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Short Communication: Sexual dimorphism of Hill Blue Flycatcher (*Cyornis banyumas*) in Hill Evergreen Forest, Mae Sa-Kog Ma Biosphere Reserve, Chiang Mai Province, Thailand

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Abstract. *Paansri P, Siri S, Ponpithuk Y, Suksavate W, Safoowong M, Nuipakdee W, Duengkae P. 2019. Sexual dimorphism of Hill Blue Flycatcher (*Cyornis banyumas*) in Hill Evergreen Forest, Mae Sa-Kog Ma Biosphere Reserve, Chiang Mai Province, Thailand. Biodiversitas 20: 1544-1548.* A sample consisting of 60 males and 39 females *Cyornis banyumas* captured in the Mae Sa-Kog Ma Biosphere Reserve was examined using 42 morphometric characters to assess sexual dimorphism. The results of the univariate analysis showed that there were ten morphometric traits (Ltail, TLF, C-middle, HB, C-outer, T-inner, C-digit, T-middle, DUTET and LG) that could be used for discrimination of sexual differences. The morphological data based on significant differences revealed that males were larger than females. The results of discriminant analysis based on the significant differences of nine raw morphometric data can be used to construct a sexual discrimination equation (D) where D = -22.051 + 0.368 (Ltail). The sexual discrimination equation can be directly used to identify both sexes with 79.6% of cross-validated grouped cases correctly classified, since positive D scores indicated males and negative D scores indicated females, with 81.4% of the males and 74.4% of the females being correctly assigned with a cutoff value between sexes = 0.

Keywords: *Cyornis banyumas*, Mae Sa-Kog Ma Biosphere Reserve, morphological characters, sexual dimorphism

INTRODUCTION

Sexual dimorphism is the difference in secondary sex characteristics between males and females of the same species. Secondary sex differences are those not directly related to sexual structures or organs, mating and/or parental investment (which are primary sex differences). Secondary sex differences include body size/mass, shape, color, and behavior, and they are highly variable. Somatic sexual dimorphism, sexual size dimorphism, and sexual divergence refer to differences between the sexes that relate to the body. One of the most obvious ways that males and females differ is in body size/mass, which can be expressed as a ratio of the larger sex divided by, the smaller sex. (Fairbairn 2013; Paciulli 2017). In some species, females have larger size/mass than males. This is called reverse dimorphism and is most common in animals other than birds and mammals. However, many sexual dimorphisms are not as extreme as this. Any trait that differs on average between sexes is considered sexually dimorphic, even if the distribution of traits in both sexes considerable overlap. Height in humans provides a familiar example of this type of sexual dimorphism (Fairbairn 2016).

Gender of the Hill Blue Flycatcher can be identified by the naked eye from the bird's color. The male head and body are blue. It has a brownish chin or a reddish-brown cone continuous with chest and lateral. The tail is blue with the upper body. The female head and upper body are brownish green. The grayish-brown head is different from the neck, which is more orange. The tail and feathers of the upper tail covert were brownish brown (Kobket 2001; Nabhitabata et al. 2012) (Figure 1). Little information is available on the population-level morphometric differences of the Hill Blue Flycatcher in Thailand. Therefore, the purpose of this study was to analyze morphometric and meristic differences between males and females of the Hill Blue Flycatcher in Thailand. The information from this study will be useful to support species identification of Hill Blue Flycatcher to assess the population for sustainable conservation in Thailand.

Figure 1. *Cyornis banyumas* adult male (*left*) and adult female (*right*)

MATERIALS AND METHODS

Study area

The study site was Huai Kog Ma Biosphere Reserve in Doi Suthep-Pui National Park, Chiang Mai Province (18°48′45.7″N, 98°54′7.7″E). This area has three seasons: a summer season from March to June, a rainy season from July to October and a winter season from November to February. Precipitation is highest (335 mm/month) in the rainy season (Glomvinya et al. 2016). The average annual temperature is 16.4°C with a minimum temperature of 13°C and a maximum temperature of 23°C. Elevation at Huai Kog Ma ranges between 1,250 and 1,540 m above mean sea level (Siri et al. 2013).

Procedures

This study sampled birds using the mist-net method by which the captures of *Cyornis banyumas* were recorded. The study site was located in a 400x400 m permanent plot at the Mae Sa-Kog Ma Biosphere Reserve Area, Chiang Mai, Thailand. Each location of mist-nets was classified into three types of habitats consisting of forest, forest gaps, and forest edges. The net height varied between habitat types: 9 m for forest gap, 4 m for forest edge, and 4 m for closed canopy forest. Nets at each site were opened before sunrise (06.00-16.00), and the opened mist-nets were inspected at least once an hour (Wunderle et al. 2005). The sampling was carried out between October 2014 and July 2018. Mist-net trapping was done three times a month in the area throughout the study period. The 42 morphological characteristics were measured for each captured bird (see table1). Sexes and the type of habitat of the capturing site were also recorded for each bird.

