東海大學生命科學系

碩士論文

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Dr. Chung-Ping Lin

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花了三年的時間，我終於完成了碩士論文，首先感謝林仲平老師在這段時間的教導，雖然大四時我已經加入了老師的實驗室，但是對於一個免強準時拿到大學文憑的我來說，在碩士的銜接上很慶幸也感謝有老師不辭辛勞的帶領，也因如此我才能夠重拾對生物學的熱情，儘管接下來的路程不一定會盡人意甚至轉換跑道，但我想我會很欣慰我仍舊充滿對生物的熱誠。這篇論文也要感謝中興大學的葉文斌老師和系上的卓逸民老師願意擔任口試委員，儘管我的題目不是他們的真正擅長的，但在口試時老師們也給予了很多的意見並點出許多研究上的盲點。

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Contents

摘要

波動性不對稱(FA)，兩側對稱的特徵產生隨機地差異，被視為個體發育穩定性(DS)的有效指標。DS 會受到環境或遺傳壓力的影響。然而，表型特徵的 FA 是否能反映發育的壓力是個長久以來的爭議。特徵變異被定型化(canalization)和 DS 所維持。定型化降低個體間的特徵變異，而 DS 降低個體內的特徵變異。天擇和性擇作用下的表型特徵被認為會產生不同形式的特徵變異和 FA。但定型化和 DS 是否使用相同的機制來調節特徵變異目前不明。本研究將雞冠細身赤銹形蟲飼養於高和低營養兩個處理來探討三個問題： (1) 幼蟲期低營養的環境壓力是否會導致成蟲形態特徵的 FA 上升? (2) 定型化和 DS 是否使用相同的機制? (3) 受到方向性和穩定性選汰的特徵是否有預期的 FA 和特徵變異? 結果顯示雞冠細身赤銹形蟲的大顎、頭、胸、翅鞘和前足腿節在高營養的處理中均顯著較大。然而，所有特徵的 FA 在兩個處理間沒有差異。特徵變異和它們的 FA 沒有一致的關係顯示雞冠細身赤銹形蟲的定型化和 DS 的機制不同，而且 DS 在雞冠細身赤銹形蟲上可能因特徵而異。大顎和頭這兩個性擇特徵如預期一般具有比非性擇特徵較大的 FA 和特徵變異。預期因保護或飛行功能而受到較大天擇的翅鞘，有較小 FA 和特徵變異。雞冠細身赤銹形蟲雄性打鬥的研究發現胸部和前足腿節也使用於領域競爭。本研究支持這兩個特徵除了天擇外也部分受到強烈的性擇，並且具有和翅鞘相似地較小特徵變異但是較大的 FA。

關鍵字：發育穩定性、定型化、特徵變異、性擇、天擇

Abstract

Fluctuating asymmetry (FA), random deviation of bilaterally symmetrical traits, is considered as an effective indicator of developmental stability (DS) which can be affected by environmental or genetic stress. However, there is an ongoing debate of whether FA of phenotypic traits can reliably reflect developmental stress. The variation of phenotypic traits can be maintained by two major processes: canalization and DS. Canalization reduces among-individual phenotypic variation, whereas DS reduces within-individual variation of traits. Phenotypic traits under natural and sexual selection had been hypothesized to generate different patterns of trait variation and FA. But whether canalization and DS share the same mechanism to regulate overall variation of traits was not clear. The stag beetle, *Cyclommatus mniszechi*, was reared in high and low nutritional treatments to investigate three questions: (1) Does environmental stress of low larval nutrition cause elevated FA of adult morphological traits? (2) Does DS share a common mechanism with canalization? (3) Do traits under directional and stabilizing selection show predicted patterns of FA and trait variation? The results showed that for *C. mniszechi* the size of the mandible, head, thorax, elytra and femur of the foreleg were all significantly larger for beetles in high nutritional treatment. However, the level of signed FA of all measured traits did not differ between the two nutritional treatments. No consistent relationship of variance of morphological traits and their FAs suggested that the mechanism of canalization and DS of *C. mniszechi* were not the same, and DS may be trait-specific in *C. mniszechi*. As predicted, two sexual traits, the mandible and head, showed greater FA and trait variation than that of non-sexual traits. The elytra, which was expected to be largely under natural selection for protection and flight, showed smaller FA and trait variation. Earlier behavioral studies of the male-male fighting in *C. mniszechi* suggested that both thorax and foreleg were involved in territorial contests. This study supported that,

in addition to natural selection, these two structures were partly under strong sexual selection and showed similarly small trait variation but greater FA than that of elytra.

Key words: developmental stability, canalization, trait variation, sexual selection, natural selection

Introduction

Fluctuating asymmetry (FA), random deviation from bilateral symmetry, is considered as a reliable indicator reflecting the level of developmental stability (DS) of phenotypic traits (Palmer, 1994; Møller & Swaddle, 1997; Nijhout & Davidowitz, 2003). FA of a trait is caused by the inability of DS of individuals to buffer against random genetic or environmental noises (Palmer, 1994; Møller & Swaddle, 1997; Nijhout & Davidowitz, 2003). DS can decrease within-individual variation against random developmental perturbation. Whereas among-individual variation is regulated by a process called canalization, which can reduce the sensitivity of organisms to genetic or environmental variation (Palmer, 1994; Møller & Swaddle, 1997; Nijhout & Davidowitz, 2003). DS and canalization are two important processes shaping phenotypic variation of an organism, however it's not clear that whether they share a common mechanism (Møller & Swaddle, 1997; Van Dongen, 2006). Clarke (1998) examined the levels of inter- and intra-individual variation across 11 invertebrate species and found a positive correlation between the coefficients of trait variation and asymmetry, indicating that DS and canalization may share a common mechanism. Breuker *et al*. (2006) found that the wing shape of *Drosophila melanogaster* also showed a positive correlation between inter- and intra-individual variation. However, other studies did not found a positive correlation between inter- and intra-individual variation suggesting that DS and canalization may involve different mechanisms (Debat *et al*., 2000; Dworkin, 2005; Debat *et al*,. 2009; Breno *et al*., 2011).

Møller and Pomiankowski (1993) suggested that natural and sexual selection have different effects on the pattern of trait variation and FA. They suggested that for traits experienced directional selection, like secondary sexual traits, sexual selection should favor extreme trait values, decrease trait variation, and increase the level of FA. FA is expected to have a positive correlation with trait size. For traits under

stabilizing nature selection, such as functional important traits, natural selection should remove extreme trait values, increase trait variation, and generate a U-shaped distribution of FA with respect to trait size (i.e., extreme sizes of a trait having the largest FA and median sizes of a trait having the smallest FA). Sexually selected traits are expected to show greater FA than that of functional traits under natural selection (Møller & Pomiankowski, 1993). However, the FA-sexual selection hypothesis proposed that FAs of secondary sexual traits may honestly reflect the quality of individuals, therefore a negative relationship between sizes and FAs is expected (Møller, 1992; Møller, 1993; Polak, 2008). This negative relationship has been found for traits favored by mate choices or used in intrasexual competition (Uetz & Smith, 1999; Møller, 2002).

The study of European stag beetle, *Lucanus cervus* (Insecta, Lucanidae) found that radioactive pollution in Chernobyl caused an increased FA of the mandible and elytra of the beetles (Møller, 2002). The size-corrected FA of moor frog, *Rana arvalis* in low PH environment was higher than that of populations in neutral PH (Söderman *et al*., 2007). Although the levels of FA were found to reflect environmental conditions in many organisms (Møller, 2002; Söderman *et al*., 2007), the studies on the horn of horned beetle, *Onthophagus taurus* (Hunt & Simmons, 1997; Hunt & Simmons, 1998), the wing shape of fruit fly, *Drosophila* (Debat *et al*., 2009) and the tarsus and rectrix of house sparrows, *Passer domesticus* (Vangestel & Lens, 2011) suggested that FA was not correlated with genetic or environmental manipulations.

Cyclommatus mniszechi (Thomsom, 1856) is a stag beetle with exaggerated male mandibles and head structures. These enlarged structures are used in male-male competition for resources and females (Emlen, 2008). The enlarged head of male *C. mniszechi* are secondary sexual traits specialized to sustain their exaggerated mandibles. A study of the nutritional manipulation of *C. mniszechi* suggested that the

size and shape of the mandible were largely determined by larval nutritional condition (Kuan, 2008). Therefore, the nutritional deficiency at larval stage would generate substantial developmental stress for *C. mniszechi*. This elevated level of developmental stresses is expected to affect the level of FA in adult morphological traits.

In this study, we investigated three specific questions regarding to the level of FA and the relationship between DS and FA of morphological traits in *C. mniszechi*: (1) Does environmental stress of low larval nutrition (developmental instability, DI) cause elevated FA? (2) Does DS share a common mechanism with canalization? (3) Does directional sexual selection increase trait variation and FA, whereas stabilizing natural selection decrease FA? First, we examined the effect of nutritional stress on the level of variation and FAs of secondary sexual and non-sexual morphological traits in *C. mniszechi*. The mandible and head of male *C. mniszechi* are used intensively in intraspecific flights, thus these structures are treated as secondary sexual traits under sexual selection. The thorax, elytra and leg are considered as functionally more important traits under stabilizing natural selection. Secondly, we test whether DS and canalization are two independent mechanisms by examining the relationships of variation of morphological traits and their FAs in *C. mniszechi*. Finally, the differences of size variance and FAs between sexual and functional traits were compared to test the prediction that sexual traits have greater variation of sizes and FAs, whereas functional traits have relatively smaller variation of sizes and FAs. The length of life history stages were recorded to examine the existence of reproduction-longevity trade-offs, in which the males having higher reproductive success are predicted to suffer from a shorter life span (Scharf *et al.*, 2013).

Materials and Methods

Study organism

Cyclommatus mniszechi is univoltine and inhabits low altitudinal forests of southeast China and northern Taiwan (Chang, 2006). In Taiwan, adult *C. mniszechi* often emerges from May to September (Chang, 2006). Like other stag beetles, *C. mniszechi* is sexually dimorphic and males often have exaggerated mandibles used for territorial combats. Males of *C. mniszechi* are polymorphic in shapes and sizes of the mandibles, which exhibit either major (α) or minor (β and γ) types (Figure 1) (Kuan, 2011). Major males of *C. mniszechi* use their mandibles as weapons in male-male competition for feeding sites (tree saps) and females. Minor males with smaller mandibles and bodies may either fight with other males (β type) or use alternative mating strategies (γ type), such as early emergence to gain access to females (Karino *et al.*, 2005; Emlen, 2008). Females of *C. mniszechi* have much smaller mandibles and body sizes compared to males.

Nutritional treatments

Beetles were collected from WuLai, Sanxia, Shenkeng and Xindian in northern Taiwan between 2007 and 2009 and kept in the laboratory (Kuan, 2008). An earlier study suggested that larval nutrition largely determine mandibular and body sizes of *C. mniszechi* (Kuan, 2008). We altered larval nutrition to generate developmentally more stable (high nutrition) and less stable (low nutrition) environments. Equal numbers of the offspring from each breeding adult pairs were assigned to the two nutritional treatments after the beetles reaching 2nd larval stages. For high nutritional treatment, the larvae were maintained in plastic containers (7.9 cm × 5.2 cm × 9.5 cm) filled with fermented sawdust (1st generation, *Dorcus* flake PREMIUM, Fujikon, Tokyo, Japan; 2nd generation, Strong effect sawdust, Bug's & I Beetle's Eco Exhibition,

Taichung, Taiwan). For low nutritional treatment, the plastic containers held three quarters of fermented wood chips (Y-000, Bug's & I Beetle's Eco Exhibition, Taichung, Taiwan), and mixed with one quarter of unfermented wood chips. The nitrogen content of the high nutritional treatment (average 0.37%) is higher than that of low nutritional treatment (0.16%, *Elaeocarpus sylvestris*; 0.21%, oak; 0.23%, *Liquidambar formosana*) (Kuan, 2008). After the emergence, the adults were provided weekly with commercial insect jelly (Beetle jelly, Bug's & I Beetle's Eco Exhibition, Taichung, Taiwan), and maintained at a temperature between 22 and 25 °C and a day/night cycle of 12 hours. The life history stages of the beetles were recorded weekly.

Morphological measurement and statistical analyses

We used an electronic caliper (CD-6" CSX, Digimatic Caliper, Mitutoyo) (±0.01 mm) to measure the length of two sides of the mandibles, heads, thoraxes, elytra, and femurs of the forelegs of male *C. mniszechi*. For females, the length of the elytra and femurs of the forelegs were measured (Figure 1). All traits were measured twice on different days. The traits were measured the third time if the difference of the two measurements was greater than 0.05 mm. Abnormal individuals exhibiting irregular sizes, shape, or asymmetry were excluded from the analyses. The SAS code for the mixed-model regression (Van Dongen *et al*., 2003) was used to quantify the population FA and measurement error (ME) of morphological traits. The *F*-statistics of the mixed-model regression was used to separate ME from total variance and to test for the presence of directional asymmetry (DA) (Van Dongen *et al*., 2003). Satterthwaite's formula was used to approximate the standard error and degree of freedom of the fixed effect (side) (Van Dongen *et al*., 2003). The presence of FA was confirmed by comparing the likelihood ratio of a full model with random side effect

and a reduced model without random side effect. Kurtosis test was used to examine the presence of antisymmetry (AS) (Palmer & Strobeck, 1986; 2003). When the distribution of asymmetry showed significantly negative *k* value (platykurtosis), the distribution may have more than one population with different asymmetric pattern (probably AS) (Palmer & Strobeck, 1986; 2003).

Hypotheses testing

The sizes of traits were calculated from the average of two measurements taken from the two sides. Two-way ANOVA was used to examine the size difference of trait values between the two nutritional treatments. After confirming that the ME of traits are significantly lower than their asymmetric values, the difference in sizes between averaged left (L) and right (R) side of the trait was calculated as FA of the trait (FA4 = R-L, Palmer, 1994). These FA values were size-corrected by dividing with mean trait values (Table 1, FA6 = (R-L) / ((R+L)/2)), Palmer, 1994). FA6 can be used to compare the difference of FAs between treatments for traits exhibiting DA (Palmer & Strobeck, 1986). Tukey's test of two-way ANOVA was used to examine the significance of differences in variance of traits and their FAs. Unsigned individual FA corrected by size (FA2 = |R-L| / ((R+L)/2)) was used for this analysis. Because the mandible exhibited significant DA (see results), the mean value of asymmetry of the mandible was used to represent the value of its target phenotype. The individual values minuses mean asymmetric value (target phenotype) of the mandible was calculated to represent its FA value (Van Dongen, 2006; Söderman *et al.*, 2007). To test whether canalization and DS share a common mechanism, we examine the relationships between FAs and the variance of traits. The variance was calculated as the difference between the values of individual and the population mean of the traits divided by individual's values to remove the effect of the body size. We expected that

if canalization and DS shared a common mechanism, the variance of traits and their FAs would be positively correlated (high nutritional treatment has lower variance and lower FA, whereas low nutritional treatment has higher variance and FA). If canalization and DS consisted distinct mechanisms, the relationships of the variance of traits and their FAs would show no consistent pattern.

Results

Kurtosis test revealed that FAs of all five traits in the two nutritional treatments showed no platykurtosis, suggesting that there was no AS (Table 1). The results of mixed-model regression showed that only the mandible of 2010 generation had significant DA with left side being larger (Table 2). All traits showed significant levels of asymmetric values with respect to ME in these generations (Table 2). For 2011 generation, the mandible, thorax and elytra showed significant DA. The left sides of the mandible and thorax were larger than their right sides. However, the right side of the elytra was larger than its left side.

