



## Original article

Sexual dimorphism in the spotted flying lizard *Draco maculatus* (Gray, 1845) (Squamata: Agamidae) from ThailandNattawut Srichairat,<sup>a</sup> Prateep Duengkae,<sup>b,\*</sup> Pattanee Jantrarotai,<sup>a</sup> Yodchaiy Chuaynkern<sup>c</sup><sup>a</sup> Department of Zoology, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand<sup>b</sup> Department of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok 10900, Thailand<sup>c</sup> Department of Biology, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand

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## ABSTRACT

Two hundred preserved specimens of the spotted flying lizard, *Draco maculatus*, from Thailand consisting of 121 males and 79 females were examined using 21 morphometric raw data, 25 character ratios and 4 meristic characters to assess sexual dimorphism. The results of univariate analysis showed that there were 9 morphometric raw data, 15 character ratios and 3 meristic characters that can be used for discrimination of sexual differences. The morphological data based on significant differences revealed that males are larger than females. The results of discriminant analysis based on significant differences of the nine morphometric raw data could be used to construct a sexual discrimination equation ( $D$ ). The sexual discrimination equation could be directly used to identify correctly the two sexes for 98.0% of cross-validated grouped cases, since positive  $D$  scores indicated males and negative  $D$  scores indicated females and 97.5% of the males and 98.7% of the females were correctly assigned.

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## Introduction

Sexual dimorphism (SD), defined as a phenotypic difference between the males and females of a species, is a common phenomenon in animals, with most species, including reptiles, being dimorphic rather than monomorphic (Schoener, 1977; Mouton and van Wyk, 1993; Stamps, 1993; Andersson, 1994). Generally, sexual dimorphism is defined at three levels. First, sexual size dimorphism (SSD) is based on two basic hypotheses: the intrasexual selection hypothesis, suggesting sexual selection for large males, and the fecundity advantage hypothesis, suggesting natural selection for large females (Thompson and Withers, 2005). Second, there is SD in body shape (Adriana et al., 2005) and third, there is SD in ornamentation (qualitative characters) such as scale pattern and coloration (Cooper and Greenberg, 1992). The lizards are a good model for studying the evolution of SD because this group presents a remarkable variation in both the direction and magnitude of SD (Cox et al., 2003).

In all *Draco* species, there is sexual dimorphism with differences between males and females in color and dewlap size; the males having brighter and longer dewlaps than females and furthermore,

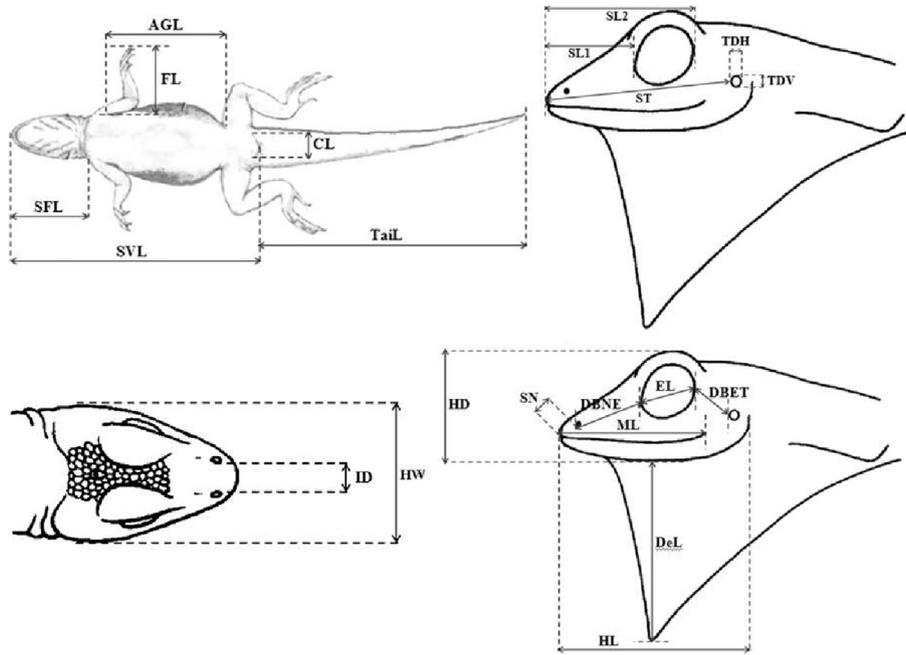
males usually have cervical and caudal crests while the females are usually larger than males (Musters, 1983; Shine et al., 1998). The spotted flying lizard (*Draco maculatus*) adult male presents as elongated and usually rounded distally sometimes with a pointed tip dewlap, cervical and caudal crest (Taylor, 1963; Musters, 1983). *D. maculatus* is distributed in all regions of Thailand (Musters, 1983; Chuaynkern and Chuaynkern, 2012) and little information is available on the morphometric and meristic differences in intrapopulations of *D. maculatus* in Thailand. Therefore, the purpose of this study was to analyze the morphometric and meristic differences between males and females of *D. maculatus* in Thailand. The information from this study would be useful to support species identification of *D. maculatus* to assess the population for sustainable conservation in Thailand.