Data analysis

Morphological characters measured in this study are consisting of 42 morphometric traits, as shown in Table 1. Only metrics of adult birds were employed to test respectively. Morphometric differences between the sexes were analyzed using an independent sample t-test and discriminant analysis. The descriptive statistics were reported for each variable consisted of the sample size (N), mean, standard deviation of the mean (SD), minimum (Min), maximum (Max) and P-value (at a significance level of 0.05). R statistical package version 3.3.3 (R Core Team 2017) was used to carry out the statistical analyses.

RESULTS AND DISCUSSION

Univariate analysis

Descriptive parameters and the significance level of t-test ($P<0.05$) of morphometric characters of both genders are presented in Tables 2. The results of the morphometric analysis showed significant differences in 10 characters consisting of Ltail, TLF, C-middle, HB, C-outer, T-inner, C-digit, T-middle, DUTET, and LG (Figure 2).

Multivariate analysis

The multivariate discriminant analysis was performed based on the ten morphometric traits that showed significantly differences between gender consisted of Ltail, TLF, C-middle, HB, C-outer, T-inner, C-digit, T-middle, DUTET, and LG resulting in sexual discrimination equation, as equation 1:

$$\begin{aligned} D = &-34.2580 + 0.2267(HB) + 0.0263(TLF) \\ &+ 0.2129(Ltail) + 0.5898(C\text{-}middle) \\ &+ 0.1844(C\text{-}outer) - 0.2102(T\text{-}inner) \\ &- 0.1748(C\text{-}digit) + 0.2032(T\text{-}middle) \\ &+ 0.0988(DUTET) + 0.0443(LG) \end{aligned} \quad (1)$$

From equation 1, D score is positively associated with males and negatively associated with females. The sexual discrimination equation could be directly used to identify the two sexes with 78.6%of cross-validated grouped cases correctly classified with 79.7% of males and 76.9% of females correctly assigned. The cutoff value between sexes was -6.5254×10^{-16}.

Table 1. Traits and methods used to measure biometrics of birds (Baldwin et al. 1931)

Morphometric characters	Code	Method
Weight (g)	W	Measuring the total body weight of birds by digital scales.
Total length with feathers	TLF	Length from the tip of the bill to the tip of the tail.
Length of exposed culmen	LEC	Length from the point where the tips of the feathers of the forehead impinge upon the culmen.
Length of total culmen	LTC	Length from the point where the integument of the forehead of the bird meets the horny covering of the bill.
Length of bill from gape	LBG	Length from the tip of the maxilla to the corner of the mouth.
Length of bill from nostril	LBN	Length from the middle of the anterior end of the nostril in a straight line to the anterior end of maxilla.
Length of bill to feathers on side of maxilla	LBFSM	The distance from the tip of the bill (culmen) to the most anterior point of the feathering on the side of the maxilla.
Height of bill at base	HBB	The distance from the base of the exposed culmen to the lower edge of the ramus of the mandible below.
Height of bill at nostrils	HBN	The distance from the culmen to the lower edge of the mandible at the anterior end of the nostrils.
Width of bill at base	WBB	The distance from below the base of the exposed culmen, and is the shortest distance from the cutting edge on one side to the cutting edge on the opposite side.
Width of bill at gape	WBG	The distance from one corner of the mouth to the opposite corner.
Length of tomium	LT	Length of rictus (LR): The measurement showing how much the corner of the mouth is bent downward can be taken by means of a protractor to obtain this angle; and the position of the angle.
Greatest height of maxilla	GHM	The distance from the culmen to the cutting edge of the maxilla.
Total length of mandible	TLM	The distance from one corner of the mouth to the opposite corner. From the culmen to the cutting edge of the maxilla.
Length of exposed mandible	LEM	Measuring in a straight line the distance from its tip to the corner of the mouth.
Width of mandible at base	WMB	From the outside of the extreme posterior end of one ramus to the same point on the other.
Length of exposed ramus	LER	The distance from the posterior end of the gonys to the edge of the feathers on the base of the ramus.
Length of gonys	LG	The distance from the tip of the mandible to the point where the rami join to form the gonys.
Length of rectal bristles	LRB	The distance to its tip from its insertion at the base.
Length of head	LH	The distance from the extreme base of the culmen to the hindmost pint of the head on the occiput.
Length of bill form head	HB	The distance from the tip of the bill to the hindmost pint of the head on the occiput.
Greatest width of head	GWH	Width of the tips of dividers placed at exactly corresponding points on opposite sides of the head.
Interorbital width of head	IWH	The distance from the middle of the upper lids of one eye to the same part of the upper lids of the other.
Height of eye	HEye	The height of the eye is measured in a straight line between the lids of the open eye.
Length of eye	LEye	The length of the eye is taken with dividers.
Length of frontal antiae	LFA	The distance from the base of the culmen, where the culmen meets the skin of the forehead.
Length of tail	Ltail	The distance from cloaca to the tip of the longest tail feather when the tail is closed.
Distance from upper tail-coverts to end of tail	DUTET	The distance from the tip of the longest upper tail-covert to the end of the tail.
Length of tibia	Tibia	The distance from its junction with the femur to its junction with the metatarsus.
Length of tarsus	Tarsus	The distance from the exact middle point of the joint between the tibia and metatarsus behind to the lower edge of the undivided scute on the front of the junction of metatarsus with the base of the middle toe.
Diameter of middle of tarsus	Mtarsus	The distance from antero-tarsus to posterior-tarsus at the middle point.
Length of toe	T-inner T-middle T-outer T-digit	The distance from the lower edge of the lowest entire tarsus scute to its distal end where its integument ends on the base of the claw.
Length of claw	C-inner C-middle C-outer C-digit	The length of the claw if taken separately, is measured from the point on its upper surface where the skin of the toe impinges on the base of the claw, in a straight line to the tip.