The effect of nutrition on traits and their FAs

The size of the mandible, head, thorax and elytra of males were all significantly larger for beetles in high nutritional treatment (Table 3) (Figure 2). Only the size of femurs of males in 2010 generation was not significantly differ between treatments (Table 3) (Figure 2). The size of the elytra and femur of the foreleg of females were significantly larger for beetles in high nutrition in 2011 but not in 2010 (Table 3) (Figure 3). The duration of 3rd larval stage of the beetles in the low nutrition was significantly longer than that of high nutrition (Figure 4A & D). The average duration of the 3rd larval stage in 2010 and 2011 generation are 28 and 20 weeks, respectively. The duration of pupal and adult stage did not differ between treatments (Figure 4B, C, E & F). The mortality of the 3rd larval stage of the two nutritional treatments were similar (2010, high = 8.2%, low = 7.4%; 2011, high = 2.9%, low = 2.3%). The mortality of pupal stage to emergence were also low (2010, high = 6.7%, low = 2.9%; 2011, high = 3.9%, low = 0.6%). The mortality of the 3rd larval stage to emergence were also similar (2010, high = 14.3%, low = 10.1%; 2011, high = 6.7%, low = 2.8%). The signed FA corrected by size did not differ between the two treatments for all traits

(Table 4) (Figure 2). Although the FAs of the mandible and the FAs of the head in 2010 and the head in 2011 showed significant family effect, there were no significant interaction between treatments and families (Table 4). The FAs of the elytra and femur of the foreleg of females were approximately the same for the two treatments (Table 4) (Figure 2).

The relationships of canalization and DS

The relationships between the variance of traits and unsigned FA corrected by size were showed in Table 5. For males, variance between five traits all showed significantly positive correlation in both generations. Whereas, the FAs of 2010 generation showed no significant correlation between all the five traits. For 2011generation, the FAs of all five traits had significant positive correlation with each other except the FA of the head. The variance of traits of females between the elytra and femur also showed significantly positive correlation in both generations. The FAs between the elytra and femur of females showed no significant correlation for the two generations. The FAs and sizes of traits (Figure 5) showed no apparent trend, except a significantly negative correlation for the thorax in high nutritional treatment of 2011 generation.

The relationships between the variance of traits and their FAs were showed in Figure 5. For 2010 generation, the relationships between the variance of trait and FA of the mandible and elytra showed no relationship. However, the relationship between the variance of the head, thorax, and femur and their FAs showed positive relationships. For 2011 generation, the mandible had no clear relationship between its variance and FA. The relationships between the variance of the head and elytra and their FAs were negative whereas the variance and FAs of the thorax and femur had a positive relationship. Among the five traits, there was no consistent relationships

between the variance of traits and their FAs.

The effect of natural and sexual selection on the variance of traits and their FA

Multiple comparisons showed that for 2010 generation the variance of the non-sexual traits, thorax, elytra and femur were significantly smaller than that of the sexual traits, mandible and head (Figure 7A). For 2011 generation, the variance of the mandible and head were significantly larger than that of thorax, elytra and femur (Figure 7B). In addition, the variance of the mandible was significantly larger than that of the head. For 2010 generation, the FA of the elytra was significantly smaller than that of the mandible, head and femur, but not significantly different from that of the thorax (Figure 7A). For 2011 generation, the FA of the elytra was significantly smaller than that of the other four traits (Figure 7B). The FA of the femur of the foreleg was significantly larger than that of the mandible and thorax, but it was not significantly different from the FA of the head (Figure 7B).

Discussion

We found that the nutritional manipulation had a strong effect on the sizes of traits and the duration of the 3rd larval stage, but showed no detectable effect on FAs, pupal, and adult duration in *C. mniszechi*. Therefore, FA was not a sensitive indicator to reflect the nutritional condition of *C. mniszechi*. Studies of other insects also found no nutritional effect on FA of the morphological traits, including drosocentral bristle of neriid fly, *Telostylinus angusticollis* (Bjorksten *et al*., 2000), the body shape of water flea, *Daphnia magna* (Stige *et al*., 2004), the number of sternopleural bristle, wing length, wing to thorax radio, sex comb tooth number of males and ovariole number of females of fruit fly, *Drosophila ananassae* (Vishalakshi & Singh, 2008), the eyes talks, wing length and width of stalk-eyed fly, *Cyrtodiopsis dalmanni* (Bonduriansky, 2009), and length, width and area of the wing of fruit fly, *D. melanogaster* (Vijendravarma *et al*., 2011).

There are a few possible explanations for no effect of nutritional stress on FA of morphological traits in *C. mniszechi*. First, the mechanism of developmental stability may have evolved to resist the nutritional stress. David *et al.* (1998) suggested that the difference of constraints on ornamental symmetry (the eyes talks and wing of stalk-eyed flies, *Cyrtodiopsis dalmanni*) or the kind of stress may influence the pattern of FA (starvation and parasites). Nutritional stress is a predictable stress that animals may have evolved higher ability of resistance (David *et al.*, 1998). Secondly, the developmental selection against high asymmetric individual at the larval stage may lower the level of FA in low nutritional treatment (Bjorksten *et al*., 2000; Van Dongen, 2006; Vishalakshi & Singh, 2008; Breno *et al*., 2011). However, this study didn't find a higher larval mortality of *C. mniszechi* in the low nutritional treatment as compared to that of high nutrition. Therefore, a stronger selection against high asymmetric larvae in low nutrition may not be the explanation for no nutritional effect

on FA of *C. mniszechi*. Thirdly, the trait-specific buffer may have the ability to insulate from the random perturbation caused by genetic or environmental stress (Van Dongen, 2006). This hypothesis suggested that FA is a trait-dependent phenomenon, and functionally more important traits like insect's wings or legs may have higher degree of developmental stability to reduce FA than other functionally less constrained traits. In our study, the functional more constrained trait like elytra in general showed the lowest FA. The fourth explanation is that the stress from the low nutritional treatment may not be strong enough to generate an elevated FA in *C. mniszechi*. In this study, the size difference of traits between the two treatments was substantial, and the proportions of variation between treatments to the total variation for the elytra and mandible were approximately equal to 10% (13.54%, 9.87%) respectively. The final possible explanation is that FA may have a trade-off with growth rate (Morris *et al*., 2012). The environmental stress needs to be strong enough to reach a threshold, and then the individual may change the developmental strategy of optimizing FA to optimizing the growth rate. The individuals optimize the growth rate thus decrease their ability to optimize FA and then shows increased level of FA under environmental stress. However, in our study, we found that individuals in high nutritional treatment had higher growth rate (shorter larval time) but approximately the same level of FA as that of low nutritional treatment, suggesting no trade-off between FA and growth rate in *C. mniszechi*. In conclusion, no nutritional effect on FA of *C. mniszechi* may be partly explained by trait-specific buffer against environmental stress.

Canalization and DS did not share common mechanisms

Our results found no consistent relationship of the variance of traits and their FAs, suggesting that the mechanism of canalization and DS for these morphological

traits of *C. mniszechi* were not the same, and DS may be trait-specific. The study of heat shock proteins (HSPs) supported the existence of multiple mechanisms for canalization and DS (Debat *et al*., 2006). The study designed three different experiments to reduce the activity of Hsp90, and found that only one experiment can simultaneously alter the intra- and inter-individual variation. Their results suggested the existence of other mechanisms which can regulate the phenotype of *Drosophila melanogaster*. In *C. mniszechi*, only the thorax in high nutritional treatment showed a significant negative correlation between its size and FA, a result suggesting the size of thorax may reflect its individual quality in *C. mniszechi* ,as the beetle getting larger, its FA decreasing.

FA of sexual and non-sexual traits

The observed variation of the mandible and head was consistent with the prediction that traits experienced sexual selection showed greater FA and trait variation than that of non-sexual traits. The elytra, which was expected to be largely under strong natural selection, showed the lowest FA and trait variation. The behavioral study of the fighting sequence in *C. mniszechi* suggested that both the thorax and the foreleg were involved having in male-male territorial contests. During the early stage of territorial fight, the males of *C. mniszechi* not only use the mandibles, they frequently use their forelegs to raise their bodies for an extensive length of time to face the competitors (Kuan, 2011). Therefore, the thorax and forelegs may also be under strong intraspecific sexual selection for their strength and sizes in addition to natural selection for their walking ability. Traits having smaller variance in sizes but greater FAs were also found in the male genitalia of *D. melanogaster* (Dreyer & Shingleton, 2011). *Drosophila melanogaster* showed hypoallometry in genital size. FA of the genitalia was larger than that of the wing,

palp and femur. They proposed that the genitalia of *Drosophila* have higher autonomous genetic variation which makes genitalia size hypoallometric. They expected that sexual selection do not change the autonomous genetic variation. To maintain overall genetic variation, small males would be selected for the alleles that produce large genitalia, but large males were selected the alleles that produce small genitalia. The opposite direction of selection between larger and small males may reduce the overall variation of the genitalia. Our result on *C. mniszechi* showed that the thorax and forelegs had smaller size variations which may be driven by stabilizing natural selection, but had greater FA variations due to strong directional sexual selection. Dreyer and Shingleton (2011) found that the femur of the foreleg of *Drosophila* were hypoallometric, and suggested that the sex-combs on the femur of the foreleg in *Drosophila* are used to grasp females, therefore the femur of the foreleg may be under sexually selective pressure as that of the genitalia.

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Table 1 Kurtosis tests of morphological traits of *C. mniszechi*. (numbers in parentheses are sample sizes; 5% level of critical k = -0.82, n = 50; -0.72, n = 70; -0.52, n = 160)

		High nutrition		Low nutrition	
Sex	Trait	2010	2011	2010	2011
Male	Mandible	0.84 (49)	0.72 (141)	0.13 (46)	4.16 (168)
	Head	0.73 (49)	3.57 (148)	0.44 (47)	2.1 (172)
	Thorax	1.22 (50)	7.08 (149)	1.07 (47)	8.66 (173)
	Elytra	0.62 (50)	1.17 (144)	1.07 (47)	1.47 (171)
	Femur	2.3 (46)	5.1 (148)	1.84 (47)	7.11 (173)
Female	Elytra	6.78 (56)	2.2 (52)	11.81 (74)	0.76 (55)
	Femur	0.74 (55)	5.52 (51)	1.47 (74)	1.05 (57)

Table 2 Mixed-model regression of asymmetry of morphological traits in *C. mniszechi*. (LRT, likelihood ratio test; FA, fluctuating asymmetry; ME, measurement error; DA, directional asymmetry; *, $P<0.05$; ***, $P<0.001$).

	Traits	σ^2FA		LRT		σ^2ME		DA					
								df		*F*		*P*	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Male	Mandible	0.017	0.0364	564***	2358.3***	0.0002	0.0002	1,93	1,308	202.23	208.06	<0.001***	<0.001***
	Head	0.0084	0.0096	422.8***	1338.4***	0.0002	0.0003	1,96	1,319	3.42	1.53	0.068	0.217
	Thorax	0.0023	0.0066	220.9***	1334.1***	0.0002	0.0002	1,97	1,321	2.28	4.9	0.134	0.028*
	Elytra	0.0049	0.0102	316.7***	1444.6***	0.0002	0.0002	1,97	1,314	2.86	5.54	0.094	0.019*
	Femur	0.0079	0.0192	474.2***	2173.9***	0.0001	0.0001	1,94	1,320	1.34	2.68	0.25	0.102
Female	Elytra	0.007	0.0042	497.1***	373.5***	0.0002	0.0002	1,129	1,106	0.16	1.9	0.693	0.172
	Femur	0.0004	0.0006	84.5***	97.4***	0.0001	0.0002	1,128	1,107	2.76	2.43	0.099	0.122

Table 3 Multivariate analysis of variance (MANOVA) of morphological traits of *C. mniszechi*. (**, *P*<0.01; ***, *P*<0.001)

	Source	Trait	*df*		Mean square		*F*		*P*	
			2010	2011	2010	2011	2010	2011	2010	2011
Male	Treatment	Mandible	1	1	15.286	234.290	15.898	102.935	<0.001***	<0.001***
		Thorax	1	1	0.492	3.863	20.891	67.223	<0.001***	<0.001***
		Elytra	1	1	5.390	72.124	22.409	143.038	<0.001***	<0.001***
		Head	1	1	5.548	126.109	10.941	105.821	0.002**	<0.001***
		Femur	1	1	0.145	15.940	0.638	127.987	0.427	<0.001***
	Family	Mandible	10	15	5.664	35.360	5.891	15.535	<0.001***	<0.001***
		Thorax	10	15	0.304	0.611	12.937	10.627	<0.001***	<0.001***
		Elytra	10	15	1.690	8.076	7.025	16.016	<0.001***	<0.001***
		Head	10	15	3.994	21.015	7.877	17.634	<0.001***	<0.001***
		Femur	10	15	1.046	1.931	4.614	15.505	<0.001***	<0.001***
	Interaction	Mandible	10	15	0.532	5.375	0.554	2.361	0.845	0.003**
		Thorax	10	15	0.035	0.130	1.468	2.268	0.171	0.005**
		Elytra	10	15	0.284	1.217	1.182	2.413	0.318	0.003**
		Head	10	15	0.396	2.640	0.781	2.215	0.647	0.006**
		Femur	10	15	0.378	0.323	1.670	2.593	0.106	0.001**
Female	Treatment	Elytra	1	1	0.940	3.267	3.409	17.285	0.068	<0.001***
		Femur	1	1	0.116	0.193	3.841	10.995	0.053	0.001**
	Family	Elytra	10	4	0.975	1.147	3.540	6.067	<0.001***	<0.001***
		Femur	10	4	0.138	0.090	4.574	5.129	<0.001***	<0.001***
	Interaction	Elytra	10	4	0.284	0.071	1.030	0.377	0.423	0.825
		Femur	10	4	0.023	0.013	0.757	0.735	0.669	0.570

Table 4 Analysis of variance (ANOVA) of FAs of morphological traits of *C. mniszechi*. (*, $P<0.05$; **, $P<0.01$)

	Traits	Source	*df*		Mean square		*F*		*P*	
			2010	2011	2010	2011	2010	2011	2010	2011
Male	Mandible	Treatment	1	1	4.38×10^{-5}	4.11×10^{-6}	0.864	0.033	0.356	0.857
		Family	10	15	1×10^{-4}	1.33×10^{-4}	2.093	0.85	0.036*	0.621
		Interaction	10	15	4.91×10^{-5}	1.33×10^{-4}	0.968	1.258	0.478	0.229
		Residuals	72	277	5.56×10^{-5}	1.26×10^{-4}				
	Head	Treatment	1	1	1.24×10^{-4}	3.33×10^{-5}	0.992	0.208	0.323	0.649
		Family	10	15	3×10^{-4}	1.95×10^{-2}	2.217	2.092	0.025*	0.01**
		Interaction	10	15	1×10^{-4}	1.13×10^{-2}	0.892	1.22	0.545	0.255
		Residuals	75	302	1.2×10^{-4}	1.59×10^{-4}				
	Thorax	Treatment	1	1	3.39×10^{-6}	2.7×10^{-7}	0.048	0.001	0.827	0.97
		Family	10	15	4.49×10^{-5}	2×10^{-4}	0.637	1.221	0.777	0.254
		Interaction	10	15	1×10^{-4}	2×10^{-4}	1.042	1.243	0.418	0.239
		Residuals	76	290	6.58×10^{-5}	1.86×10^{-4}				
	Elytra	Treatment	1	1	1.09×10^{-6}	3.9×10^{-7}	0.068	0.013	0.794	0.911
		Family	10	15	1.2×10^{-5}	2.43×10^{-5}	0.753	0.784	0.673	0.696
		Interaction	10	15	1.04×10^{-5}	2.11×10^{-5}	0.65	0.683	0.767	0.801
		Residuals	76	283	1.32×10^{-5}	3.09×10^{-5}				
	Femur	Treatment	1	1	2.58×10^{-5}	3.05×10^{-4}	0.211	0.986	0.647	0.322
		Family	10	15	1×10^{-4}	4×10^{-4}	0.865	1.397	0.569	0.147
		Interaction	10	15	1×10^{-4}	3.33×10^{-4}	0.625	1.039	0.787	0.415
		Residuals	73	289	1.23×10^{-4}	3.08×10^{-4}				
Female	Elytra	Treatment	1	1	1.5×10^{-5}	3.2×10^{-5}	0.425	1.576	0.516	0.212
		Family	10	8	1.39×10^{-5}	2.43×10^{-5}	0.396	0.784	0.946	0.696
		Interaction	10	8	3.75×10^{-5}	2.11×10^{-5}	1.064	0.683	0.397	0.801
		Residuals	108	97	3.52×10^{-5}	2.03×10^{-5}				
	Femur	Treatment	1	1	3.69×10^{-5}	8.87×10^{-5}	1.906	2.821	0.170	0.096
		Family	10	8	2.43×10^{-5}	5.08×10^{-5}	1.257	1.615	0.264	0.176
		Interaction	10	8	1.1×10^{-5}	2.14×10^{-5}	0.568	0.68	0.837	0.607
		Residuals	107	98	1.94×10^{-5}	3.14×10^{-5}				

Table 5 The correlations of variance and FAs between traits. (above the diagonal are the r values of the correlation of variance between traits, below the diagonal are the r values of the correlation of FAs between traits; ***, $P<0.001$)

	Trait	Mandible	Thorax	Elytra	Head	Femur	Mandible	Thorax	Elytra	Head	Femur
		2010					2011				
Male	Mandible		0.556***	0.544***	0.733***	0.609***		0.806***	0.802***	0.918***	0.851***
	Thorax	0.016		0.698***	0.571***	0.719***	0.085		0.768***	0.814***	0.794***
	Elytra	-0.108	0.150		0.639***	0.790***	0.140*	0.182**		0.832***	0.816***
	Head	0.092	-0.002	0.152		0.709***	0.278***	0.073	0.094		0.891***
	Femur	-0.099	-0.043	0.020	-0.016		0.167**	0.315***	0.215***	0.149*	
Female	Elytra					0.898***					0.701***
	Femur		-0.154					0.017			

Figure Legends

Figure1. The male morphs and measurement of *C. mniszechi.* (A) Dorsal view of an α male . (B) Ventral view of an α male. (C) β male. (D) γ male. (E) Female. ML, mandible length; HW, head width; TL, thorax length; EL, elytra length; FL, femur length.

