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# Sexual size dimorphism in *Ophisops elegans* (Squamata: Lacertidae) in Iran

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Twenty-three morphological features of 140 specimens of *Ophisops elegans* were analysed in order to identify sexual dimorphism in west and northwestern populations of Iran. Sexual dimorphism is significant ($P<0.05$) in nearly all metric features except for trunk length (TL) and length of widest part of belly (LWB), and in only two meristic characters, the number of dorsal scales around mid-body (DSN) and the number of femoral pores (FPN). Males have a relatively longer snout-vent length (SVL) than females and males have generally relatively larger heads compared to females.

**Keywords:** *Ophisops elegans*, sexual size dimorphism, descriptive statistics.



## Introduction

The phenomenon of sexual dimorphism is relatively well studied in lacertid lizards (e.g. Herrel, Spithoven, van Damme, & de Vree, 2002; Kaliontzopoulou, Carretero, & Lorente 2007; Roitberg, 2007). As a relatively common trait in lacertid lizards, males are usually larger than females. However, in some species or populations, females are larger than males or there are no size differences between sexes (Braña, 1996). The size pattern is usually attributed to sexual selection (Gvozdik & van Damme, 2003), where the larger size of males may play an important role in interasexual interactions (e.g., male-male combat, territorial contests; Bull & Pamula 1996), intersexual interactions (copulatory bites; Herrel, van Damme, & de Vree, 1996), and resource partitioning (e.g., males being able to eat larger prey than female conspecifics; Preest, 1994; Schoener, 1977).

The Snake-eyed Lizard, *Ophisops elegans* Ménétriés, 1832, is distributed throughout the eastern Mediterranean region and southwestern Asia (Kyriazi et al., 2008). In Iran, it is one of the most common lacertid lizards, which can easily be found in many different habitats (Anderson, 1999). This makes the species a good subject for different aspects of evolutionary studies such as sexual dimorphism. Gharzi and Yari (2013) found in a study of a population of *O. elegans* in the Kermanshah region no significant length differences (snout-vent length, SVL) between the sexes. Our study comprised 23 morphological features to bring possible sexual differences to light.

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## Material and Methods

Specimens for this study were collected during May and June of the years 2008–2011, and were then deposited in 80% alcohol in Tehran University Zoological Museum (TUZM) and Razi University Zoological Museum (RUZM). Only adult specimens (83 males, 57 females) were taken into account. The sampling sites were located throughout the range of distribution of *O. elegans* in the western and northwestern regions of Iran (province given in parentheses): Meshkinshahr (Ardebil): 8♂, 1♀; Uromiyeh (W. Azerbaijan): 2♂, 2♀; Khoram Abad (Lorestan): 3♂, 1♀; Marand (E. Azerbaijan): 3♂, 4♀; Bijar (E. Azerbaijan): 7♂, 5♀; Nossod (Kurdestan): 1♂, 5♀; Shoot (W. Azerbaijan): 2♂, 6♀; Shahindej (E. Azerbaijan): 6♂, 3♀; Khoy (E. Azerbaijan): 1♂, 5♀; Ajabshir (E. Azerbaijan): 2♂, 1♀; Kandovan (E. Azerbaijan): 2♂; Sanandaj (Kurdestan): 2♂, 1♀; Takab (E. Azerbaijan): 1♂, 1♀; Marivan (Kurdestan): 6♂, 3♀; Zardkoh, 55 km NE Kermanshah: 12♂, 8♀; Lordegan (Yasuj): 3♂, 1♀; Sarpole Zahab (Kermanshah): 4♀; Kelibar (E. Azerbaijan): 3♂, 1♀; Dareh Shahr (Ilam): 2♂, 1♀; Jolfa (E. Azerbaijan): 5♂; Eslam Abad (Kermanshah): 3♂, 2♀; Ilam (Ilam): 2♂; Toyserkan (Hamadan): 7♂, 2♀.

The sex of the individuals was determined by means of the size of the basal area of the tail (larger in males than in females as copulatory organs are located at the tail base of males), and, for absolute certainty, by exerting some pressure on to the tail base of the males. The hemipenis easily ejects and sexual identification could be confirmed in this way after capture.

Seventeen morphometric and six pholidotic characters were analysed in all specimens. Scale counts were taken using a stereomicroscope, while measurements were taken using a digital caliper to the nearest 0.1 mm. Measurements of arms, legs and head as well as scale counts beneath the toes were principally taken on the right side of the animal. The metric characters studied are: snout-vent length (SVL), trunk length (between axial and groin) (TL), head length (HL), head width (HW), head height (HH), fore limb length (FLL), arm length (AL), hind limb length (HLL), femur length (FL), nostril to eye distance (NED), ear-to-eye distance (EED), interorbital distance (IOR), cloaca length (CL), neck length (NL), length of widest part of tail base (LBT), length of widest part of belly (LWB), length of $4^{th}$ toe (TOL). Since some specimens had a damaged tail, this character was not included in our analysis. Six pholidotic characters were studied: collar scale number (CSN), gular scale number (GSN), dorsal scales around midbody (DSN), number of ventral scales from gular to vent (VSN), femoral pores on the left and right sides of the body (FPNL and FPNR, respectively) and subdigital lamella under the $4^{th}$ toe (SDLT).

