould's op. cit.



Image 33. Starling (*Sturnus vulgaris*, Linn.). Drawn by J. & E. Gould (Plate 210) from Vol. III of John Gould's op. cit.

Along with transmutation and migration, was a belief in hibernation. Aristotle set forth the *theory of hibernation*, a theory that survived for more than 20 centuries. He believed that the disappearance of many species of birds as fall turned into winter was explained by their passing into a torpid (inactive) state where they remained during the cold season, hidden (φωλοῦσι) in holes in trees or in the ground. He observed that many swallows (χελιδόνες) have been found in holes for the winter, bare of all their feathers “and believed them to be the smaller-bodied swallows awakening from a featherless state of torpor (hibernation).”³⁶

φωλοῦσι δὲ πολλοὶ καὶ τῶν ὀρνίθων, καὶ οὐχ ὥς τινες οἴονται ὀλίγοι ἢ εἰς ἀλεινοῦς τόπους ἀπέρχονται πάντες· ἀλλ’ οἱ μὲν πλησίον ὄντες τοιούτων τόπων ἐν οἷς αἰεὶ διαμένουσι, καὶ ἰκτῖνοι καὶ χελιδόνες, ἀποχωροῦσιν ἐνταῦθα, οἱ δὲ πορρωτέρω ὄντες τῶν τοιούτων οὐκ ἐκτοπίζουσιν ἀλλὰ κρύπτουσιν ἑαυτοὺς. ἥδη γὰρ ὠμμένοι πολλὰ χελιδόνες εἰσὶν ἐν ἀγγείοις ἐψιλωμένοι πάμπαν. (Aristotle, *Historia animalium*, VII(VIII).16, 600a 10-16)

In Greece there are five species of swallows (family *Hirundinidae*): (i) [Barn] Swallow (*Hirundo rustica*), (ii) [Common] House Martin (*Delichon*

urbicum), (iii) Red-rumped Swallow (*Cecropis daurica*), (iv) Eurasian Crag Martin (*Ptyonoprogne rupestris*), (v) Sand Martin (*Riparia riparia*). All of these birds are migratory and spend their winter in Africa south of the Sahara, in Arabia and in the Indian sub-continent. Aristotle had never been to those places to see them there, and he had no reports of them from travelers being anywhere else in the known world.³⁷ So he determined that swallows must hibernate during the cold season, hidden in holes, crevices, or hollow trees.

The Stageirite assigned hibernation not only to swallows but also to kites (ἰκτῖνοι),³⁸ storks (πελαργοί),³⁹ [common] blackbirds (κόττυφοι),⁴⁰

37. See Armand Marie Leroi, *The Lagoon: How Aristotle Invented Science* (New York: Viking Penguin, 2014), 42: “The world that Aristotle knew was bound by the Straits of Gibraltar to the west, the Oxus to the east, the Libyan desert to the south and the Eurasian plains to the north.”

38. Ἰκτῖνος includes the Red Kite (*Milvus milvus*, formerly *Milvus regalis* or *Milvus ictinus*) and the Black Kite (*Milvus migrans* or *Milvus ater*). In ancient times the ἰκτῖνος was well known to people. “Today in Greece, the Red Kite is a rare winter visitor and passage migrant, no longer breeding in Greece, while the Black Kite is a rare resident (10-30 pairs) and a scarce winter visitor and a passage migrant” (William Geoffrey Arnott, op. cit., 114).

39. Two species, white (*Ciconia ciconia* or *Ciconia alba*) and scarcely black (*Ciconia nigra*) stork, are still summer visitors to the northern part of Greece, although they can be seen throughout the country.

40. Κόττυφος or κόσσυφος is the [Common] Blackbird (*Turdus merula*). It is a widespread and common resident in the woodlands of Greece.