Figure 2. Morphological traits and their FAs of male *C. mniszechi* between high and low nutritional treatments for (A) 2010 and (B) 2011 generation.

Figure 3. Morphological traits and their FAs of female *C. mniszechi* between high and low nutritional treatments for (A) 2010 and (B) 2011 generation.

Figure 4. The duration of the 3rd larval stage of male *C. mniszechi* for (A) 2010 and (D) 2011 generation. The duration of pupal stage of male *C. mniszechi* for (B) 2010 and (E) 2011 generation. The duration of adult stage of male *C. mniszechi* for (C) 2010 and (F) 2011 generation.

Figure 5. The relationship of FAs and trait sizes for (A) 2010 and (B) 2011 generation. The solid ● and hollow ○ point represent low and high nutritional treatments, respectively. Each data point represents a family.

Figure 6. The relationship of FAs and variance of traits for (A) 2010 and (B) 2011 generation. The solid ● and hollow ○ point represent low and high nutritional treatments, respectively.

Figure 7. Multiple comparisons of variance and FAs of sexual and non-sexual traits for (A) 2010 and (B) 2011 generation.

Appendix 1. Analysis of variance (ANOVA) of morphological traits of *C. mniszechi*. (*, *P*<0.05; **, *P*<0.01; ***, *P*<0.001)

	Traits	Source	*df*		Mean square		*F*		*P*	
			2010	2011	2010	2011	2010	2011	2010	2011
Male	Mandible	Treatment	1	1	14.366	255.695	14.803	110.496	<0.001***	<0.001***
		Family	10	15	56.065	37.175	5.777	16.065	<0.001***	<0.001***
		Interaction	10	15	0.525	5.639	0.541	2.437	0.856	0.002**
		Residuals	72	277	0.97	2.314				
	Head	Treatment	1	1	7.5	131.362	15.004	98.839	<0.001***	<0.001***
		Family	10	15	4.23	21.4	8.409	16.102	<0.001***	<0.001***
		Interaction	10	15	0.39	3.328	0.766	2.504	0.660	0.002**
		Residuals	75	288	0.503	1.329				
	Thorax	Treatment	1	1	0.58	4.288	26.437	70.848	<0.001***	<0.001***
		Family	10	15	0.353	0.665	15.983	10.979	<0.001***	<0.001***
		Interaction	10	15	0.036	0.158	1.634	2.611	0.113	0.001***
		Residuals	76	290	0.022	0.061				
	Elytra	Treatment	1	1	6.2	41.06	27.681	53.275	<0.001***	<0.001***
		Family	10	15	1.96	8.117	8.698	10.532	<0.001***	<0.001***
		Interaction	10	15	0.29	1.738	1.31	2.255	0.241	0.024*
		Residuals	76	297	0.225	0.771				
	Femur	Treatment	1	1	0.8	17.148	13.004	125.389	<0.001***	<0.001***
		Family	10	15	0.74	2.034	12.033	14.875	<0.001***	<0.001***
		Interaction	10	15	0.05	0.417	0.853	3.047	0.580	<0.001***
		Residuals	73	289	0.062	0.137				
Female	Elytra	Treatment	1	1	0.881	3.329	3.25	17.765	0.074	<0.001***
		Family	10	8	0.973	1.148	3.589	6.127	<0.001***	<0.001***
		Interaction	10	8	0.264	0.067	0.975	0.358	0.469	0.838
		Residuals	108	97	0.271	0.187				
	Femur	Treatment	1	1	0.111	0.19	3.76	10.971	0.055	0.001***
		Family	10	8	0.145	0.089	4.921	5.157	<0.001***	<0.001***
		Interaction	10	8	0.022	0.012	0.737	0.699	0.688	0.594
		Residuals	107	98	0.03	0.017				

Appendix 2. Analysis of variance (ANOVA) of the traits and FAs (Brackets is the data of 2011 generation)

	Effect	*df*	Mean square	*F*	*P*
Trait					
Mandible	Treatment	1 / 1	6.42×10^{-4} / 0.213	0.603 / 19.912	0.440 / <0.001***
	Family	10 / 15	5.05×10^{-3} / 0.059	4.746 / 5.571	<0.001*** / <0.001***
	Interaction	10 / 15	2.56×10^{-3} / 0.033	2.405 / 3.068	0.016* / <0.001***
Thorax	Treatment	1 / 1	1.06×10^{-3} / 7.88×10^{-3}	3.195 / 7.996	0.078 / 0.005**
	Family	10 / 15	2.76×10^{-3} / 4.7×10^{-3}	8.278 / 4.763	<0.001*** / <0.001***
	Interaction	10 / 15	7.5×10^{-4} / 1.34×10^{-3}	2.253 / 1.354	0.024 / 0.170
Elytra	Treatment	1 / 1	4.96×10^{-4} / 0.011	1.913 / 9.919	0.171 / 0.002**
	Family	10 / 15	8.32×10^{-4} / 5.14×10^{-3}	3.21 / 4.566	0.002** / <0.001***
	Interaction	10 / 15	5.15×10^{-4} / 1.69×10^{-3}	1.986 / 1.505	0.048* / 0.103
Head	Treatment	1 / 1	2.37×10^{-4} / 0.076	0.364 / 16.964	0.549 / <0.001***
	Family	10 / 15	4.34×10^{-3} / 0.020	6.657 / 4.399	<0.001*** / <0.001***
	Interaction	10 / 15	6.62×10^{-4} / 6.98×10^{-3}	1.016 / 1.557	0.440 / 0.086
Femur	Treatment	1 / 1	5.2×10^{-4} / 0.024	1.325 / 17.630	0.254 / <0.001***
	Family	10 / 15	1.74×10^{-3} / 7.52×10^{-3}	4.445 / 5.553	<0.001*** / <0.001***
	Interaction	10 / 15	4.78×10^{-4} / 2.3×10^{-3}	1.219 / 1.700	0.295 / 0.051
FA					
Mandible	Treatment	1 / 1	5.39×10^{-6} / 8.7×10^{-7}	0.615 / 0.033	0.436 / 0.857
	Family	10 / 15	1.28×10^{-5} / 3.78×10^{-5}	1.454 / 1.416	0.176 / 0.139
	Interaction	10 / 15	4.49×10^{-6} / 3.93×10^{-5}	0.512 / 1.473	0.876 / 0.115
Thorax	Treatment	1 / 1	6.11×10^{-5} / 4.55×10^{-10}	3.339 / 9.41×10^{-6}	0.072 / 0.998
	Family	10 / 15	2.05×10^{-5} / 5.44×10^{-5}	1.123 / 1.124	0.358 / 0.334
	Interaction	10 / 15	2.02×10^{-5} / 1.92×10^{-5}	1.106 / 0.397	0.370 / 0.979
Elytra	Treatment	1 / 1	4.1×10^{-7} / 4.61×10^{-6}	0.157 / 0.983	0.693 / 0.322
	Family	10 / 15	1.73×10^{-6} / 7.12×10^{-6}	0.663 / 1.517	0.754 / 0.099
	Interaction	10 / 15	3.15×10^{-6} / 2.84×10^{-6}	1.206 / 0.606	0.303 / 0.869
Head	Treatment	1 / 1	2.69×10^{-5} / 9.79×10^{-7}	1.876 / 0.027	0.175 / 0.869
	Family	10 / 15	1.39×10^{-5} / 4.31×10^{-5}	0.969 / 1.208	0.478 / 0.265
	Interaction	10 / 15	1.65×10^{-5} / 5.4×10^{-5}	1.153 / 1.513	0.338 / 0.100
Femur	Treatment	1 / 1	6.9×10^{-5} / 1.32×10^{-4}	1.159 / 1.293	0.286 / 0.257
	Family	10 / 15	1.48×10^{-5} / 1.43×10^{-4}	0.249 / 1.397	0.990 / 0.148
	Interaction	10 / 15	2.47×10^{-5} / 5.25×10^{-5}	0.414 / 0.514	0.935 / 0.932

Appendix 3. Tukey's test of multiple comparisons of variance of morphological traits of *C. mniszechi*. (**, *P*<0.01; ***, *P*<0.001)

Trait (I)	Trait (J)	Mean difference (I-J)		95% CI		*P*	
		2010	2011	2010	2011	2010	2011
Elytra	Head	-0.0195	-0.0405	(-0.029, -0.01)	(-0.0562, -0.0249)	<0.001***	<0.001***
	Femur	-0.0078	-0.0052	(-0.0173, -0.0017)	(-0.0208, 0.0104)	0.16	0.893
	Mandible	-0.0254	-0.671	(-0.0349, -0.0159)	(-0.0828, -0.0515)	<0.001***	<0.001***
	Thorax	-0.0024	0.0023	(-0.0119, -0.0071)	(-0.0133, 0.0179)	0.958	0.994
Head	Femur	0.0116	0.0353	(0.0021, 0.0211)	(0.0197, 0.051)	0.008**	<0.001***
	Mandible	-0.0059	-0.0266	(-0.0154, 0.0036)	(-0.0422, -0.011)	0.429	<0.001***
	Thorax	0.0171	0.0428	(0.0076, 0.0266)	(0.0272, 0.0585)	<0.001***	<0.001***
Femur	Mandible	-0.0175	-0.0619	(-0.027, -0.008)	(-0.0776, -0.0463)	<0.001***	<0.001***
	Thorax	0.0054	0.0075	(-0.0041, 0.0149)	(-0.0081, 0.0231)	0.517	0.683
Mandible	Thorax	0.023	0.0695	(0.0135, 0.0325)	(0.0538, 0.0851)	<0.001***	<0.001***

Appendix 4. Tukey's test of multiple comparisons of FA of morphological traits of *C. mniszechi*. (*, *P*<0.05; **, *P*<0.01; ***, *P*<0.001)

Trait (I)	Trait (J)	Mean difference (I-J)		95% CI		*P*	
		2010	2011	2010	2011	2010	2011
Elytra	Head	-0.0043	-0.0046	(-0.0069, -0.0017)	(-0.0066, -0.0025)	<0.001***	<0.001***
	Femur	-0.0038	-0.0066	(-0.0064, -0.0012)	(-0.0086, -0.0045)	0.001***	<0.001***
	Mandible	-0.0029	0.0043	(-0.0055, -0.0003)	(-0.0064, -0.0023)	0.022*	<0.001***
	Thorax	-0.0025	-0.0042	(-0.0051, 0.0001)	(-0.0062, -0.0021)	0.063	<0.001***
Head	Femur	0.0005	-0.002	(-0.0021, 0.0031)	(-0.0041, 0.0001)	0.981	0.061
	Mandible	0.0014	0.0003	(-0.0012, 0.004)	(-0.0018, 0.0023)	0.548	0.997
	Thorax	0.0018	0.0004	(-0.0008, 0.0044)	(-0.0017, 0.0025)	0.319	0.984
Femur	Mandible	0.0009	0.0023	(-0.0017, 0.0035)	(0.0002, 0.0043)	0.869	0.024**
	Thorax	0.0013	0.0024	(-0.0013, 0.0039)	(0.0003, 0.0045)	0.663	0.013**
Mandible	Thorax	0.0004	0.0001	(-0.0022, 0.0029)	(-0.0019, 0.0022)	0.996	1

Appendix 5. The morphological measurements and the duration of life history stages of males for 2010 generation.

Family: (I)(6)♂Lvs(28)♀H：(5)♂ VS (F)(20)♀Lvs(24)♂L：(14)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
12	L	L	18.7	18.67	5.89	5.87	18.56	18.55	7.94	7.93	8.47	8.48	30	2	32
		R	18.44	18.45	5.9	5.92	18.44	18.4	7.99	7.99	8.32	8.33			
13	L	L	19.26	19.25	6.12	6.14	19.11	19.1	8.37	8.39	8.56	8.53	29	4	9
		R	19.04	19.01	6.12	6.13	19.1	19.11	8.31	8.3	8.56	8.56			
5	L	L	19.26	19.25	6.12	6.14	19.11	19.1	8.37	8.39	8.56	8.53	27	3	10
		R	19.04	19.01	6.12	6.13	19.1	19.11	8.31	8.3	8.56	8.56			
8	L	L	17.96	17.92	5.95	5.97	18.43	18.39	7.64	7.63	8.35	8.36	26	3	19
		R	17.67	17.66	5.97	5.97	18.31	18.31	7.66	7.64	8.31	8.3			
4	L	L	18.7	18.67	5.89	5.87	18.56	18.55	7.94	7.93	8.47	8.48	28	3	20
		R	18.44	18.45	5.9	5.92	18.44	18.4	7.99	7.99	8.32	8.33			
9	L	L	18.67	18.68	6.12	6.12	18.54	18.53	7.99	7.99	8.56	8.55	27	3	25
		R	18.55	18.57	6.11	6.09	18.63	18.61	8.12	8.11	8.52	8.51			
14	L	L	17.96	17.95	5.87	5.89	18.08	18.05	7.66	7.64	8.2	8.24	29	3	21
		R	17.7	17.67	5.85	5.85	17.96	17.92	7.67	7.66	8.21	8.21			
6	L	L	18.23	18.23	6.08	6.1	18.81	18.78	7.95	7.94	8.57	8.58	28	3	11
		R	18.04	18.04	6.1	6.11	18.82	18.85	7.93	7.94	8.57	8.57			
18	L	L	17.98	17.95	5.87	5.87	17.77	17.76	7.66	7.69	7.92	7.9	30	3	13
		R	17.81	17.79	5.88	5.86	17.84	17.82	7.64	7.66	8.14	8.15			
15	L	L	19.43	19.42	6.33	6.32	18.95	18.94	8.34	8.36	8.71	8.69	28	4	
		R	19.11	19.12	6.33	6.35	18.99	19	8.34	8.33	8.76	8.76			
22	H	L	19.36	19.38	6.29	6.27	19.29	19.26	8.29	8.31			27	2	24
		R	19.09	19.07	6.3	6.27	19.29	19.28	8.32	8.31					
37	H	L	18.13	18.16	5.98	5.99	18.43	18.42	7.71	7.72	8.35	8.36	27	3	26
		R	17.91	17.93	5.95	5.97	18.35	18.32	7.77	7.78	8.3	8.33			