Statistical analyses were performed using SPSS (ver.16) and S-Plus (v8) for Windows. The significance level for all the statistical tests was set at $p \le 0.05$. Data analysis was performed using parametric analyses after the assumptions of parametric analysis were checked and found to be met in metric characters. Since pholidotic characters were not normally distributed (Kolmogorov-Smirnov test), nonparametric statistics were performed for their analysis. To reveal dispersal patterns among morphological characters between the sexes, descriptive statistical parameters including minimum, maximum, mean and standard deviation were employed separately for each sex. For metric variables, the means of the two groups (males and females) were compared by ANOVA. In order to investigate the contribution of metric characters in the patterns of sexual dimorphism pattern, all individuals were subjected to a Principal Component Analysis (PCA). Also Discriminant Function Analysis (DFA*)* was used in order to evaluate the actual degree of discrimination among the sexes as well as to predict their group membership. Since the differences between males and females were mainly in metric characters (see results), only metric traits were included in the PCA and DFA.

## Results

**Descriptive analysis.** Morphometric and meristic characters are presented in Tables 1–2. An analysis of variance (ANOVA) revealed significant differences between males and females in all morphometric characters except for trunk length (TL) and length of widest part of belly (LWB) at the level of 95% ($p \le 0.05$) (Table 1); males are thus larger than females in 15 metric characters except TL and LWB. Nonparametric statistics (Kolmogorov-Smirnov test) for meristic characters revealed that no significant differences exist at the level of 95% ($p \le 0.05$) between the sexes except FPN and DSN (Table 2).

Table 1. Descriptive analysis including, minimum, maximum, mean, and standard deviation of metric characters and ANOVA based intra-sexual comparison of metric characters in *Ophisops elegans* (Male: N=83; Female: N=57). P values of significant differences are printed in **bold**.

| | Sex | Mean±SD | Min./Max. | P |
|---|---|---|---|---|
| **SVL** | ♂ | 48.53±4.01 | 39.0-58.9 | **0.046** |
| | ♀ | 47.10±4.25 | 40.20-64.2 | |
| **TL** | ♂ | 26.17±3.12 | 21.5-34.3 | 0.298 |
| | ♀ | 26.69±2.57 | 20.9-33.8 | |
| **HL** | ♂ | 11.44±0.91 | 9.4-13.6 | **0.000** |
| | ♀ | 10.41±0.68 | 9.1-12.1 | |
| **HH** | ♂ | 5.67±0.57 | 4.2-6.9 | **0.000** |
| | ♀ | 5.13±0.63 | 4.2-8.3 | |
| **HW** | ♂ | 7.10±0.62 | 5.2-8.9 | **0.000** |
| | ♀ | 6.42±0.51 | 4.4-7.3 | |
| **FLL** | ♂ | 19.01±1.86 | 13.5-23.8 | **0.000** |
| | ♀ | 17.26±1.70 | 10.6-20.5 | |
| **AL** | ♂ | 7.22±0.94 | 4.5-9.4 | **0.000** |
| | ♀ | 6.62±0.84 | 4.8-8.9 | |
| **HLL** | ♂ | 33.28±3.11 | 26.1-45.0 | **0.000** |
| | ♀ | 30.47±2.44 | 25.8-35.9 | |
| **FL** | ♂ | 10.58±1.33 | 7.4-15.0 | **0.002** |
| | ♀ | 9.95±0.92 | 8.0-12.6 | |
| **NED** | ♂ | 5.38±046 | 4.4-6.8 | **0.000** |
| | ♀ | 4.99±0.47 | 4.0-6.4 | |
| **EED** | ♂ | 4.18±0.54 | 3.2-6.5 | **0.000** |
| | ♀ | 3.74±0.45 | 1.7-4.7 | |
| **IOR** | ♂ | 5.04±0.59 | 3. 9-6.5 | **0.000** |
| | ♀ | 4.55±0.45 | 3.4-5.8 | |
| **CL** | ♂ | 5.22±0.66 | 4.0-7.2 | **0.000** |
| | ♀ | 4.41±0.44 | 3. 6-5.2 | |
| **NL** | ♂ | 7.82±1.24 | 4.3-11.9 | **0.021** |
| | ♀ | 7.35±1.13 | 4.5-9.9 | |
| **LBT** | ♂ | 6.04±0.61 | 4.7-8.0 | **0.000** |
| | ♀ | 5.06±0.65 | 4.2-8.8 | |
| **LWB** | ♂ | 9.38±1.14 | 6.8-13.3 | 0.119 |
| | ♀ | 9.73±1.45 | 7.2-12.9 | |
| **TOL** | ♂ | 11.73±1.18 | 8.8-14.8 | **0.000** |
| | ♀ | 10.71±0.86 | 8.4-12.8 | |
| **GSN** | ♂ | 18.50±1.64 | 15.0-23.0 | **0.092** |
| | ♀ | 18.12±1.44 | 15.0-23.0 | |
| **CSN** | ♂ | 8.18±1.17 | 6.0-11.0 | **0.460** |
| | ♀ | 8.43±1.14 | 6.0-10.0 | |
| **VSN** | ♂ | 41.15±7.71 | 25.0-53.0 | **0.260** |
| | ♀ | 43.50±5.87 | 26.0-50.0 | |
| **DSN** | ♂ | 24.14±2.11 | 19.0-29.0 | **0.023** |
| | ♀ | 23.15±2.25 | 18.0-29.0 | |
| **FPN** | ♂ | 10.40±0.93 | 9.0-13.0 | **0.047** |
| | ♀ | 9.92±0.94 | 8.0-12.0 | |
| **SDLT** | ♂ | 22.72±1.59 | 19.0-26.0 | 0.968 |
| | ♀ | 22.89±1.39 | 20.0-26.0 | |