36. Janet Schmidt, “Theory of Transmutation vs. Migration Mythbusting,” *Peninsula Clarion* (15 July 2011): <<http://peninsulaclarion.com/outdoors/2011-07-15/refuge-notebook-migration-mythbusting>>.

turtle doves (τρυγόνες),⁴¹ larks (κόρυδοι),⁴² ring doves (φάτται),⁴³ song thrushes (κίχλαι),⁴⁴ [common] starlings (ψάρροι),⁴⁵ and little owls (γλαῦ-και).⁴⁶

καὶ ἰκτῖνοι ἐκ τοιούτων ἐκπετόμενοι χωρίων, ὅταν φαίνωνται τὸ πρῶτον. φωλοῦσι δ' οὐθὲν διακεκριμένως καὶ τῶν γαμψωνύχων καὶ τῶν εὐθυωνύχων· φωλεῖ γὰρ καὶ πελαργὸς καὶ κόττυφος καὶ τρυγὼν καὶ κόρυδος, καὶ ἡ γε τρυγὼν ὁμολογουμένως μάλιστα πάντων· οὐθεις γὰρ ὡς εἰπεῖν λέγεται τρυγὼνα ἰδεῖν οὐθαμοῦ χειμῶνος. ἄρχεται δὲ τῆς φωλείας σφόδρα πείρα οὔσα, καὶ πτερορρῦει μὲν ἐν τῇ φωλείᾳ, παχεῖα μέντοι διατελεῖ οὔσα τῶν δὲ φασσῶν ἔναι μὲν φωλοῦσιν, ἔναι δ' οὐ φωλοῦσιν ἀπέρχονται δ' ἅμα ταῖς χελιδόσιν. φωλεῖ δὲ καὶ ἡ κίχλη καὶ ὁ ψάρος καὶ τῶν γαμψωνύχων ἰκτίνος ὀλίγας ἡμέρας καὶ ἡ γλαυξ (Aristotle, *Historia animalium*, VII(VIII).16, 600a 17-27)

41. European turtle doves (*Streptopelia turtur*).

42. Aristotle describes (*Historia animalium*, VIII(IX).25, 617b 20-24) two species of the κόρυδος (also κορυδός, κορυδαλός, κορυδαλλός, κορυδαλλίς): i) the Crested Lark (*Alauda/Galerida Cristata*, Linn.), "a permanent resident in Greece," and ii) the Common or Eurasian Skylark (*Alauda arvensis*, Linn.), "a winter migrant" [see D' Arcy Wentworth Thomson, *A Glossary of Greek Birds* (Oxford: at the Clarendon Press, 1895), 96]. In Greece today are found five species (Arnott, op. cit., 172): 1) Greater Short-toed Lark (*Calandrella brachydactyla*), 2) Crested Lark (*Alauda/Galerida cristata*), 3) Wood Lark (*Lullula arborea*), 4) Common or Eurasian Skylark (*Alauda arvensis*), 5) Calandra Lark (*Melanocorypha calandra*).

43. Ring doves or cushats (φάτται) are the common wood pigeons (*Columba palumbus*).

44. Aristotle describes three species of the κίχλη (*Historia Animalium*, VIII(IX).20, 617a 18-23), that is applied to the genus *Turdus*: 1) the ἰξοβόρος, which is the Mistle Thrush (*Turdus viscivorus*), 2) the τριχάς, which is probably the Song Thrush (*Turdus philomelos*), and 3) the ἰλιάς, which is probably the Redwing (*Turdus iliacus*). "It surprises modern ornithologists that Aristotle here makes no separate mention of the Field-fare (*Turdus pilaris*) also a common winter visitor to Greece. Possibly it was not distinguished from the Mistle Thrush, being similar in size (25.5 cm) and also heavily spotted on the breast" (see Arnott, op. cit., 140-141).

45. Ψάρ, ψάρ or ψάρος, ψᾶρος is the [Common] Starling (*Sturnus vulgaris*). In modern Greek it is the ψαρόνι, μαυροπούλι. Starlings are gregarious and migrate short distances in winter.

46. Γλαυξ is the Little Owl (*Athene noctua*). In modern Greek is the κουκουβάγια.