## Materials and methods

From 1967 to 2012, 200 preserved specimens (121 males and 79 females) of *D. maculatus* in 70% ethanol were sampled from collections in the Thailand Natural History Museum (THNHM) and the National Science Museum, Pathum Thani province, Thailand and investigated for morphometric characters using a vernier caliper to the nearest 0.05 mm (Fig. 1) and meristic counts under a stereo microscope (Figs. 2 and 3). There were two sets of

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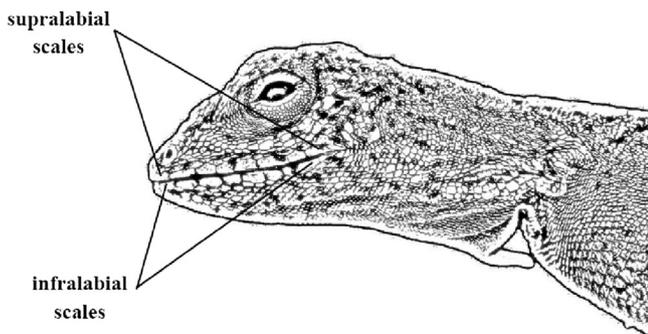
**Fig. 1.** Morphometric characters of *Draco maculatus*. Snout–vent length (SVL), snout–forelimb length (SFL), forelimb length (FL), axilla–groin length (AGL), tail length (Tail), cloacal length (CL), head width (HW), internarial distance (ID), head length (HL), head depth (HD), mouth length (ML), dewlap length (DeL), snout to nostril (SN), distance between nostril to anterior edge of eye (DBNE), distance between posterior edge of eye to anterior edge of tympanum (DBET), eye length (EL), snout to anterior edge of eye (snout length 1 (SL1)), snout to posterior edge of eye (snout length 2 (SL2)), snout to anterior edge of tympanum (ST), tympanum diameter in vertical (TDV), and tympanum diameter in horizontal (TDH). The figure is modified from [Musters \(1983\)](#) and [Stebbins \(2003\)](#).

morphological characters in this study consisting of 46 morphometric (21 raw data and 25 character ratios) and 4 meristic characters that were investigated as shown in [Tables 1 and 2](#), respectively. Morphometric differences between the sexes were analyzed using an independent sample *t* test and discriminant analysis. The meristic characters were compared between males and females using the Mann–Whitney *U* test. The descriptive statistics reported for each variable consisted of the sample size (*N*), mean, standard deviation of the mean (SD), minimum (Min), maximum (Max), *p*-value (at a significance level of 0.05). The SPSS software version 16 (SPSS Inc.; Chicago, IL, USA) was used to carry out the statistical analyses.

**Results**

*Univariate analysis*

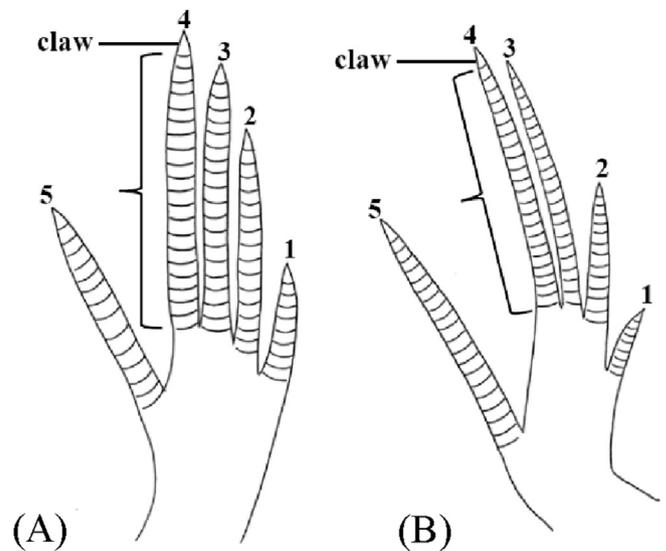
Descriptive parameters and significance levels (*p* < 0.05) of morphometric and meristic characters are separately presented for males and females in [Tables 3 and 4](#), respectively.



**Fig. 2.** Supralabial and infralabial scales of *Draco maculatus*.

The results of morphometric analysis showed significant differences in 24 characters consisting of 9 morphometric raw data—SVL, SFL, FL, Tail, HL, HD, ML, DeL and DBET—and 15 character ratios—AGL/SVL, Tail/SVL, HW/SVL, ID/SVL, HL/SVL, ML/SVL, DeL/SVL, EL/SVL, SL1/SVL, SL2/SVL, ST/SVL, FL/AGL, HW/HL, HD/HW and DeL/HL ([Table 3](#)).

The results of meristic analysis showed significant differences in three characters consisting of the number of infralabial scales, the number of subdigital lamellae on the fourth finger and the number of subdigital lamellae on the fourth toe ([Table 4](#)).



**Fig. 3.** *Draco maculatus* subdigital lamellae (brackets): (A) Subdigital lamellae on the fourth finger of the right forelimb; (B) subdigital lamellae on the fourth toe of the right hindlimb.

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