21	H	L	20.07	20.06	6.43	6.44	19.88	19.86	8.62	8.64	9.03	9.02	27	2	35
		R	19.99	19.96	6.46	6.48	19.86	19.89	8.72	8.73	9.04	9.04			
34	H	L	19.72	19.72	6.13	6.15	19.13	19.13	8.56	8.55	8.79	8.78	27	4	35
		R	19.5	19.49	6.13	6.14	19.11	19.1	8.58	8.6	8.74	8.75			
24	H	L	18.62	18.62	6.13	6.12	18.98	18.99	8.24	8.23	8.72	8.71	26	3	29
		R	18.28	18.29	6.27	6.28	19.04	19.03	8.21	8.22	8.73	8.71			
26	H	L	19.69	19.69	6.18	6.22	18.68	18.66	8.53	8.52	8.66	8.64	27	2	5
		R	19.59	19.61	6.2	6.19	18.69	18.68	8.53	8.5	8.79	8.77			
23	H	L	18.04	18.04	6.01	6.05	19.01	19.01	8.06	8.08	8.59	8.58	27	2	32
		R	17.96	17.97	6.13	6.14	18.89	18.91	8.12	8.15	8.57	8.56			
27	H	L	19.37	19.37	6.25	6.28	19.01	19.01	8.16	8.15	8.7	8.72	25	4	31
		R	19.19	19.18	6.33	6.35	18.96	18.92	8.14	8.16	8.68	8.71			

Family: (A)(28)♂vs(20)♀：(29)♂ VS (H)(17)♂Lvs(4)♀H：(5)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	19.61	19.59	6.27	6.3	19.2	19.19	8.71	8.68	8.88	8.88	31	2	22
		R	19.54	19.54	6.26	6.29	19.2	19.22	8.83	8.84	8.88	8.88			
4	L	L	19.89	19.91	6.15	6.15	18.69	18.7	8.85	8.84	8.63	8.64	30	3	22
		R	19.67	19.65	6.15	6.15	18.69	18.71	8.86	8.85	8.62	8.61			
5	L	L	18.86	18.84	6.06	6.06	18.96	18.97	8.42	8.43	8.58	8.62	31	2	27
		R	18.64	18.61	6.04	6.05	18.99	18.98	8.46	8.47	8.59	8.59			
11	L	L	20	20	6.44	6.44	19.34	19.32	8.94	8.96	9.09	9.11	28	3	22
		R	20	20	6.43	6.42	19.38	19.4	8.94	8.95	9.07	9.07			
8	L	L	18.66	18.65	6.13	6.13	19.08	19.06	8.5	8.51	8.59	8.62	28	3	20
		R	18.66	18.67	6.13	6.15	18.99	18.96	8.6	8.63	8.58	8.6			
20	H	L	20.43	20.41	6.65	6.64	19.94	19.96	8.87		8.95	8.96	28	3	17
		R	20.31	20.3	6.54	6.53	19.98	19.96	9.05	9	8.96	8.97			
21	H	L	20.93	20.91	6.57	6.6	20.36	20.34	9.22	9.23	9.22	9.23	28	2	27

		R	20.91	20.9	6.59	6.62	20.32	20.36	9.33	9.3	9.28	9.27			
13	H	L	20.41	20.41	6.45	6.48	20.31	20.27	9.01	9.05	9.37	9.35	27	2	20
		R	20.3	20.31	6.48	6.48	20.27	20.27	9.12	9.09	9.23	9.23			
14	H	L	18.59	18.58	6.53	6.49	19.91	19.9	8.81	8.82			27	3	26
		R	18.25	18.23	6.46	6.47	19.82	19.82	8.89	8.86					
16	H	L	21.25	21.28	6.48	6.44	19.95	19.95	9.12	9.15	9.08	9.08	28	3	30
		R	20.92	20.89	6.59	6.58	19.97	20	9.1	9.11	9.12	9.1			

Family: (D)(14)♀Lvs(5)♂H：(2)♂ VS (G)(6)H♂vs(5)L♀：(18)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
13	L	L	19.15	19.12	6.11	6.12	18.69	18.67	8.12	8.15	8.43	8.43	27	4	14
		R	18.66	18.65	6.17	6.17	18.7	18.7	7.9	7.91	8.41	8.4			
18	L	L	16.68	16.69	5.79	5.79	17.48	17.46	7.41	7.41	7.88	7.89	29	3	30
		R	16.47	16.5	5.79	5.78	17.4	17.39	7.41	7.38	7.87	7.88			
21	L	L	18.22	18.23	6.07	6.06	17.92	17.9	8.01	8.02	8.24	8.25	31	3	28
		R	18.16	18.16	6.02	6.02	17.95	17.97	7.94	7.95	8.26	8.24			
19	L	L	15.6	15.59	5.87	5.88	17.95	17.95	7.16	7.18	7.83	7.84	29	3	28
		R	15.33	15.32	5.85	5.86	17.79	17.82	7.22	7.24	7.84	7.85			
4	L	L	16.83	16.84	5.91	5.92	17.79	17.79	7.68	7.69	8.13		30	3	6
		R	16.49	16.51	5.88	5.88	17.75	17.76	7.51	7.53					
16	L	L	16.79	16.83	5.76	5.77	17.69	17.7	7.51	7.51	7.86	7.86	28	5	6
		R	16.52	16.55	5.96	5.95	17.83	17.86	7.4	7.4	7.92	7.91			
22	H	L	18.01	18.04	6.11	6.08	18.3	18.3	7.7	7.7	8.14	8.13	29	3	26
		R	18.09	18.09	5.97	5.95	18.38	18.37	7.66	7.65	8.05	8.04			
41	H	L	17.75	17.77	6	6	18.17	18.17	7.81	7.81	8.11	8.11	30	3	29
		R	17.45	17.48	6	6.01	18.07	18.08	7.68	7.65	8.1	8.11			
23	H	L	16.93	16.98	5.8	5.8	17.95	17.94	7.61	7.63	7.99	7.96	30	3	27
		R	16.82	16.86	5.78	5.77	17.96	17.96	7.62	7.62	8.03	8.03			

28	H	L	20.36	20.34	6.3	6.31	19.61	19.6	8.65	8.66	8.56	8.55	28	3	24
		R	20.04	20.06	6.32	6.29	19.61	19.63	8.66	8.63	8.24	8.22			
32	H	L	21.14	21.12	6.26	6.27	19.74	19.73	8.89	8.89	8.73	8.71	29	3	27
		R	20.8	20.8	6.37	6.36	19.62	19.64	8.94	8.94	8.78	8.75			
Family: (E)(9)♀Lvs(8)♂H：(9)♂ VS No coding♀(2009)															
Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
4	L	L	17.42	17.4	5.94	5.97	18.27	18.29	7.98	7.99	8.28	8.29	31		
		R	17.23	17.23	5.94	5.94	18.25	18.25	7.98	7.97	8.26	8.28			
7	L	L	18.95	18.97	6.26	6.27	19.17	19.19	8.39	8.39	8.69	8.69	29	3	24
		R	18.71	18.71	6.23	6.27	19.16	19.19	8.39	8.39	8.66	8.67			
2	L	L	17.79	17.81	6.11	6.11	18.23	18.23	7.99	7.98	8.22	8.21	31		
		R	17.64	17.65	6.02	6.03	18.26	18.29	8.17	8.15	8.01	8.03			
1	L	L	17.07	17.09	5.8	5.78	17.67	17.68	7.54	7.56	7.97	7.97	31		
		R	16.95	16.9	5.87	5.87	17.63	17.61	7.57	7.57	7.93	7.92			
17	H	L	18.08	18.07	5.98	5.97	18.41	18.44	7.97	7.99	8.27	8.28	26	4	14
		R	17.77	17.76	5.94	5.94	18.36	18.37	7.84	7.8	8.28	8.29			
21	H	L	18.18	18.17	5.95	5.93	18.51	18.53	7.94	7.97	8.37	8.38	27	2	18
		R	17.91	17.91	5.95	5.94	18.35	18.39	8.11	8.12	8.4	8.39			
22	H	L	18.31	18.31	5.88	5.87	18.93	18.96	8.08	8.1	8.31	8.33	27	3	26
		R	18.27	18.25	5.83	5.83	18.8	18.8	8.21	8.19	8.33	8.35			
20	H	L	19.15	19.14	6.23	6.19	18.81	18.81	8.25	8.26	8.48	8.52	29	3	27
		R	18.94	18.93	6.26	6.24	18.68	18.72	8.36	8.38	8.5	8.5			
23	H	L	19.65	19.66	6.17	6.15	19.34	19.36	8.54	8.57	8.69	8.67	27	3	29
		R	19.66	19.68	6.15	6.12	19.35	19.36	8.69	8.68	8.71	8.68			
24	H	L	19.57	19.56	6.36	6.34	19.51	19.55	8.64	8.67	8.75	8.76	28	3	29
		R	19.4	19.4	6.34	6.35	19.5	19.54	8.71	8.7	8.73	8.75			
Family: (A)(28)♂vs(20)♀：(18)♀ VS (G)(6)H♂vs(5)L♀：(1)♂L															

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
9	L	L	19.25	19.26	6.09	6.08	18.63	18.64	8.37	8.41	8.47	8.5	28	4	30
		R	19.08	19.08	6.06	6.04	18.62	18.59	8.37	8.37	8.5	8.46			
7	L	L	17.65	17.63	5.86	5.83	17.72	17.73	7.82	7.8	8.07	8.07	28	4	11
		R	17.49	17.46	5.89	5.9	17.7	17.69	7.8	7.77	8.05	8.06			
10	L	L	17.8	17.83	5.94	5.94	18.09	18.08	7.87	7.85	8.14	8.13	30	3	30
		R	17.42	17.44	5.95	5.94	18.06	18.07	7.78	7.81	8.11	8.09			
3	L	L			5.7	5.68	17.41	17.42	7.2	7.24	7.86	7.84	29	3	24
		R			5.78	5.75	17.43	17.43	7.08	7.08	7.83	7.81			
11	H	L	17.47	17.49	6.04	6.03	18.47	18.5	7.66	7.69	8.02	8.02	26	3	30
		R	17.15	17.14	6.03	6.02	18.46	18.46	7.55	7.56	7.81	7.81			
12	H	L	19.65	19.65	6.12	6.15	19.16	19.13	8.61	8.6	8.65	8.69	27	3	23
		R	19.56	19.55	6.2	6.16	19.15	19.14	8.58	8.6	8.67	8.69			
13	H	L	19.45	19.45	6.08	6.12	19.05	19.06	8.36	8.35	8.49	8.5	26	3	27
		R	19.09	19.1	6.1	6.09	19.01	18.99	8.51	8.53	8.39	0			

Family: (B)(13)♂Hvs(5)♀L：(14)♂ VS (A)(28)♂vs(20)♀：(7)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
11	L	L	15.18	15.16	5.43	5.43	17.15	17.14	6.92	6.87	7.59	7.59	26	3	16
		R	14.64	14.65	5.45	5.43	17.23	17.24	6.89	6.87	7.54	7.53			
15	L	L	16.83	16.84	5.65	5.65	18.1	18.08	7.47	7.44	7.88	7.86	28	3	19
		R	16.5	16.49	5.7	5.67	18.07	18.07	7.6	7.54	7.89	7.89			
20	L	L	16.18	16.17	5.34	5.36	17.58	17.56	7.34	7.31	7.73	7.71	27	3	25
		R	15.85	15.85	5.35	5.39	17.57	17.55	7.32	7.31	7.66	7.64			
13	H	L	17.39	17.37	5.89	5.86	17.98	17.98	7.84	7.81	8.05	8.03	27	3	25
		R	17.36	17.33	5.85	5.86	17.87	17.88	7.83	7.79	8.07	8.06			
28	H	L	16.62	16.65	5.54	5.52	17.83	17.82	7.36	7.35	7.93	7.94	27	3	17
		R	16.45	16.47	5.56	5.56	17.85	17.81	7.34	7.38	7.89	7.87			

32	H	L			5.62	5.58	17.87	17.87	7.99	8.02	8.05	8.05	27	2	3
		R			5.57	5.57	17.9	17.94	8.01	8	8.03	8.03			
43	H	L	17.09	17.14	5.77	5.76	18.49	18.53	7.64	7.65	8.34	8.31	27	2	21
		R	16.89	16.88	5.74	5.75	18.27	18.31	7.65	7.65	8.16	8.14			
46	H	L	16.5	16.52	5.51	5.51	17.59	17.59	7.68	7.66	7.67	7.67	27	3	22
		R	16.14	16.19	5.5	5.5	17.6	17.58	7.68	7.65	7.64	7.62			
47	H	L	18.81	18.82	5.92	5.94	18.63	18.63	8.1	8.11	8.2	8.19	27	3	24
		R	18.65	18.66	5.98	5.96	18.63	18.63	8.09	8.11	8.22	8.21			
48	H	L	18.4	18.38	5.84	5.86	18.88	18.9	7.98	7.98	8.26	8.28	27	3	2
		R	17.75	17.77	5.81	5.85	18.89	18.9	7.98	7.97	8.22	8.21			

Family: (F)(20)♀Lvs(24)♂L：(2)♂ VS (G)(6)H♂vs(5)L♀：(20)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
10	L	L	19.44	19.44	6.1	6.08	18.78	18.74	8.13	8.12	8.5	8.52	27	3	33
		R	19.22	19.22	6.11	6.12	18.73	18.73	8.29	8.27	8.52	8.5			
15	L	L	17.66	17.64	5.97	5.96	18.31	18.29	7.58	7.59	8.2	8.2	27	3	10
		R	17.49	17.52	5.97	5.97	18.3	18.28	7.72	7.71	8.14	8.12			
1	H	L	20.7	20.69	6.53	6.52	20.23	20.29	8.81	8.79	9.05	9.06	27	2	28
		R	20.46	20.49	6.51	6.51	20.26	20.29	8.84	8.81	9.06	9.08			
2	H	L	20.01	20	6.67	6.72	20.02	20.02	8.68	8.68	9	8.99	27	4	22
		R	19.71	19.71	6.7	6.69	20.09	20.13	8.64	8.69	8.92	8.91			
7	H	L	19.71	19.73	6.35	6.4	19.47	19.52	8.48	8.48	8.85	8.83	27	3	28
		R	19.49	19.48	6.4	6.4	19.45	19.48	8.49	8.5	8.84	8.85			
8	H	L	19.53	19.52	6.45	6.45	19.52	19.54	8.47	8.49	8.67	8.66	26	3	29
		R	19.4	19.43	6.56	6.53	19.67	19.65	8.5	8.5	8.72	8.72			

Family: (G)(6)H♂vs(5)L♀：(2)♂ VS (B)(13)♂Hvs(5)L♀：(19)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
4	L	L	16.67	16.7	5.73	5.72	17.69	17.69	7.39	7.35	7.84	7.84	27	3	20

		R	16.45	16.48	5.71	5.7	17.7	17.67	7.36	7.36	7.82	7.83			
5	L	L	18.94	18.95	5.97	5.95	18.43	18.45	8.17	8.2	8.38	8.38	28	3	21
		R	18.79	18.77	5.98	5.98	18.44	18.46	8.18	8.19	8.31	8.3			
6	L	L	18.98	18.99	5.81	5.8	18.66	18.65	8.28	8.29	8.46	8.45	28	2	32
		R	18.98	18.99	5.79	5.8	18.66	18.64	8.29	8.31	8.44	8.45			
7	L	L	17.5	17.5	5.77	5.79	17.54	17.53	7.49	7.46	7.95	7.96	27	3	22
		R	17.07	17.11	5.78	5.77	17.52	17.52	7.46	7.44	8.01	8			
10	H	L	17.77	17.79	5.79	5.8	18.46	18.45	7.77	7.79	8.19	8.18	28	3	25
		R	17.78	17.78	5.79	5.8	18.47	18.49	7.76	7.78	8.15	8.15			
13	H	L	17.52	17.52	5.76	5.79	17.94	17.94	7.42	7.41	7.93	7.9	27	4	23
		R	17.25	17.26	5.78	5.78	18.05	18.04	7.27	7.27	7.97	7.98			

