

## A Bilateral Gynandromorph Northern Cardinal from South Bass Island

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**Abstract:** We report on a Northern Cardinal from South Bass Island, in the western basin of Lake Erie, which showed male plumage characteristics on the right side and female plumage characteristics on the left side. This condition, termed bilateral gynandromorphism, is rare among wild birds, and there are few (<100) preserved specimens available for research. This bird had a slightly enlarged ovary on the left side and a small and probably non-functional testis on the right side. The plumage was fairly well demarcated between the two sides, but the female side was interspersed with red feathers and the male side was interspersed with brown. A recent study of gynandromorph domestic chickens provides a likely pathway for the origin and appearance of these Northern Cardinals. We suggest that a recent spate of records is probably due to increasing numbers of observant birdwatchers as well as the ubiquity of digital cameras.

**Keywords:** *Cardinalis cardinalis*, bilateral gynandromorph, plumage

### Introduction

Gynandromorphy is a rarely encountered condition in which an organism displays a combination of male and female characteristics. This condition may be bilateral, with one half of the organism phenotypically male and the other half phenotypically female, often with a clear line separating the two sides. Individuals with this condition are known across multiple classes of Metazoans, and individuals with this condition have been documented in both captive fowl as well as wild birds (Kumerloeve 1954). Kumerloeve (1954) conducted a review of this condition and the mechanisms that may underlie it, and documented several dozen instances in wild birds. Patten (1993) updated this review, and several additional records have been published since then (e.g., DaCosta et al. 2007, Peer and Motz 2014). No formal systematic review of gynandromorphism records has been conducted, but there are certainly more than fifty published examples as of this writing. Wild birds with gynandromorphism have been documented in many taxonomic orders and families across Aves, though there are multiple reports of gynandromorphy in Eurasian Bullfinch (*Pyrrhula pyrrhula*) and Evening Grosbeak (*Coccothraustes vespertinus*), two members of the Fringillidae family. Published records are an underrepresentation of the prevalence of this condition, as any species without obvious size or plumage-related sex differences could only be documented through dissection by a knowledgeable museum specimen preparator.

In this article, we document a bilateral gynandromorph Northern Cardinal (*Cardinalis cardinalis*) from South Bass Island, Ottawa County, Ohio.

### Specimen Data

Bartlett operates a banding station for several weeks every spring and fall on private property on the east end of South Bass Island, in the western basin of Lake Erie (Ottawa County, Ohio, USA: 41.66239°N, 82.79624°W). While banding on 01 May 2011, Bartlett and Jones encountered an unusual Northern Cardinal. The bird was initially identified as a female with an unusual molt pattern; Bartlett has encountered other female Northern Cardinals with excessive red presumably due to age and/or eccentric molt. Further examination demonstrated that the red coloration was primarily restricted to the right side of the bird, and there was a fairly sharp color demarcation down the middle of the bird's body. Jones made the decision to collect the bird, and the specimen was transferred to the ornithology research collection at the Cleveland Museum of Natural History.

Jones prepared the bird specimen (collector number AWJ 596, and cataloged as CMNH 74623). The bird weighed 43.1 g. There was a little molt on this bird, which is unusual for a Northern Cardinal in May (like most songbirds, they typically do not molt during the early part of the breeding season): several feathers on the right breast were being replaced, the left innermost tail

feather (R1) was being replaced and was about 80% grown, and the right innermost tail feather was missing. There was no cloacal protuberance nor brood patch, suggesting that this bird was unpaired. The wing chord of both wings was 91 mm, which is within the size range of both male and female Northern Cardinals (Pyle 1997). During dissection, Jones found an ovary on the bird's left side that measured 8 × 5 mm, with the largest ovum 2 mm in diameter, and with a slightly enlarged oviduct. On the right side, an apparent testis was found, but it was small (for this time of year; 2 × 1 mm) and black in color, indicating that it may not have been functional.