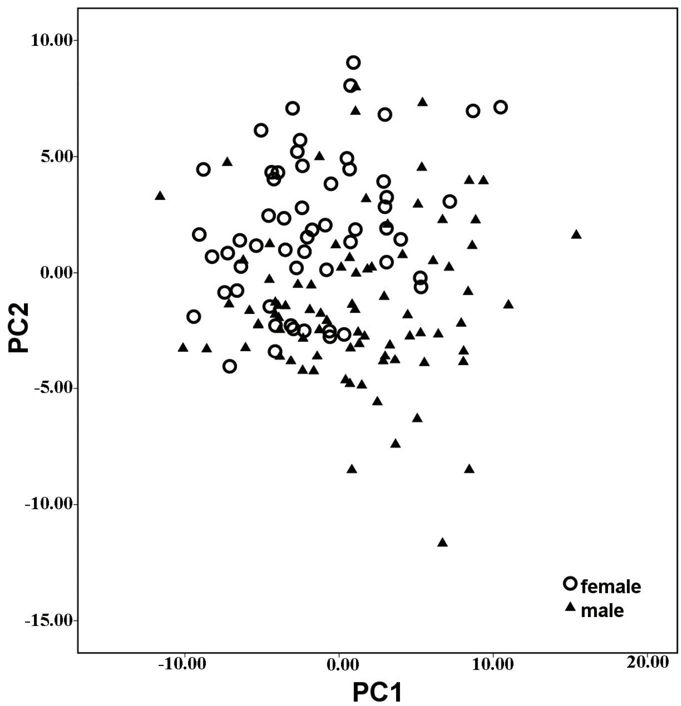


Figure 1. Ordination of individual male (▲) and female (○) specimens of *Ophisops elegans* for the first two principal components.

**Multivariate analysis.** To explore the patterns of sexual dimorphism at the multivariate level, Principal Components Analysis (PCA) was used, plotting individual males and females. Most of characters loaded heavily on the first three components. The PC1 alone could explain 50.9%, and the first three principal components address 85.5% of the total variation (Table 3). The greatest impact on the first component (PC1) was by characters such as SVL, TL, HHL, FLL, HL, LWB, and so PC1 can be interpreted as a general body size factor providing a good measure of overall size. Males tend to be larger than females in general body size. The magnitude and sign of the loadings on PC1 and PC2 show a consistent pattern between samples, and the high degree of sexual dimorphism is easy to interpret (Figure 1). For a further survey and in order to assess the accuracy of grouped males and females based on the metric characters, the Discriminant Function Analysis (DFA) was done. The results showed that 80.7% of male and 77.19% of female specimens were correctly classified into their relevant groups.

## Discussion

Significant differences between the sexes in most metric characters revealed a pattern of sexual dimorphism in *Ophisops elegans*. At first glance, in contrast to Gharzi and Yari (2013), significant differences between males and females were found in the snout-vent length (SVL) character. Although males have on average relatively longer snout-vent lengths (SVL) than females, in some instances female individuals are larger than males in SVL. On the other hand, our results show that differences between males and females are not high (p=0.046) so separation of males from females based on the length of the body is not completely accurate.

The sexual selection theory may explain why males are larger than females in most characters. In particular, males with longer limbs (FLL, AL, HLL and FL) could be more successful in interasexual interactions such as male-male combat and territorial contests (Anderson & Vitt, 1990).

Consistent with previous studies on lacertid lizards (Gvozdik & Boukal, 1998; Gvozdik & van Damme, 2003), a clear sexual dimorphism in head size was found in *O. elegans*. In most characters (HL, HH, HW, IOR, RED, and EED) which related to head size, males accounted for the larger number. It follows the prevailing trend in lacertid lizards (Braña, 1996; Huang, 1998). Males with bigger heads have advantages in male-male combat and territorial contests with other males (Censky, 1996; Gvozdik & van Damme, 2003). In mating attempts, males with larger heads succeed in grasping a female faster than males with smaller heads and can successfully grasp and hold a female during copulation (Braña, 1996; Herrel et al., 1996). And finally, bigger heads allow males to feed upon bigger and harder prey items than females, thus reducing intersexual competition for food (Stamps, 1977; Preest, 1994).

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