Family: (E)(9)♀Lvs(8)♂H：(29)♂ VS (H)(17)♂Lvs(4)♀H：(2)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
6	L	L	17.31	17.32	5.82	5.86	17.91	17.91	7.71	7.71	8.03	8.02	31	4	24
		R	17.01	16.99	5.82	5.85	17.9	17.9	7.75	7.75	8.03	8.04			
8	L	L	18.03	18.02	6	6.01	19.03	19.02	8.08	8.07	8.29	8.27	31	3	27
		R	17.84	17.87	5.98	6.01	18.95	18.93	8.26	8.26	8.32	8.33			
14	H	L	19.36	19.35	6.24	6.25	18.97	18.96	8.4	8.39	8.53	8.52	29	2	34
		R	19.21	19.22	6.15	6.16	18.93	18.91	8.49	8.49	8.62	8.62			
15	H	L	17.87	17.88	6.1	6.08	18.16	18.15	7.87	7.87	7.73	7.77	29	3	16
		R	17.71	17.71	6.14	6.11	18.17	18.16	7.93	7.93	8.25	8.25			
19	H	L	19.56	19.55	6.12	6.14	19.16	19.18	8.61	8.59	8.62	8.62	28	2	32
		R	19.4	19.39	6.12	6.12	19.1	19.09	8.64	8.62	8.66	8.67			
21	H	L	17.75	17.76	5.81	5.83	18.14	18.12	7.99	8	7.97	7.95	28	3	31
		R	17.7	17.71	5.87	5.88	18.12	18.13	7.93	7.97	8	8.01			
22	H	L	18.33	18.32	5.95	5.94	18.48	18.5	7.99	8.01	8.25	8.27	28	3	31
		R	18.33	18.33	5.93	5.94	18.44	18.43	8.02	8.04	8.23	8.22			

23	H	L	18.51	18.52	6.05	6.03	18.35	18.38	8.02	8.02	8.3	8.32	29	3	22
		R	18.51	18.51	6.05	6.05	18.37	18.36	8.19	8.19	8.29	8.3			

Family: (D)(14)♀Lvs(5)♂H：(6)♂H VS (G)(6)H♂vs(5)L♀：(6)♀L

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	19.42	19.42	6.1	6.09	18.65	18.65	8.4	8.39	8.47	8.46	28	3	25
		R	19.33	19.33	6.07	6.08	18.65	18.64	8.43	8.44	8.47	8.47			
3	L	L	19.46	19.46	5.97	5.96	19.07	19.05	7.37	7.38	8.72	8.72	26	3	28
		R	19.04	19.04	6.06	6.04	18.97	18.96	7.38	7.37	8.65	8.64			
16	L	L	15.7	15.7	5.63	5.62	17.35	17.35	7.35	7.35	7.88	7.86	32		
		R	15.53	15.53	5.62	5.64	17.44	17.42	7.21	7.25	7.85	7.82			
23	H	L			6.12	6.15	18.5	18.51	7.92	7.92	8.12	8.1	27	3	5
		R			6.15	6.12	18.61	18.62	7.91	7.93	8.1	8.12			
26	H	L	19.22	19.21	6.17	6.2	18.74	18.73	7.82	7.81	8.6	8.58	27	3	7
		R	18.79	18.78	6.14	6.13	18.73	18.71	7.85	7.81	8.6	8.56			

Family: (J)(3)♂vs(4)♀：(4)♂ VS (A)(28)♂vs(20)♀：(13)♀

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	17.79	17.79	5.89	5.88	17.66	17.66	7.91	7.9	7.89	7.9	31	2	11
		R	17.5	17.51	5.87	5.87	17.69	17.68	7.91	7.91	7.73	7.75			
2	L	L	19.15	19.15	6.06	6.08	18.58	18.58	8.72	8.71	8.49	8.51	28	3	27
		R	19.17	19.15	6.08	6.07	18.62	18.62	8.72	8.7	8.47	8.5			
5	L	L			6.02	5.99	17.95	17.94	7.45	7.44	8.07	8.07	30	2	27
		R			6.03	5.98	17.97	17.97	7.9	7.91	8.1	8.09			
6	L	L	17.17	17.2	6.02	6	18.37	18.35	7.93	7.96	8.13	8.12	28	3	23
		R	16.98	17	6	5.98	18.14	18.15	7.97	7.96	8.16	8.18			
7	L	L	17.51	17.51	5.98	5.97	18.23	18.2	7.84	7.85	8.13	8.1	28	3	4
		R	17.22	17.23	6	5.98	18.41	18.41	7.7	7.7	8.21	8.2			
10	H	L	18.94	18.96	5.87	5.85	17.97	17.98	8.38	8.38	8.15	8.14	29	3	25

		R	18.82	18.83	6.01	6	17.96	17.98	8.35	8.36	8.16	8.16			
11	H	L	18.1	18.1	5.96	5.97	18.23	18.22	7.96	7.92	8.11	8.12	29	3	27
		R	17.9	17.88	5.99	5.99	18.29	18.27	7.92	7.9	8.08	8.1			

Appendix 6. The morphological measurements and the duration of life history stages of males for 2011 generation.

Family: 11.9-1

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	17.78	17.78	5.86	5.86	18.8	18.8	7.77	7.76	8.24	8.23		1	18
		R	17.51	17.51	5.82	5.83	18.66	18.66	7.75	7.74	8.18	8.18			
4	L	L			6.03	6.05	19.05	19.04	8.74	8.73	8.68	8.66		3	20
		R			5.98	5.99	18.92	18.9	8.67	8.69	8.69	8.68			
5	L	L	18.51	18.5	5.53	5.53	18.11	18.11	7.96	7.97	8.03	8.04		2	19
		R	18.19	18.19	5.51	5.55	18.12	18.11	7.97	7.95	7.76	7.74			
6	L	L	18.63	18.62	5.91	5.89	18.72	18.73	8.36	8.32	8.15	8.17		4	20
		R	18.37	18.37	5.94	5.96	18.58	18.61	8.4	8.42	8.28	8.26			
7	L	L	19.52	19.51	6.13	6.13	19.58	19.6	8.52	8.53	8.63	8.64		3	16
		R	19.19	19.19	6.12	6.12	19.49	19.52	8.48	8.51	8.61	8.63			
8	L	L	20.33	20.33	6.27	6.29	19.97	19.97	8.7	8.71	9	9.02		3	25
		R	20.23	20.24	6.29	6.3	19.98	19.98	8.85	8.86	8.97	8.95			
23	L	L	14.71	14.74	5.53	5.55	17.67	17.67	6.98	6.95	7.58	7.58		4	22
		R	14.37	14.39	5.52	5.52	17.72	17.71	6.96	6.96	7.56	7.54			
25	L	L	19.89	19.9	6.01	6.05	19.01	19.01	8.39	8.4	8.45	8.44		3	19
		R	19.7	19.68	5.81	5.77	18.84	18.88	8.61	8.61	8.32	8.32			
26	L	L	19.21	19.21	5.99	6	18.7	18.72	8.29	8.25	7.95	7.95		4	19
		R	19.15	19.15	6.36	6.38	18.89	18.88	8.27	8.29	8.08	8.1			
27	L	L	18.16	18.15	5.81	5.82	18.59	18.55	8.13	8.17	8.37	8.37		3	25
		R	17.91	17.95	5.81	5.82	18.74	18.72	8.28	8.3	8.37	8.38			
28	L	L	18.97	18.98	6.42	6.41	18.47	18.51	8.51	8.52	8.54	8.53		2	22
		R	18.72	18.74	6.41	6.44	18.77	18.76	8.51	8.52	8.37	8.37			
29	L	L	19.83	19.84	6.08	6.04	19.7	19.74	8.87	8.86	8.71	8.71		4	19
		R	19.73	19.73	6.07	6.08	19.7	19.72	8.85	8.84	8.7	8.68			

30	L	L	20.76	20.78	6.3	6.3	19.4	19.41	8.37	8.41	8.47	8.47	4	23
		R	20.32	20.32	6.23	6.22	19.41	19.42	8.55	8.57	8.35	8.36		
13	H	L	21.2	21.21	6.23	6.26	19.93	19.93	9.07	9.05	9.02	9.03	3	20
		R	20.71	20.71	6.2	6.23	20.17	20.17	9.01	8.99	9	9.02		
14	H	L	20.56	20.55	6.54	6.52			8.94	8.92	9	9	3	20
		R	20.73	20.72	6.56	6.53			9.08	9.07	8.31	8.28		
19	H	L	18.4	18.39	5.64	5.68	18.64	18.64	8.25	8.22	8.33	8.33	3	13
		R	18.45	18.49	5.77	5.76	18.67	18.63	7.99	7.98	8.22	8.24		
20	H	L	21.7	21.7	6.18	6.2	20.7	20.72	9.52	9.49	9.45	9.46	3	23
		R	21.54	21.56	6.23	6.2	20.79	20.81	9.52	9.49	9.41	9.38		
33	H	L	19.69	19.67	5.67	5.68	19.06	19.08	8.73	8.73	8.56	8.59	3	22
		R	19.28	19.28	5.68	5.7	18.97	19	8.63	8.63	8.52	8.51		
37	H	L	20.53	20.53	6.14	6.14	19.54	19.54	8.67	8.7	8.76	8.76	3	13
		R	20.43	20.45	5.97	5.99	19.64	19.69	9	8.98	8.68	8.67		
41	H	L			6.2	6.21	19.53	19.55	8.33	8.37	8.62	8.62	3	18
		R			5.9	5.92	19.17	19.22	8.59	8.58	8.51	8.49		

Family: 11.9-2

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	19.34	19.35	6.35	6.36	19.22	19.26	8.51	8.51	8.75	8.77		3	25
		R	19.01	19.02	6.33	6.32	19.18	19.22	8.53	8.53	8.75	8.75			
2	L	L	19.85	19.86	6.34	6.34	18.92	18.97	8.49	8.5	8.4	8.4		1	23
		R	19.64	19.66	6.37	6.37	18.91	18.95	8.57	8.6	8.39	8.4			
4	L	L	17.66	17.67	6.07	6.08	18.74	18.74	7.97	7.99	8.28	8.29			28
		R	17.45	17.48	6.1	6.1	18.75	18.75	7.96	7.99	8.37	8.39			
5	L	L	17.73	17.73	5.94	5.9	18.35	18.34	8.06	8.07	8.44	8.43			
		R	17.79	17.83	5.94	5.93	18.34	18.33	8.15	8.13	8.4	8.41			
6	L	L	19.24	19.23	6.21	6.21	19.45	19.43	8.09	8.07	8.41	8.41		2	14

		R	18.89	18.9	6.22	6.22	19.41	19.39	8.08	8.1	8.35	8.34		
9	L	L	20.36	20.36	6.48	6.49	19.95	19.98	9.01	8.98	8.97	8.96	3	26
		R	20.35	20.35	6.48	6.49	19.94	19.91	9.04	9.01	8.97	8.95		
10	L	L	19.8	19.8	6.31	6.33	19.42	19.39	8.53	8.54	8.75	8.74	3	22
		R	19.56	19.57	6.23	6.26	19.44	19.43	8.54	8.52	8.78	8.76		
11	L	L	19.62	19.64	6.18	6.17	19.14	19.15	8.37	8.36	8.53	8.55	3	22
		R	19.18	19.22	6.1	6.13	19.24	19.28	8.44	8.47	8.64	8.65		
12	L	L	12.54	12.53	5.3	5.31	16.29	16.31	6.04	6.05	7.22	7.26	3	23
		R	11.98	11.95	5.32	5.32	16.28	16.28	6.06	6.06	7.25	7.25		
14	L	L	19.6	19.61	6.55	6.56	19.81	19.82	8.94	8.93	8.72	8.7	2	26
		R	19.64	19.66	6.63	6.63	19.98	19.95	8.97	8.93	9.15	9.12		
15	L	L	20.39	20.39	6.44	6.44	20.3	20.28	8.75	8.75	9.04	9.05	3	23
		R	20.7	20.69	6.36	6.35	20.18	20.18	8.8	8.78	8.95	8.96		
17	L	L	19.62	19.63	6.36	6.35	19.81	19.81	9.02	9.02	8.73	8.75	3	29
		R	19.23	19.25	6.26	6.26	19.82	19.81	9.02	9.02	8.7	8.71		
20	H	L	18.88	18.87	6.36	6.39	19.35	19.35	8.21	8.22	8.56	8.56	2	23
		R	19.2	19.21	6.35	6.4	19.24	19.23	8.22	8.21	8.45	8.45		
27	H	L	20.48	20.48	6.71	6.7	20.27	20.27	9.37	9.33	9.3	9.3		25
		R	20.48	20.49	6.67	6.68	20.29	20.27	9.35	9.32	9.32	9.31		
30	H	L	19.6	19.61	6.31	6.3	19.53	19.55	8.61	8.6	8.4	8.4	4	22
		R	18.8	18.83	6.33	6.32	19.49	19.47	8.44	8.41	8.49	8.5		
31	H	L	17.76	17.76	6.14	6.12	18.93	18.95	8.32	8.3	8.69	8.66	2	7
		R	17.99	18	6.14	6.12	18.94	18.97	8.4	8.36	8.85	8.86		
32	H	L	19	19	6.15	6.17	19.1	19.07	8.47	8.48	8.48	8.48	4	32
		R	18.92	18.93	6.12	6.11	19.02	19.01	8.46	8.45	8.48	8.48		
33	H	L			6.38	6.35			8.95	8.91	8.83	8.81	4	22
		R			6.75	6.75			8.82	8.79	8.85	8.84		

36	H	L			6.42	6.44	20.09	20.07	8.53	8.5	8.8	8.79		4	17
		R			6.62	6.62	20.21	20.23	8.72	8.72	8.81	8.79			
Family: 11.9-3															
Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	14.59	14.59	5.55	5.56	17.31	17.27	6.64	6.67	7.8	7.81	20	5	9
		R	15.34	15.32	5.47	5.48	17	17.03	7.01	6.98	7.83	7.8			
3	L	L	13.68	13.7	5.83	5.81			6.69	6.69	7.16	7.17	14	6	27
		R	13.57	13.57	5.83	5.81			6.68	6.69	7.32	7.32			
4	L	L	16.02	16.06	5.8	5.8	17.7	17.72	7.28	7.28	8.04	8.05	20	2	31
		R	15.63	15.6	5.8	5.76	17.72	17.73	7.16	7.17	8.02	8.02			
6	L	L	18.34	18.34	6.26	6.25	18.6	18.6	8.22	8.26	8.34	8.36	18	4	32
		R	18.02	18.03	6.16	6.15	18.65	18.65	8.34	8.31	8.44	8.46			
9	L	L	19.46	19.45	6.26	6.24	18.79	18.82	8.38	8.41	8.36	8.36	20	2	19
		R	19.42	19.43	6.12	6.13	18.76	18.74	8.49	8.49	8.14	8.13			
12	L	L	19.09	19.1	6.37	6.41	19.18	19.19			8.73	8.73	20		
		R	19.13	19.16	6.32	6.32	19.18	19.18			8.72	8.71			
13	L	L	19.3	19.3	5.95	5.98	18.82	18.82	9.18	9.14	9.01	9	20	4	43
		R	18.82	18.81	5.92	5.94	18.81	18.82	9.14	9.13	8.94	8.94			
14	H	L	17.21	17.22	5.96	5.95	18.4	18.4	7.88	7.86	8.33	8.35	18	4	28
		R	16.95	16.96	5.94	5.93	18.47	18.45	7.93	7.96	8.35	8.33			
16	H	L	16.14	16.14	5.78	5.8	18.22	18.2	7.49	7.51	7.69	7.67	20	2	27
		R	15.82	15.83	5.8	5.79	17.98	18.02	7.48	7.46	8	8.02			
18	H	L	18.45	18.44	6.3	6.3	19.35	19.36	8.4	8.42	8.67	8.67	20	2	31
		R	18.25	18.24	6.2	6.2	19.36	19.36	8.47	8.48	8.69	8.68			
21	H	L	19.33	19.32	6.36	6.37	19.59	19.57	8.74	8.73	8.87	8.86	18	2	31
		R	19.06	19.06	6.37	6.36	19.65	19.65	8.67	8.66	8.89	8.89			
25	H	L	19.54	19.54	6.28	6.27	19.38	19.39	8.56	8.58	8.76	8.76	18	4	25