The bird's plumage differs between the left and right sides most sharply on the ventral side, with a sharp demarcation on the breast, belly, and undertail coverts (Figure 1). The right side is red, though not nearly as bright red as a typical male, and interspersed with several partly or completely brown feathers. The left side is the same color of brown as a typical female, interspersed with a few red feathers. The head plumage is consistent with a female: dusky rather than solid black feathers surrounding the bill, brownish-gray feathers with a red crest, but with scattered red feathers on the face on the right side. The back is also consistent with a female, with brownish-gray feathers across the nape, mantle, scapulars, and uppertail coverts, but interspersed with some red feathers on the right side. The left tail feathers have dusky tips on the underside and dusky outer margins; the right tail feathers are almost entirely red.



**Figure 1.** Ventral view of a specimen (CMNH 74623) of a bilateral gynandromorph Northern Cardinal. The red plumage on the bird's right side is not as fully red as a typical male Northern Cardinal. The bird is not perfectly bilaterally symmetrical; there are female-like feathers on the male side, and male-like feathers on the female side.

## Discussion

This Northern Cardinal specimen is the third record of gynandromorphism in this species in the peer-reviewed literature. Laskey (1954) banded one in central Tennessee. Like our report, it was male on the right side, but she noted that hers had brilliant red feathers rather than the dull red we observed. Her record was otherwise similar to ours, with a sharp demarcation line on the underside, and a female-like head. Peer and Motz (2014) observed a gynandromorph which was male on the left side. It had brilliant red feathers on the left side. Despite being observed throughout the breeding season, the bird did not pair with another bird. Playback experiments were conducted, and the bird changed its posture and awareness in response to the song of another Northern Cardinal, but did not sing. Other Northern Cardinals did not show any noticeable behavior such as aggression towards the gynandromorph.

We are also aware of several putative records of gynandromorph Northern Cardinals that have been circulated on various internet websites, with photographs. Some of these individuals appear to be gray rather than brown over part of the body, suggesting a pigment abnormality rather than gynandromorphism. However, we have also seen photographs of a bird from Virginia that closely resembles our bird (<https://www.flickr.com/photos/birdsofvirginia/3370349942/>). A newsletter article (Bohlen 2006) reported on two records from Illinois. One was accompanied by a series of photographs and indicated that the

bird was seen singing, was seen carrying nesting material, and was socially associating with a female. Overall, there have been perhaps six records of Northern Cardinal gynandromorphs, and five of these have been in the last two decades. We attribute this to an increase in the number of active birdwatchers, increasing access to digital cameras and cell phones to document these birds, and an improved ability to communicate these sightings through the Internet.

Including the present study, four of the five verifiable bilateral gynandromorph Northern Cardinals were male-plumaged on the right side. This is the typical condition for bilateral gynandromorphs in other birds as well; in birds, the females typically only develop an ovary on the left side (Kumerloeve 1954). However, some gynandromorphs have an ovary on the left and a testis on the right, yet the plumage sides are reversed from the gonads (e.g., DaCosta et al. 2007). Most of these Northern Cardinal records include scattered red feathers on the female side, and brown feathers on the male side. Plumage differences between the two sides are often imperfect in gynandromorphs, and this may be related to the mechanism causing the condition. The genetic basis underlying gynandromorphism is not completely understood. Graves (1996) reviewed variations on the symmetry of gynandromorphs and indicated that there may be multiple pathways to this condition. Zhao et al. (2010) examined three gynandromorphic domestic chickens (*Gallus gallus*) from a genetic and cellular perspective and demonstrated that those individuals were male-female chimaeras; some cells have ZW sex chromosomes typical of females, and other cells have ZZ sex chromosomes typical of males. Most of the cells on the male-plumaged side were ZZ, and most of the cells on the female-plumaged side were ZW. As a result of the incomplete sorting of male and female cells between the two sides, the chickens they studied had feathers on each side that corresponded to the opposite sex. This mechanism likely explains why the Northern Cardinals in this and other reports tend to have imperfect plumage symmetry. The gynandromorphs studied by Zhao et al. (2010) probably result from an error in oogenesis in the mother of the gynandromorph, resulting into two nuclei in the fertilized ovary. It is unclear if this explanation is universal to all gynandromorphs, and we encourage further collection and study of wild and domestic birds with this condition. We suggest that researchers should preserve extensive tissue samples, including freezing or formalin preserving of the entire body and sectioning the gonads to ascertain their functionality.

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