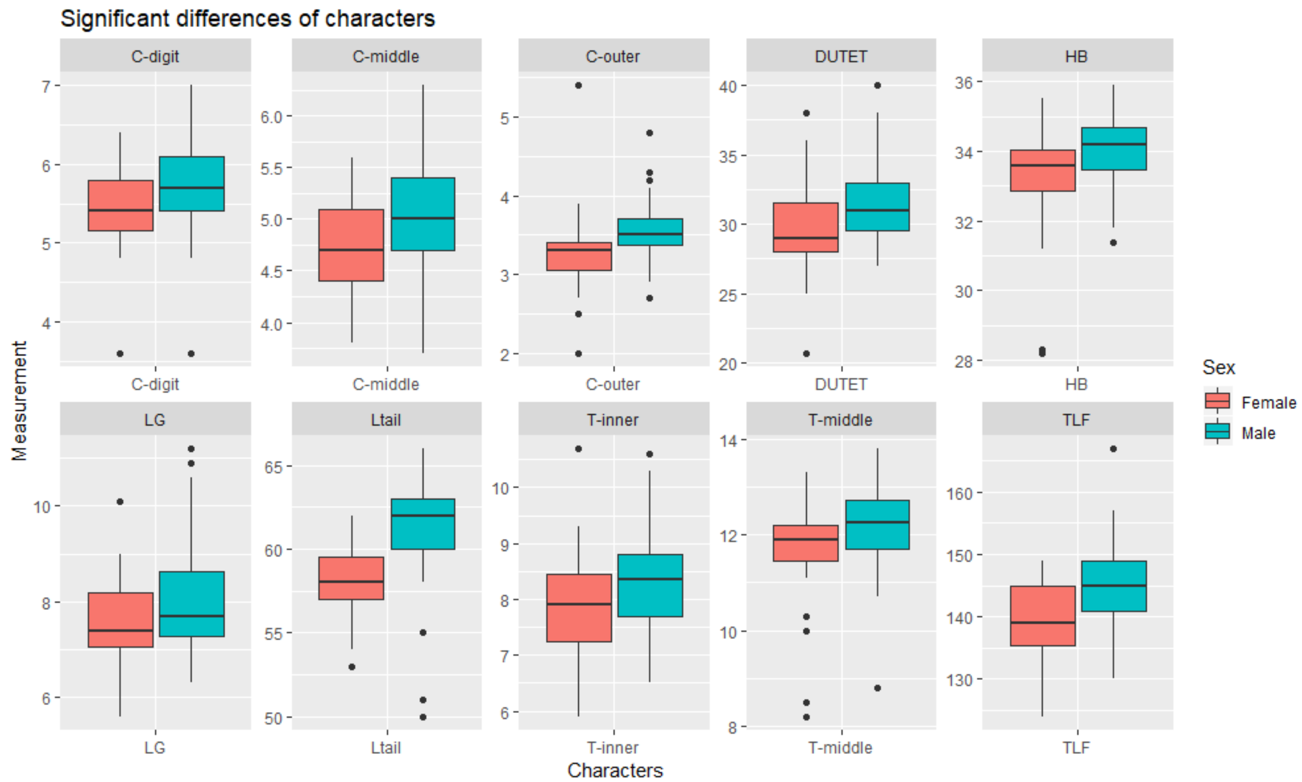

Figure 2. Descriptive parameters and significance levels (P<0.05) of morphometric characters are separately presented for males and females