		R	19.48	19.48	6.31	6.33	19.55	19.54	8.57	8.56	8.78	8.77			
26	H	L	18.03	18.03	5.81	5.83	18.18	18.22	7.87	7.87	8.5	8.52	18	2	26
		R	17.77	17.79	5.67	5.69	18.08	18.07	7.86	7.88	8.4	8.42			

Family: 11.9-4

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	19.06	19.09	6.12	6.14	19.37	19.41	8.85	8.83	8.52	8.52		3	17
		R	18.85	18.86	6.16	6.17	19.49	19.49	8.76	8.78	8.48	8.5			
2	L	L	18.6	18.61	6.22	6.18	18.25	18.27	8.38	8.35	8.4	8.39		4	27
		R	18.59	18.6	6.12	6.1	18.29	18.31	8.37	8.35	8.44	8.44			
5	L	L	17.69	17.73	5.9	5.9	18.45	18.47	8.2	8.22	8.25	8.25		1	28
		R	17.75	17.76	5.87	5.87	18.57	18.57	8.18	8.18	8.29	8.32			
8	L	L	16.12	16.16	5.78	5.76	18.03	18.04	7.75	7.77	8.08	8.11		3	30
		R	16.01	16.05	5.74	5.73	18.01	18.02	7.76	7.78	8.07	8.1			
9	L	L	18.04	18.04	6.19	6.2	18.15	18.19	8.26	8.29	8.02	8.03		3	29
		R	17.95	17.97	6.23	6.21	18.14	18.18	8.27	8.29	8.2	8.23			
10	L	L	18.3	18.3	6.1	6.12	18.73	18.77	8.87	8.85	8.51	8.5		3	27
		R	18.77	18.77	6.13	6.15	18.73	18.76	8.89	8.89	8.55	8.52			
12	L	L			6.02	6.02	17.48	17.49	8	8	7.85	7.85		3	30
		R			6.05	6.04	17.52	17.54	8.01	8.02	7.84	7.85			
13	L	L	16.08	16.08	5.92	5.92	17.82	17.85	7.7	7.7	7.88	7.9		4	27
		R	16.04	16.05	5.88	5.86	17.81	17.83	7.69	7.67	7.88	7.9			
14	L	L	18.15	18.16	5.81	5.83	18.27	18.3	8.41	8.41	8.35	8.39		2	13
		R	18.07	18.08	5.81	5.81	18.35	18.34	8.39	8.4	8.26	8.26			
22	H	L	20.25	20.24	6.43	6.45	19.12	19.16			8.44	8.46		3	23
		R	19.76	19.76	6.39	6.41	19.02	19.03			8.3	8.3			
26	H	L	20.02	20.03	6.17	6.16	19.58	19.6	8.89	8.88	8.71	8.7		3	26
		R	19.83	19.84	6.06	6.08	19.72	19.71	8.94	8.94	8.92	8.93			

27	H	L	18	18.03	5.86	5.88	18.81	18.85	8.37	8.34	8.4	8.38	1	28
		R	17.91	17.94	5.87	5.87	18.93	18.96	8.36	8.33	8.37	8.38		
29	H	L	19.14	19.15	6.09	6.1	19.54	19.53	8.5	8.52	8.54	8.56	3	31
		R	19.1	19.13	6.09	6.06	19.45	19.43	8.5	8.52	8.41	8.39		
30	H	L	19.6	19.62			19.31	19.35			8.4	8.42		
		R	19.46	19.49			18.98	18.97			8.25	8.25		
32	H	L	19.02	19.05	6.16	6.15	19.52	19.55	8.74	8.71	8.33	8.33	3	19
		R	19.04	19.04	6.17	6.17	19.56	19.56	8.59	8.61	8.33	8.33		
33	H	L	19.67	19.7	6.02	6.01	18.65	18.68	8.75	8.78	8.5	8.48	1	26
		R	19.44	19.48	6.08	6.07	18.67	18.7	8.76	8.76	8.39	8.35		
34	H	L			4.91	4.9	15.47	15.51	5.04	5.08	6.25	6.25	3	21
		R			4.91	4.91	15.48	15.51	5.04	5.06	6.26	6.25		
35	H	L	19.73	19.75	6.29	6.3	19.27	19.3	8.91	8.97	8.76	8.78		33
		R	19.24	19.27	6.28	6.31	19.47	19.5	8.87	8.89	8.75	8.72		

Family: 11.9-5

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	19.55	19.56	6.25	6.26	19.4	19.41	8.8	8.79	8.67	8.69		1	27
		R	19.36	19.37	6.14	6.16	19.5	19.5	8.99	9.01	8.49	8.51			
3	L	L	20.07	20.07	6.06	6.09	19.35	19.31	8.93	8.91	8.52	8.52		3	23
		R	19.76	19.78	6.11	6.09	19.23	19.2	9.03	9.06	8.56	8.55			
4	L	L	17.13	17.13	5.86	5.88	17.93	17.91	7.97	7.99	8.13	8.14		3	34
		R	16.96	16.94	5.89	5.89	17.84	17.81	7.94	7.9	8.14	8.14			
5	L	L	17.94	17.97	6.1	6.08	18.38	18.36	7.8	7.82	8.06	8.09		1	30
		R	17.84	17.86	6.03	6.01	18.35	18.36	7.82	7.83	8.13	8.13			
6	L	L	17.5	17.52	6.12	6.12	18.49	18.48	8.05	8.09	8.22	8.25		3	29
		R	17.45	17.43	6.11	6.13	18.51	18.49	7.87	7.87	8.22	8.23			
9	L	L	18.5	18.51	6.14	6.14	19.26	19.24	8.4	8.36	8.52	8.52		1	20

		R	18.29	18.27	6.13	6.11	19.25	19.25	8.4	8.38	8.52	8.51		
14	L	L	17.74	17.75	6.23	6.22	18.88	18.9	8.04	8.08	8.41	8.4	1	15
		R	17.31	17.33	6.18	6.18	18.95	18.95	7.99	7.95	8.35	8.37		
17	L	L	19.11	19.13	6.14	6.14	19.09	19.11	8.59	8.61	8.56	8.58	3	21
		R	19.04	19.04	6.14	6.14	19.17	19.19	8.71	8.71	8.52	8.51		
21	L	L	14.66	14.65	5.96	5.95	17.44	17.42	6.94	6.96	7.56	7.56	2	18
		R	14.77	14.75	5.94	5.98	17.48	17.49	6.95	6.94	7.57	7.57		
22	L	L	17.5	17.51	6.19	6.18	18.32	18.33	7.92	7.91	8.15	8.13	1	24
		R	17.39	17.39	6.1	6.11	18.26	18.27	7.89	7.91	8.14	8.18		
23	L	L	18.08	18.08	6.12	6.12	18.43	18.45	8.28	8.29	8.14	8.16	4	31
		R	18.11	18.11	6.13	6.13	18.51	18.51	8.29	8.27	8.15	8.16		
24	L	L	19.75	19.74	6.51	6.51	19.53	19.52	8.8	8.79	8.79	8.79	3	32
		R	19.65	19.65	6.52	6.53	19.55	19.53	8.77	8.8	8.78	8.79		
25	L	L	19.53	19.57	6.09	6.09	19.63	19.62	8.66	8.68	8.69	8.7	2	31
		R	19.51	19.53	6.25	6.26	19.79	19.77	8.63	8.63	8.74	8.75		
26	L	L	18.49	18.48	6.09	6.06	18.87	18.91	8.58	8.59	8.33	8.36	4	25
		R	18.42	18.44	6.07	6.09	18.89	18.91	8.46	8.47	8.27	8.28		
30	H	L	18.15	18.14	6.32	6.35	19.24	19.23	8.7	8.73	8.79	8.8	3	22
		R	17.98	18.01	6.3	6.32	19.22	19.22	8.73	8.73	8.65	8.66		
32	H	L	16.04	16.07	5.84	5.84	17.93	17.92	7.51	7.54			3	16
		R	15.75	15.78	5.89	5.85	17.99	17.98	7.37	7.38				
35	H	L	21.05	21.07	6.67	6.64	20.56	20.55	9.24	9.22	8.89	8.91	4	23
		R	20.65	20.65	6.53	6.54	20.33	20.33	9.21	9.24	8.93	8.94		
38	H	L	18.55	18.57	6.13	6.14	19.35	19.38	8.6	8.61	8.52	8.53	4	30
		R	18.52	18.52	6.1	6.12	19.36	19.38	8.66	8.67	8.52	8.54		
39	H	L	20.05	20.05	6.38	6.35	19.51	19.51	8.94	8.94	8.76	8.77	3	25
		R	19.29	19.3	6.47	6.44	19.6	19.6	8.81	8.8	8.77	8.78		

43	H	L	18.04	18.04	5.95	5.95	18.77	18.76	8.2	8.18	8.29	8.28	3	26
		R	17.89	17.91	5.88	5.87	18.79	18.8	8.16	8.16	8.29	8.3		
44	H	L	18.74	18.75	6.09	6.09	19.37	19.38	8.15	8.14	8.25	8.24	1	29
		R	18.74	18.77	6.09	6.11	19.47	19.48	8.19	8.18	8.35	8.36		
45	H	L	19.11	19.13	6.53	6.52	19.82	19.84	8.68	8.64	8.77	8.77	1	25
		R	19.03	19.04	6.55	6.55	19.93	19.91	8.77	8.77	8.77	8.78		
48	H	L	21	21	6.41	6.39	20.93	20.91	9.61	9.58	9.27	9.26	5	27
		R	20.81	20.81	6.46	6.48	20.86	20.83	9.77	9.8	9.28	9.28		
50	H	L	20.66	20.67	6.4	6.41	20.04	20.05	9	9.02	8.93	8.94	2	26
		R	20.33	20.35	6.38	6.38	20.02	20.05	9	9.03	8.88	8.89		
52	H	L	19.49	19.49	6.32	6.36	19.92	19.91	8.68	8.7	8.49	8.49	1	31
		R	19.7	19.67	6.33	6.36	19.81	19.83	8.7	8.68	8.67	8.69		
53	H	L	19.09	19.1	6.41	6.4	19.82	19.82	8.68	8.69	8.55	8.57	3	27
		R	18.51	18.52	6.44	6.43	19.84	19.84	8.7	8.68	8.5	8.52		
55	H	L	20.08	20.09	6.4	6.39	19.71	19.71	9.04	9.05	8.77	8.79	1	36
		R	19.92	19.94	6.41	6.41	19.81	19.79	9.08	9.07	8.77	8.77		

Family: 11.9-7

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	17.2	17.22	5.72	5.7	17.68	17.69	7.48	7.44	7.81	7.81	24	4	23
		R	17.12	17.15	5.7	5.68	17.75	17.75	7.38	7.36	7.88	7.88			
3	L	L	18.85	18.85	6	6.05	18.54	18.55	8.02	8.04	8.37	8.4	28	1	24
		R	18.82	18.84	6.04	6.02	18.52	18.5	8.21	8.21	8.3	8.31			
4	L	L	15.48	15.47	5.73	5.71	17.31	17.34	6.98	7	7.69	7.68	24	4	22
		R	15.44	15.46	5.73	5.74	17.29	17.28	6.85	6.88	7.74	7.75			
5	L	L	16.05	16.06	5.88	5.88	17.64	17.68	6.98	7	7.92	7.9	28	3	11
		R	15.61	15.64	5.8	5.79	17.68	17.65	6.97	7	7.86	7.85			
7	L	L	16.68	16.67	5.73	5.74	17.52	17.52	7.29	7.25	7.7	7.7	28	3	21

		R	16.29	16.32	5.74	5.75	17.51	17.53	7.14	7.16	7.4	7.43			
8	L	L	7.16	7.16	4.39	4.39	13.19	13.2	4.18	4.22	5.69	5.7	22	2	11
		R	7.01	7.01	4.41	4.38	13.16	13.17	4.16	4.2	5.62	5.62			
9	L	L	14.46	14.46	5.51	5.5	16.83	16.87	6.65	6.63	7.37	7.4	26	2	32
		R	14.48	14.47	5.5	5.49	16.81	16.83	6.48	6.64	7.39	7.43			
10	L	L	17.17	17.15	5.84	5.84	17.72	17.74	7.59	7.55	8.01	7.99	26	3	9
		R	16.98	17	5.78	5.76	17.7	17.72	7.56	7.57	8.04	8.03			
11	L	L	19.01	19.02	5.94	5.95	18.2	18.23	8.17	8.19	8.22	8.24	26	3	22
		R	18.88	18.9	5.91	5.88	18.18	18.17	8.17	8.15	8.23	8.27			
14	L	L	15.83	15.83	5.95	5.97	17.65	17.63	7.24	7.21	7.76	7.74	29	2	14
		R	15.64	15.67	5.98	5.97	17.77	17.8	7.22	7.2	7.74	7.73			
15	L	L	17.17	17.21	6	6	17.94	17.95	7.5	7.49	8.04	8.04	26	3	19
		R	17.07	17.11	6.03	6	17.93	17.96	7.4	7.38	8.02	8.01			
16	L	L	15.5	15.53	5.88	5.88	17.55	17.53	7.08	7.05	7.86	7.86	29	2	24
		R	15.41	15.43	5.93	5.92	17.57	17.58	7.06	7.04	7.88	7.87			
17	L	L	17.76	17.78	5.87	5.88	17.98	18.02	7.83	7.8	8.1	8.09	26	3	24
		R	17.69	17.72	5.93	5.93	17.93	17.96	7.83	7.82	8.1	8.12			
18	L	L	15.65	15.65	5.71	5.7	17.17	17.17	6.99	7.01	7.58	7.57	26	3	23
		R	15.59	15.58	5.74	5.75	17.22	17.23	6.97	6.94	7.6	7.56			
22	L	L	16.21	16.21	5.87	5.88	18.32	18.32	7.34	7.35	7.88	7.88	31	1	11
		R	16.11	16.13	5.93	5.94	18.26	18.29	7.34	7.32	7.99	8			
23	L	L	18.95	18.99	6.22	6.21	19.11	19.12	8.45	8.48	8.51	8.52	29	2	23
		R	18.75	18.78	6.15	6.15	19.15	19.18	8.47	8.48	8.52	8.53			
24	L	L	16.26	16.23	5.93	5.93	17.51	17.53	7.31	7.32	7.74	7.72	26	4	24
		R	16.1	16.13	5.92	5.88	17.55	17.54	7.32	7.34	7.74	7.74			
30	L	L	16.61	16.61	5.7	5.74	17.27	17.28	7.21	7.2	7.63	7.64	28	2	25
		R	16.36	16.36	5.71	5.73	17.32	17.32	7.21	7.22	7.5	7.5			

