

Original Research Article

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Morphometrical Analysis of the Wing of the Blue-And-Yellow Macaw (*Ara ararauna*) With Reference to the Aerodynamics

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ABSTRACT

Knowledge about the morphological adaptations of body and wing in birds helps to know about their aerodynamic performance. The present study was aimed to analyze the morphometry of the wing of the blue and yellow macaw (*Ara ararauna*) with reference to aerodynamics. Various aerodynamic measurements namely body weight, body length, wing span, wing area, wing load and aspect ratio were measured in three adult male birds. The wings were short, elliptical and rounded. The mean value of body weight, body length, wing length, wing span, wing area, wing load and aspect ratio of the blue and yellow macaw were 1080 ± 95.34 g, 174.46 ± 4.87 cm, 34.67 ± 4.87 cm, 77.4 ± 3.67 cm, 1294 ± 54.32 cm², 0.834 ± 0.01 cm⁻² and 4.626 ± 0.57 respectively. The low aspect ratio suggested ability to maneuver tightly in confined spaces like dense vegetation. All anatomical and aerodynamical measurements concluded that blue-and-yellow macaw was adapted to flapping flight.

Keywords

Morphometry,
Wing, Blue-and-
yellow macaw,
Aerodynamics.

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Introduction

Flight mechanism in Aves is a complex and most energy-demanding mode of animal locomotion. Considerable knowledge about avian flight, particularly flapping flight, has been acquired during the last few decades, and some of the findings can be applied to avian medicine too (Beaufrère *et al.*, 2007 and Beaufrère, 2009). Birds are well-known for the ability to move quickly and easily, maneuverability and flexibility during flight.

These features help the birds' ability to fly under a wide range of flight conditions (Aldheeb *et al.*, 2016).

The Blue-and-yellow Macaws (*Ara ararauna*) belongs to family Psittacidae (parrots and macaws) and are the most beautiful among the macaw family. They are one of the large macaws, can reach a length of 76 to 86cm long and weight of approximately 900 to

1300grams (Wikipedia, 2011). It is ultramarine blue above and mostly golden yellow below with a long tail, a large black bill, and a bare white facial patch on each side of its head with narrow lines of black feathers.

Macaws, the largest psittacines, may be both habitat and foraging specialists (Collar 1997, Sick 1997, Juniper and Parr 1998). Wings have been the most inspirational element in birds' flight.

Morphometry of bird's wing and its mechanical properties leads to an understanding about aerodynamic performance (Bachmann *et al.*, 2010, Bonser and Purslow, 1995; Jacob, 1998; Macleod, 1980; Purslow and Vincent, 1978).

In addition movement and vibration of feathers also play a role in flight control as mentioned by Brown and Fedde (1993) and Jacob (1998), influencing aerodynamic performance.

In birds, wings consist of feathers, bones, muscles, nerves, and patagial skin flaps. The complex kinematics of wing beats and the perfect control of aerodynamics make avian flight possible (Beaufrère *et al.*, 2009).

Every illness or injury affecting a specific portion of the wing can lead to serious biomechanical and aerodynamic consequences during flight.

Thorough understanding of the avian locomotion will help to diagnose and to evaluate the avian patient, particularly when perfect flight is required for release of wild birds.

Hence, the present study was aimed to document the morphometric details of blue and yellow macaw and to correlate with its flight mechanism.

Materials and Methods

Materials for the present study were collected from three-adult male blue-and-yellow macaw (*Ara ararauna*) which was presented for Necropsy to the Department of Veterinary Pathology, Madras Veterinary College, Chennai. Various aerodynamical and biometrical characteristics of the wings were measured and calculated as per the methods mentioned by Withers (1981), Pennycuick (2008) and Tobalske *et al.*, (2003).

Wing length (cm) is the length of the full stretched wing from tip to point of attachment of wing at the humerus.

Projected wing area (cm²) was measured by tracing the outline of the wing. The trace area acquired was divided into smaller geometrical figures (squares and triangles).

Sum of the individual areas of such figures was the projected wing area.

Wing span is the total length of the full stretched wings, from tip of one wing to tip of the other wing.

Aspect ratio (AR) = (Wing span)² / Wing area

Wing load = Body Weight / Wing area

Results and Discussion

Gross morphology of wing

In the present study, the anterior border was thicker, posterior border was thin and tapered behind. The dorsal or upper surface was convex and streamlined.

The ventral or lower surface was concave as reported by Kotpal (2008). As the air flow across slightly tilted wing during the bird's flight the velocity is higher on the convex

dorsal surface than the concave ventral surface. The wings of macaw were found to be short and rounded *i.e.* elliptical wings as reported in hawks, passerines, pheasants and partridges, allowing for tight maneuvering in confined spaces.

Morphometry

The morphometric details such as Body weight, Wing length, projected wing area etc. were measured in total of six wings collected from three blue and yellow macaw (Table 1).

Table.1 Morphometric details of wing in blue and yellow macaw

Attributes	Measurements
Body Weight(gm)	1080 ± 95.34
Wing length (cm)	34.67 ± 4.87
Projected Wing Area (cm)	1294 ± 54.32
Wing Span (cm)	77.4 ± 3.67
Aspect Ratio	4.626 ± 0.57
Wing Load (gmcm ⁻²)	0.834± 0.01

In the present study, with regard to body weight was in accordance with the findings of Renton and Brightsmith (2008) in Blue- and-yellow macaw. The calculated aspect ratio of blue and yellow macaw was 4.626± 0.57 indicated that these birds showed low aspect ratio as reported in Zebra finch with an aspect ratio of 4.5 (Tobalske *et al.*, 2003). Low aspect ratio wings in blue and yellow macaw resulted in a highly flexed wing posture with a ‘feathered’ upstroke in which the primary feathers are separated slightly with each other and resembles a venetian blind as the wing is elevated except Galliformes. The low aspect ratio wings in the present study results in high fat consumption during flight. Also these birds might not migrate continuously for longer distance.

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