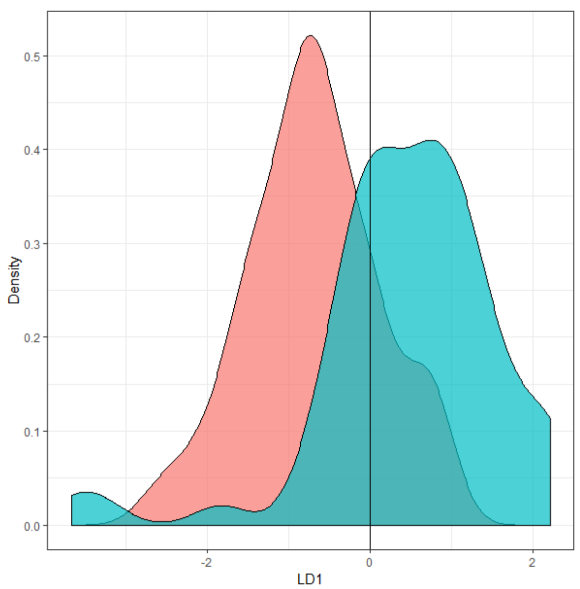

Figure 3. Groups of distribution morphometric length of tail (Ltail) between sex

The results of the discriminant analysis were based on the significant difference of only one morphometric Ltail and can be used to construct sexual discrimination equation, as equation 2:

$$D = -22.051 + 0.368\ (Ltail) \quad (2)$$

From equation 2, positive D scores indicated males and negative D scores indicated females. The sexual discrimination equation could be directly used to identify the two sexes with 79.6% of cross-validated grouped cases correctly classified, 81.4% of males and 74.4% of females being correctly assigned. The cutoff value between sexes was 0 (Figure 3).

Discussion

The morphological data based on significant differences composed of length of tail (Ltail), total length with feathers (TLF), length of middle claw (C-middle), length of bill form head (HB), length of outer claw (C-outer), length of inner toe (T-inner), length of digit claw (C-digit), length of middle toe (T-middle), distance from upper tail-coverts to end of tail (DUTET), and length of gonys (LG) revealed that males are larger than females for *Cyornis banyumas* in Hill Evergreen Forest, Mae Sa-Kog Ma Biosphere Reserve. The morphological is important for evolution, especially for passerine birds, in order to adapt to the environment which always changes and for survival of the species. The morphological size affects food searching and protecting their territories, such as the size of the middle toe and tarsus. These traits have a strong correlation with the behavior of finding food (Mile & Ricklefs 1984). Western bluebirds (*Sialia mexicana*) have been under strong evolutionary constraints since the extremely change in their breeding habitat. Therefore, their several abilities such as foraging techniques, nest boxes competition, and manipulating a resource are required to be more aggressive. As a result, aggressive and non-aggressive males are allocated into different specific breeding habitats depending on the strength of selection on morphological traits. Especially, longer tails males, more popular in the open habitat. Because the advantage of having long tail is high agility which is required for foraging and other purposes (Duckworth 2006) and show that behaviors affect how organisms interact with their environment, and therefore, can influence the evolutionary trajectory of a population (Mayr 1963; Wcislo 1989). Changes in behavior can expose organisms to novel environments. In turn, this set the stage for subsequent evolution of the morphology, life history, and physiology of an organism (Plotkin 1988; Wcislo 1989; West-Eberhard 2003). Even behavioral plasticity may buffer an organism from strong selection by allowing an individual to either avoid a stressful environment or to modify its interaction with the environment in order to maintain homeostasis (Wake et al. 1983; Huey et al. 2003; Badyaev 2005). The information from this study will be useful to assess the population of *Cyornis banyumas* for sustainable conservation in Thailand.

In conclusion, a sample consisting of 60 males and 39 females *Cyornis banyumas* population captured in Mae Sa-Kog Ma Biosphere Reserve was examined using 42 morphometric characters to assess sexual dimorphism. The results of univariate analysis showed that there were ten morphometric traits (Ltail, TLF, C-middle, HB, C-outer, T-inner, C-digit, T-middle, DUTET and LG) that could be used for discrimination of sexual differences. The morphological data based on significant differences revealed that males were larger than females. The results of discriminant analysis based on the significant differences of nine morphometric raw data could be used to construct a sexual discrimination equation (D) where D = -22.051 + 0.368 (Ltail). The sexual discrimination equation could be directly used to identify the two sexes with 79.6% of cross-validated grouped cases correctly classified, since positive D scores indicated males and negative D scores indicated females, with 81.4% of the males and 74.4% of the females being correctly assigned with a cutoff value between sexes = 0.

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