35	H	L	19.63	19.63	6.32	6.31	19.68	19.72	8.86	8.87	8.68	8.68	26	4	23
		R	19.63	19.62	6.31	6.29	19.51	19.51	8.68	8.69	8.69	8.69			
38	H	L	19.35	19.36	6.15	6.13	19.29	19.29	7.98	7.99	8.59	8.57	28	1	23
		R	19.22	19.23	6.13	6.14	19.24	19.26	8.11	8.09	8.55	8.56			
39	H	L			6.32	6.32	19.94	19.93	8.3	8.32	8.66	8.66			28
		R			6.34	6.3	19.83	19.83	8.38	8.4	8.69	8.66			
41	H	L	21.11	21.11	6.48	6.52	20.48	20.47	9.22	9.22	8.99	8.97	28	2	21
		R	20.78	20.8	6.49	6.49	20.58	20.59	9.14	9.14	9.02	9.04			
42	H	L	20.67	20.62	6.23	6.21	19.72	19.72	9.03	8.99	9.01	9	26	3	26
		R	20.24	20.26	6.21	6.2	19.89	19.92	8.79	8.84	9.05	9.06			
43	H	L	20.41	20.46	6.35	6.33	19.63	19.65	8.92	8.91	8.67	8.66	24	4	14
		R	20.21	20.25	6.32	6.32	19.64	19.62	8.9	8.89	8.71	8.71			
44	H	L	19.91	19.9	6.27	6.25	19.77	19.78	8.57	8.56	8.75	8.76	24	4	24
		R	19.44	19.46	6.33	6.36	19.87	19.91	8.45	8.45	8.74	8.73			
45	H	L			6.16	6.17	19.59	19.58	8.74	8.76	8.88	8.87	26	4	19
		R			6.61	6.6	19.87	19.87	8.56	8.57	8.85	8.85			
53	H	L	18.79	18.78	6.11	6.08	18.47	18.51	7.78	7.77	8.37	8.4	26	3	25
		R	18.32	18.33	5.97	6	18.48	18.51	7.97	7.96	8.24	8.25			
54	H	L	20.42	20.43	6.41	6.41	19.43	19.45	9	8.97	8.68	8.68	28	2	25
		R	19.75	19.76	6.41	6.38	19.45	19.44	8.42	8.44	8.6	8.61			
55	H	L	18.87	18.86	6.22	6.21	19.27	19.31	8.69	8.69	8.36	8.37	26	4	28
		R	18.74	18.78	6.31	6.32	19.47	19.43	8.66	8.69	8.41	8.41			
56	H	L	19.27	19.28	6.02	6.04	18.55	18.58	8	7.97	8.39	8.37	23	5	20
		R	19.06	19.04	6	6.04	18.54	18.53	7.96	7.94	8.36	8.35			
57	H	L	20.97	20.98	6.71	6.75	19.94	19.92	8.94	8.94	8.88	8.87	26	2	23
		R	20.74	20.74	6.49	6.5	19.7	19.73	9.12	9.16	8.87	8.88			
58	H	L	19.67	19.68	6.37	6.4	20.03	20.07	8.4	8.42	8.81	8.79	28	1	24

		R	19.5	19.53	6.38	6.38	19.91	19.88	8.54	8.56	8.78	8.76		
Family: 11.9-8														
Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
3	L	L	14.51	14.52	5.63	5.63	16.62	16.61	6.48	6.5	7.48	7.46		2	21
		R	14.36	14.36	5.61	5.61	16.61	16.58	6.47	6.46	7.48	7.46			
5	L	L	17.31	17.32	5.87	5.86	17.72	17.71	7.4	7.38	8.01	8.03			33
		R	17.1	17.12	5.82	5.85	17.67	17.64	7.39	7.42	7.93	7.96			
9	L	L	15.98	15.98	5.67	5.67	17.57	17.57	7.09	7.1	7.7	7.72		2	29
		R	16	16.01	5.81	5.83	17.58	17.58	7.08	7.09	7.81	7.81			
11	L	L	17.3	17.33	5.8	5.8	17.97	17.95	7.7	7.74	8.04	8.02		3	26
		R	17.23	17.24	5.79	5.8	18.02	18	7.71	7.73	8.04	8.04			
12	L	L	16.85	16.86	6.02	6.02	18.01	17.99	7.76	7.76	7.88	7.89		2	24
		R	16.49	16.48	6.13	6.15	18.1	18.08	7.66	7.64	7.95	7.94			
14	L	L	15.27	15.31	5.53	5.54	17.21	17.2	6.95	6.93	7.6	7.6		3	25
		R	15.24	15.26	5.5	5.5	17.2	17.21	6.83	6.83	7.63	7.62			
21	L	L	16.66	16.66	5.8	5.83	17.48	17.48	7.17	7.17	7.7	7.68		3	18
		R	16.47	16.47	5.77	5.79	17.43	17.42	7.15	7.17	7.72	7.72			
23	L	L	15.2	15.22	5.58	5.58	17.11	17.12	6.81	6.82	7.54	7.51		4	27
		R	15.12	15.14	5.51	5.53	17.11	17.11	6.81	6.84	7.51	7.5			
28	H	L	18.78	18.79	6.08	6.1	18.15	18.14	7.98	8	8.09	8.07		3	33
		R	18.6	18.6	6.12	6.1	18.29	18.28	7.97	7.99	8.11	8.12			
29	H	L	19.25	19.25	6.29	6.29	19.16	19.17	8.38	8.37	8.32	8.33		3	26
		R	19.2	19.21	6.31	6.29	19.23	19.26	8.31	8.34	8.34	8.33			
31	H	L	18.63	18.62	6.4	6.39	19.41	19.38	7.79	7.81	8.46	8.47		3	18
		R	18.4	18.36	6.21	6.23	19.19	19.18	7.88	7.87	8.58	8.6			
32	H	L	19.11	19.11	6.22	6.2	19.06	19.07	8.27	8.28	8.58	8.55		3	29
		R	18.84	18.86	6.23	6.21	19.11	19.1	8.25	8.27	8.61	8.62			

34	H	L	19.11	19.11	6.28	6.26	18.85	18.88	8.07	8.07	8.33	8.32	3	31
		R	18.78	18.78	6.28	6.27	18.76	18.74	8.16	8.18	8.19	8.2		
35	H	L	19.45	19.47	6.45	6.44	19.55	19.59	8.78	8.77	8.83	8.82	3	11
		R	19.37	19.37	6.38	6.36	19.57	19.61	8.76	8.74	8.77	8.78		
36	H	L	19.65	19.64	6.3	6.31	19.04	19.03	8.25	8.24	8.67	8.67	3	30
		R	19.44	19.44	6.29	6.26	19.08	19.09	8.24	8.26	8.72	8.72		
38	H	L	19.04	19.06	6.32	6.34	19.22	19.22	8.13	8.15	8.61	8.6	4	34
		R	18.84	18.87	6.35	6.36	19.3	19.28	8.16	8.17	8.58	8.58		
42	H	L	19.27	19.25	6.08	6.07	19.57	19.55	8.27	8.31	8.39	8.41	2	28
		R	19.15	19.12	6.19	6.21	19.48	19.45	8.29	8.3	8.82	8.82		
44	H	L	18.68	18.68	6.02	6.02	18.5	18.5	8.01	8	8.37	8.39	4	25
		R	18.5	18.49	6.03	6.01	18.51	18.52	8.11	8.13	8.3	8.32		
47	H	L	19.6	19.62	6.09	6.07	18.95	18.97	8.24	8.25	8.85	8.86	3	28
		R	19.36	19.38	6.06	6.09	18.92	18.94	8.19	8.22	8.76	8.77		
48	H	L	19.54	19.56	6.26	6.26	19.14	19.14	8.36	8.36	8.47	8.48	2	27
		R	19.33	19.34	6.17	6.19	19.2	19.19	8.27	8.3	8.1	8.14		

Family: 11.9-9

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	18.04	18.02	5.94	5.94	18.71	18.72	8.06	8.07	8.63	8.61		2	13
		R	17.84	17.84	5.97	5.96	18.72	18.7	7.97	8	8.57	8.59			
2	L	L	17.38	17.39	6.07	6.07	18.84	18.85	8.09	8.1	8.39	8.37		3	13
		R	17.2	17.18	6.05	6.07	18.93	18.95	8.02	8	8.39	8.39			
6	L	L	17.45	17.46	5.87	5.87	18.27	18.29	7.76	7.74	8.23	8.23		2	24
		R	17.18	17.17	5.89	5.9	18.37	18.34	7.72	7.72	8.26	8.28			
8	L	L	17.38	17.41	6.05	6.06	18.68	18.69	7.85	7.87	8.39	8.39		5	21
		R	17.36	17.39	6.06	6.04	18.62	18.64	7.85	7.86	8.38	8.37			
13	L	L	18.42	18.43	5.86	5.89	18.28	18.3	7.96	7.97	8.53	8.54		3	16

		R	18.23	18.24	5.87	5.9	18.28	18.29	7.93	7.91	8.53	8.53		
17	L	L	17.52	17.49	5.96	5.97	18.46	18.46	7.9	7.93	8.37	8.37	3	19
		R	17.4	17.39	5.98	5.97	18.69	18.69	7.91	7.87	8.13	8.15		
18	L	L	17.36	17.36	5.95	5.96	17.97	18.01	7.78	7.78	8.16	8.18	2	24
		R	17.33	17.35	5.94	5.9	17.91	17.92	7.77	7.77	8.18	8.19		
19	L	L	15.92	15.9	5.74	5.78	18.08	18.07	7.26	7.23	7.92	7.9	3	18
		R	15.85	15.85	5.72	5.71	17.96	17.94	7.16	7.14	7.92	7.92		
24	L	L	13.9	13.89	5.39	5.41	17.15	17.17	6.78	6.76	7.53	7.53	3	20
		R	13.9	13.86	5.39	5.39	17.11	17.14	6.66	6.64	7.52	7.51		
26	L	L	15.57		5.62	5.6	17.14	17.17	7.1	7.07	7.74	7.76	2	25
		R			5.65	5.63	17.19	17.23	7.07	7.04	7.75	7.75		
27	L	L	16.47	16.49	5.66	5.62	18.04	18.06	7.6	7.58	8.21	8.23	3	17
		R	16.36	16.38	5.66	5.63	17.75	17.76	7.52	7.5	8.12	8.12		
29	L	L	16.26	16.26	5.75	5.73	17.52	17.56	7.26	7.22	7.95	7.95	4	9
		R	15.87	15.9	5.73	5.73	17.7	17.69	7.12	7.16	7.37	7.37		
31	L	L	17.66	17.64	5.87	5.86	17.73	17.75	7.79	7.78	8.02	8.02	2	20
		R	17.48	17.52	5.77	5.77	17.77	17.77	7.75	7.77	7.89	7.88		
32	L	L	16.53	16.52	5.81	5.82	18.02	18.01	7.23	7.24	8.17	8.17	3	17
		R	16.18	16.21	5.84	5.83	17.98	17.95	7.18	7.18	8.09	8.1		
33	L	L	17.5	17.49	6.04	6.02	18.62	18.64	8.11	8.07	8.33	8.34	2	18
		R	17.87	17.88	5.75	5.77	18.56	18.55	8.17	8.21	7.98	7.97		
38	H	L	19.69	19.66	6.4	6.36			8.7	8.71	8.96	8.94	4	12
		R	19.25	19.29	6.4	6.36			8.71	8.69	8.86	8.86		
40	H	L	18.72	18.73	6.23	6.21	19.82	19.84	8.54	8.55	8.79	8.79	3	19
		R	18.86	18.87	6.22	6.21	19.88	19.92	8.56	8.58	8.68	8.68		
41	H	L	16.91	16.92	6.1	6.11	18.41	18.41	7.91	7.93	8.39	8.38	2	19
		R	17.1	17.1	6.12	6.13	18.53	18.56	7.89	7.9	8.44	8.45		

43	H	L	20.15	20.15	6.18	6.18	19.72	19.75	8.9	8.9	9.01	9.04	2	20
		R	19.74	19.78	6.15	6.19	19.78	19.77	9.08	9.11	8.81	8.85		
47	H	L	20.34	20.36	6.6	6.57	20.17	20.17	9.14	9.14	9.12	9.13	4	25
		R	20.16	20.17	6.59	6.58	20.24	20.25	9.14	9.14	9.13	9.13		
48	H	L	18.16	18.17	6.08	6.09	18.73	18.75	8.46	8.44	8.58	8.6	2	20
		R	18.1	18.11	6.14	6.13	19.05	19.03	8.35	8.39	8.51	8.49		
49	H	L	19.13	19.12	6.15	6.14	19.3	19.3	8.13	8.14	8.8	8.8	3	10
		R	18.8	18.81	6.16	6.13	19.37	19.36	8.39	8.39	8.98	8.98		
53	H	L	18.97	18.98	6.3	6.3	19.41	19.45	8.64	8.63	8.95	8.97	4	17
		R	18.97	18.96	6.34	6.34	19.56	19.58	8.51	8.55	8.63	8.64		
54	H	L	18.34	18.34	6.21	6.19	19.06	19.08	8.42	8.39	8.53	8.52	3	17
		R	18.11	18.13	6.21	6.17	18.74	18.72	8.42	8.44	8.37	8.35		
57	H	L	17.15	17.17	5.94	5.95	18.55	18.57	8.15	8.16	8.48	8.47	2	19
		R	17.06	17.07	5.91	5.87	18.59	18.61	8.2	8.21	8.43	8.43		
59	H	L	16.72	16.73	5.9	5.87	19.18	19.21	7.73	7.71	8.39	8.37	3	13
		R	16.81	16.84	5.95	5.93	19.22	19.22	8	7.97	8.21	8.23		
61	H	L	17	17.01	6.14	6.17	19.27	19.26	8.13	8.14	8.55	8.56	2	15
		R	16.49	16.5	6.07	6.07	18.94	18.94	8.07	8.08	8.68	8.72		
62	H	L	17.63	17.63	6.1	6.13	19.08	19.12	8.46	8.48	8.57	8.57	2	21
		R	17.39	17.42	6.1	6.11	19.27	19.31	8.43	8.46	8.53	8.54		
65	H	L	18.01	18.02	6.14	6.13	18.5	18.48	8.18	8.17	8.57	8.57	3	25
		R	17.74	17.75	6.08	6.08	18.45	18.44	8.05	8.07	8.6	8.63		
67	H	L	19.17	19.18	6.36	6.36			8.66	8.64	8.69	8.7	2	11
		R	19.01	19	6.38	6.39			8.69	8.67	8.75	8.75		

Family: 11.9-10

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
4	L	L	15.94	15.93	5.94	5.92	17.32	17.35	7.15	7.16	7.63	7.65	20	3	11

		R	15.77	15.77	5.78	5.76	17.32	17.32	7.18	7.14	7.25	7.24			
6	L	L	13.6	13.62	5.69	5.67	16.39	16.39	6.4	6.4	7.36	7.34	20	3	21
		R	13.79	13.8	5.7	5.67	16.32	16.31	6.4	6.38	7.36	7.34			
15	L	L	15.88	15.86	5.71	5.72	16.97	16.95	7.18	7.21	7.7	7.7	22	2	23
		R	15.78	15.77	5.68	5.67	17.02	16.99	7	7	7.76	7.75			
18	L	L	17.07	17.04	5.95	5.93	17.97	17.95	7.52	7.54	7.97	7.95	17	3	25
		R	16.81	16.81	5.98	5.93	17.93	17.92	7.52	7.54	8.18	8.19			
22	H	L	16.9	16.9	5.76	5.76	17.07	17.05	7.33	7.35	7.87	7.89	23	2	23
		R	16.85	16.84	5.77	5.78	17.09	17.08	7.22	7.21	7.96	7.97			
25	H	L	17.79	17.77	6.08	6.05	18.4	18.37	7.5	7.51	8.12	8.12	20	2	27
		R	17.68	17.7	6.09	6.07	18.41	18.42	7.56	7.55	7.98	7.95			
27	H	L	16.75	16.74	5.91	5.93	18.27	18.27	7.42	7.44	8.14	8.14	20	3	31
		R	16.04	16.03	5.69	5.66	18.28	18.25	7.44	7.46	8.07	8.05			
32	H	L	15.57	15.54	5.65	5.64	17.31	17.27	6.91	6.93	7.75	7.77	20	3	31
		R	15.67	15.63	5.68	5.65	17.35	17.33	6.93	6.91	7.62	7.58			
37	H	L	15.59	15.56	5.57	5.56	17.36	17.35	7.03	7.03	7.39	7.39	22	3	19
		R	15.13	15.12	5.58	5.59	17.43	17.4	6.97	6.95	7.79	7.8			
39	H	L	16.91	16.9	5.77	5.76	18.16	18.16	7.65	7.64	7.71	7.72	20	3	27
		R	16.98	17.02	5.93	5.95	18.14	18.13	7.62	7.62	7.43	7.42			
40	H	L	19.1	19.08	6.16	6.14	18.44	18.46	8.22	8.21	8.43	8.42	22	2	26
		R	18.65	18.67	6.18	6.21	18.58	18.56	8.3	8.31	8.37	8.37			
41	H	L	16.23	16.21	5.83	5.83	18.01	18	7.42	7.4	8.01	7.99	23	3	21
		R	16.5	16.47	5.82	5.81	18.18	18.16	7.53	7.55	8.23	8.23			