His theory survived for more than two thousand years. Olaus Magnus, Bishop of Uppsala, Sweden, in his 1555 work entitled *Historia de Gentibus Septentrionalibus* (*History of the Northern People*) wrote that when fishermen in northern waters pulled their nets from the lakes or ponds they sometimes had a mixed catch of fish and hibernating swallows (see *Image 34*). Swallows, swifts and martins, according to Magnus, congregate in marshes during autumn, allow themselves to gradually sink into the mud, settle down and hibernate soon.⁴⁷



Image 34. Hibernating swallows drawn with fish from water. Source: Olaus Magnus, Historia de Gentibus Septentrionalibus (Rome: Giovanni Maria de Viottis, 1555).

It was not until the end of the 18th century that migration and not hibernation was accepted as an explanation for the disappearance of swallows and other kinds of birds in the fall. Whereas, it is interesting to note, although the particular birds Aristotle observed are not hibernators, "in 1946 an American naturalist specializing in desert wildlife, Dr. Edmund Jaeger, discovered a common poorwill, a species of small nightjar, in a state of extended torpor,⁴⁸ which amounted to hibernation,⁴⁹ in a rock crevice in the Chuckwal-

47. Carolus Linnaeus (1707-1778), George-Louis Leclerc, Comte de Buffon (1707-1788) and George Cuvier (1769-1832) believed in the hibernation of swallows. In 1878, Elliott Coues, one of the founders of the *American Ornithologist Union*, listed as many as 182 papers dealing with the hibernation of swallows.

48. Torpor is a short-term reduction of body temperature and metabolic rate during times of cold exposure, food shortage, or drought. Torpor usually lasts for less than 12 hours.

49. Hibernation is an extended form of torpor.

la Mountains of southern California. Further research showed that the species did effectively hibernate and that the name given to it by Native Americans of the Hopi tribe meant 'the sleeping one' [Hölchoko].⁵⁰

The non-migrating common poorwill (*Phalaenoptilus nuttallii*, Audubon, 1844)⁵¹ or "the sleeping one" to the Hopi, is the first avian species known to hibernate for weeks or even months under natural conditions. Researchers found that "in hibernating poorwills, T_b falls to as low as 4.8°C and BMR [Basal Metabolic Rate] drops from 0.80 to 0.06 ml O_2 /g/h (a decrease of 93%)."⁵²

Scientists have also found that certain birds, such as hummingbirds, swifts, nightjars or goat-suckers, and nighthawks go into an extremely torpid condition for brief periods ("temporary hibernation") in cold weather. Whereas, they don't sink into the mud and sleep, as Magnus asserted. Thus Aristotle was wrong about the swallows. But he was not wrong about hibernation.

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50. Michael McCarthy, *Say Goodbye to the Cuckoo: Migratory Birds and the Impending Ecological Catastrophe* (Great Britain: John Murray, 2009), 26.

51. It is the smallest member of the North American nightjar family.

52. M. E. Fowler and R. E. Miller, *Zoo and Wild Animal Medicine* (Philadelphia: W. B. Saunders Co, 2003), 225.

Conclusion

The aim of this paper was to outline the Aristotelian explanations of bird migration. From the analysis undertaken before we could say that the Stageirite philosopher was the first natural physiologist to write about the seasonal movements of birds as an observable fact. His research on birds appears to be rooted in the ancient Greeks' cultural interest in those living beings and in his own attention to them. It led him to conduct observations, the accuracy of which remains astonishing in many cases (see *altitudinal avian migration*, *partial migration*, *avian flight metabolism*).⁵³

Finally, it is not necessary to say, if Aristotle had been able to use the tools and techniques of contemporary ornithology to study bird migration, as for example radar, VHF radio-tracking transmitters, bird ringing and field reports from people around the world, he would never have suggested that redstarts transmuted themselves into robins, and swallows hibernate in winter.

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53. William McGillivray, *Lives of Eminent Zoologists: From Aristotle to Linnaeus: With Introductory Remarks on the Study of Natural History, and Occasional Observations on the Progress of Zoology* (Edinburgh: Oliver & Boyd, Tweeddale Court - Simpkin & Marshall, London, 1834), 73: "the observations of Aristotle, considering the period at which he lived, and the proneness of the human intellect to wander from the true path, are remarkable for the great proportion of truth which they present to us. Whatever may be their actual merits, they are certainly superior to those of any other naturalist whose works have come down to us from the remote ages of classical antiquity."

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