Family: 11.9-11

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	12.33	12.35	5.31	5.31	16.08	16.07	6.05	6.03	7.32	7.32	23	2	24
		R	12.21	12.21	5.31	5.3	16.1	16.08	6.06	6.05	7.28	7.27			

3	L	L	18.01	18	6.05	6.06	18.38	18.38	7.7	7.71	8.31	8.3	19		
		R	18.16	18.16	6.06	6.02	18.57	18.57	7.77	7.76	8.39	8.4			
5	L	L	15.96	15.96	5.82	5.82	17.56	17.57	7.38	7.38	7.83	7.84	19		
		R	15.94	15.95	5.9	5.86	17.69	17.7	7.24	7.24	8.09	8.11			
8	L	L			5.82	5.81	17.81	17.8	7.28	7.3	8.16	8.14	19	3	21
		R			5.86	5.86	17.84	17.82	7.19	7.17	8.2	8.21			
9	L	L	12.19	12.2	5.44	5.45	16.43	16.45	5.99	6.01	7.44	7.47	22	2	21
		R	11.94	11.94	5.41	5.4	16.43	16.44	6	6.02	7.34	7.33			
12	L	L	14.95	14.94	5.62	5.63	17.31	17.28	6.64	6.67	7.69	7.73	21	2	23
		R	14.72	14.7	5.68	5.67	17.35	17.34	6.63	6.64	7.71	7.7			
14	L	L	14.25	14.25	5.63	5.62	17.21	17.18	6.74	6.75	7.9	7.91	18	3	19
		R	14.11	14.09	5.65	5.66	17.17	17.15	6.72	6.75	7.9	7.91			
15	L	L	16.51	16.5	5.99	5.99	17.92	17.93	7.4	7.39	7.7	7.69	21	2	27
		R	16.41	16.42	6.06	6.03	17.94	17.93	7.46	7.47	7.65	7.64			
17	L	L	17.73	17.71	6.11	6.11	18.11	18.08	7.89	7.9	8.4	8.42	19	3	12
		R	17.63	17.63	6.11	6.12	18.18	18.15	7.89	7.92	8.21	8.25			
22	L	L	15.09	15.1	5.79	5.75	17.79	17.8	7.15	7.15	7.86	7.84	19	3	26
		R	15.09	15.08	5.79	5.77	17.82	17.81	7	6.99	7.75	7.75			
23	L	L	17.53	17.52	6.28	6.27	18.34	18.35	7.63	7.62	8.32	8.31	19		
		R	17.27	17.28	6.27	6.28	18.51	18.49	7.41	7.45	8.42	8.42			
24	L	L	16.55	16.54	6.14	6.12	17.98	17.95	7.54	7.53	8.39	8.37	18	3	27
		R	16.28	16.28	6.1	6.07	18.07	18.06	7.58	7.58	8.22	8.2			
25	L	L	17.06	17.04	6.01	6	18.35	18.36	7.64	7.6	8.32	8.33	18	3	27
		R	17.04	17.04	5.9	5.91	18.38	18.4	7.59	7.59	8.12	8.1			
26	L	L	17.98	18	6.12	6.13	18.23	18.23	8.16	8.12	7.7	7.73	19	4	29
		R	18.15	18.14	6.12	6.15	18.4	18.37	7.94	7.94	8.16	8.18			
27	L	L	18.04	18.03	6.14	6.13	18.69	18.67	8.06	8.08	8.44	8.44	19	3	27

		R	17.97	17.98	6.11	6.09	18.63	18.63	8.1	8.14	8.44	8.44			
29	L	L	15.67	15.66	5.78	5.76	17.21	17.2	7.26	7.28	7.99	8.01	22	3	23
		R	15.64	15.63	5.76	5.8	17.19	17.17	7.18	7.16	8.02	8.01			
30	L	L	14.7	14.7	5.4	5.39	17.18	17.18	7.17	7.16	7.4	7.43			
		R	14.86	14.84	5.74	5.73	17.32	17.32	7.01	6.98	7.72	7.75			
31	L	L	16.15	16.15	5.76	5.76	17.4	17.38	7.25	7.28	8.09	8.09	21	2	25
		R	15.98	15.96	5.73	5.74	17.48	17.49	7.26	7.28	8.1	8.12			
32	H	L	17.51	17.49	6.03	6.05	18.02	18.03	7.77	7.77	8.31	8.33	22	2	21
		R	17.43	17.45	6.04	6.02	17.89	17.89	7.77	7.76	8.34	8.37			
33	H	L	13.34	13.38	5.51	5.51	16.65	16.64	6.46	6.45	7.52	7.55	21	2	21
		R	13.23	13.24	5.5	5.5	16.66	16.63	6.34	6.38	7.53	7.53			
34	H	L			5.98	5.98	17.98	18.01	7.96	7.95	8.29	8.3	19	2	15
		R			5.99	6.01	18.01	18.01	7.95	7.98	8.29	8.29			
35	H	L	17.5	17.52	6.05	6.08	18.04	18.03	7.59	7.6	8.33	8.34	19	2	29
		R	17.15	17.15	5.93	5.97	18.01	18.01	7.52	7.51	8.08	8.11			
36	H	L	16.62	16.63	5.88	5.88	18.28	18.27	7.56	7.57	8.19	8.18	19	2	33
		R	16.4	16.42	5.87	5.89	18.27	18.31	7.43	7.45	8.05	8.07			
38	H	L	18.54	18.55	6.24	6.25	18.65	18.65	8.05	8.05	8.56	8.59	15	4	31
		R	18.35	18.37	6.17	6.15	18.77	18.75	8.08	8.05	8.48	8.47			
39	H	L			5.96	5.95	18.15	18.18	8.2	8.24	8.43	8.43	19	3	23
		R			5.99	5.96	18.44	18.4	7.98	8	8.5	8.5			
40	H	L	16.16	16.16	5.89	5.9	17.88	17.86	7.27	7.3	7.88	7.88	21	1	24
		R	16.14	16.17	5.78	5.75	17.9	17.88	7.22	7.25	7.92	7.94			
41	H	L	19.4	19.42	6.48	6.48	19.31	19.31	8.54	8.58	8.79	8.79	19	3	22
		R	19.26	19.28	6.38	6.39	19.19	19.2	8.23	8.27	8.41	8.41			
43	H	L	18.57	18.57	6.12	6.09	18.45	18.48	8.01	8.02	8.46	8.47	18	3	21
		R	18.19	18.17	5.99	5.97	18.24	18.26	7.98	7.94	8.46	8.45			

44	H	L	16.72	16.7	6.02	6.02	18.4	18.36	7.35	7.35	8.18	8.18	19	3	19
		R	16.48	16.47	5.95	5.94	18.27	18.29	7.33	7.33	8.18	8.19			
48	H	L	21.08	21.09	6.98	6.99	20.53	20.53	9.24	9.24	9.14	9.15	19	3	11
		R	20.6	20.62	6.98	6.98	20.54	20.55	9.39	9.38	9.15	9.18			
50	H	L	15.41	15.41	5.71	5.72	17.4	17.4	6.95	6.97	7.92	7.91	17	2	35
		R	15.58	15.59	5.71	5.73	17.59	17.55	6.71	6.71	7.7	7.71			
51	H	L	16.17	16.17	6.1	6.08	18.23	18.21	7.17	7.15	8.26	8.26	18	4	25
		R	16.2	16.2	5.97	5.95	18.24	18.22	7.19	7.18	8.23	8.25			
54	H	L	17.85	17.83	5.95	5.94	18.44	18.45	7.63	7.6	8.3	8.27	19	3	28
		R	17.56	17.56	5.94	5.95	18.27	18.27	7.67	7.7	8.38	8.4			
60	H	L	17.78	17.77	5.98	5.96	19.15	19.14	8.04	8	8.42	8.43	17	2	26
		R	17.87	17.89	5.99	6.02	19.19	19.2	7.71	7.69	8.45	8.45			
61	H	L	16.34	16.34	5.89	5.9	18.24	18.26	7.63	7.66	8.04	8.08	19	3	22
		R	16.59	16.62	5.9	5.88	18.35	18.34	7.63	7.62	8.05	8.07			

Family: 11.9-12

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
2	L	L	18.25	18.26	6.27	6.28	18.28	18.28	7.85	7.85	8.38	8.4	19	3	24
		R	18.25	18.27	6.31	6.32	18.31	18.33	7.9	7.87	8.27	8.29			
10	L	L	14.29	14.28	5.66	5.63	17.01	17.02	6.61	6.61	7.49	7.49	22	2	28
		R	14.16	14.18	5.89	5.91	16.99	17	6.57	6.59	7.5	7.5			
13	L	L	16.38	16.4	5.89	5.9	17.62	17.62	7.37	7.39	7.88	7.9	19	4	29
		R	16.33	16.34	5.9	5.9	17.61	17.62	7.39	7.38	7.85	7.87			
17	L	L	14.64	14.66	5.71	5.72	17.58	17.59	6.77	6.79	7.51	7.52	21	2	25
		R	14.29	14.28	5.69	5.7	17.48	17.45	6.7	6.72	7.55	7.56			
18	L	L	15.23	15.22	5.98	5.96	17.58	17.59	7.31	7.31	7.79	7.81	19		
		R	15.2	15.18	6	6	17.54	17.57	7.3	7.3	7.98	8			
20	L	L	15.95	15.98	5.74	5.76	17.18	17.19	7.16	7.17	7.71	7.73	21	2	30

		R	15.7	15.7	5.75	5.75	17.14	17.18	7.13	7.13	7.71	7.72			
24	H	L	19.55	19.55	6.31	6.34	19.21	19.2	8.56	8.53	8.67	8.67	17	2	28
		R	19.33	19.34	6.24	6.21	19.15	19.16	8.55	8.52	8.65	8.65			
29	H	L	17.96	17.97	6.1	6.1	18.56	18.54	7.84	7.86	8.1	8.1	19	3	26
		R	17.82	17.82	6.07	6.07	18.55	18.52	7.72	7.76	7.96	7.97			
33	H	L	17.28	17.29	5.95	5.95	18.01	18.05	7.86	7.86	7.93	7.96	19	3	26
		R	17.43	17.44	6.04	6.05	18.27	18.29	7.71	7.71	8.16	8.18			
38	H	L	16.62	16.64	5.95	5.96	17.85	17.88	7.43	7.41	7.98	7.98	19	2	21
		R	16.62	16.61	5.97	5.96	17.83	17.81	7.31	7.3	7.99	8.01			
39	H	L	16.5	16.53	6.18	6.19	17.68	17.69	7.81	7.82	7.99	8	19	3	32
		R	16.56	16.58	6.08	6.06	17.77	17.78	7.88	7.86	8.24	8.23			

Family: 11.9-14

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	17.13	17.14	6.03	6	17.93	17.92	7.74	7.75	8.1	8.1	21	2	11
		R	16.88	16.87	6.03	6.02	17.99	17.98	7.69	7.69	8.05	8.07			
3	L	L	15.99	16.01	5.9	5.91	17.86	17.84	7.33	7.32	7.64	7.64	22	2	26
		R	15.96	15.99	5.76	5.76	17.99	17.96	7.38	7.35	7.32	7.34			
4	L	L	15.15	15.19	5.66	5.67	17.31	17.34	7.05	7.08	7.5	7.53	21	2	24
		R	15.53	15.54	5.68	5.68	17.34	17.32	7.01	7	7.62	7.62			
5	L	L	15.13	15.11	5.77	5.75	16.94	16.93	7.13	7.1	7.63	7.62	21	2	27
		R	15.05	15.01	5.78	5.76	17.02	17.02	7.03	7.06	7.67	7.67			
6	L	L	17.15	17.17	6.06	6.09	18	17.98	7.73	7.75	8.11	8.13	19	3	27
		R	16.94	16.97	6	6.02	18.17	18.15	7.77	7.75	8.1	8.11			
8	L	L	16.11	16.14	5.94	5.92	17.38	17.35	7.17	7.15	7.8	7.78	21	3	16
		R	15.93	15.93	5.92	5.91	17.52	17.5	7.08	7.09	7.77	7.76			
9	L	L	17.57	17.57	6	6	17.73	17.73	7.64	7.66	7.99	7.99	19	4	29
		R	17.32	17.32	5.99	5.96	17.68	17.71	7.64	7.67	7.97	7.98			

10	L	L	13.97	13.98	5.5	5.47	16.31	16.32	6.63	6.61	7.24	7.24	19	3	25
		R	13.64	13.62	5.41	5.39	16.32	16.3	6.67	6.66	7.21	7.22			
12	L	L	12.08	12.07	5.67	5.67	16.37	16.37	5.9	5.88	7.14	7.14	27		
		R	12.24	12.23	5.59	5.57	16.34	16.38	6.03	6.01	6.76	6.79			
13	L	L	18.49	18.52	6.11	6.07	18.76	18.75	8.11	8.12	8.23	8.24			
		R	18.24	18.27	6.07	6.06	18.66	18.69	8.12	8.1	8.27	8.29			
15	H	L	19.51	19.51	6.02	6.03	19.22	19.18	8.69	8.7	8.69	8.69	19	2	10
		R	19.19	19.19	6.02	6.02	19.19	19.21	8.66	8.64	8.68	8.69			
17	H	L	18.66	18.66	6.32	6.34	18.89	18.89	8.48	8.5	8.38	8.38	21	2	28
		R	18.66	18.67	6.34	6.35	18.92	18.9	8.45	8.49	8.44	8.46			
18	H	L	17.53	17.52	5.84	5.88	18.08	18.09	7.86	7.87	8.05	8.06	21	2	26
		R	17.33	17.37	5.79	5.82	18.08	18.08	7.81	7.79	8.06	8.06			
21	H	L	19.34	19.34	6.34	6.34	19.01	19.03	8.32	8.3	8.4	8.42	19	3	28
		R	19.05	19.08	6.37	6.37	18.94	18.97	8.36	8.37	8.38	8.4			

Family: 11.9-15

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	18.5	18.5	6.21	6.2	18.97	18.98	8.28	8.3	8.61	8.63	23	1	25
		R	17.72	17.74	6.29	6.28	18.88	18.87	8.1	8.11	8.61	8.61			
2	L	L	17.8	17.79	6.16	6.14	18.49	18.51	7.96	7.97	8.14	8.16	20	3	27
		R	17.47	17.46	6.11	6.11	18.4	18.41	7.96	7.99	8.12	8.12			
11	L	L	17.25	17.24	6.19	6.17	18.62	18.63	8.03	8.03	8.13	8.14	20	3	24
		R	17	17	6.18	6.16	18.69	18.69	8.02	8.01	8.13	8.13			
12	L	L	17.23	17.24	5.86	5.86	18.04	18.05	7.6	7.62	8.07	8.08	20	3	25
		R	16.91	16.9	5.86	5.89	18.07	18.04	7.46	7.44	7.99	8.01			
15	L	L	16.95	16.95	5.82	5.81	17.79	17.79	7.75	7.72	8.11	8.09	21	2	21
		R	16.75	16.75	5.92	5.96	17.89	17.9	7.7	7.7	8.12	8.1			
16	L	L	17.05	17.07	6.2	6.18	18.34	18.36	7.69	7.7	8.04	8.04	19	4	21

		R	16.89	16.89	6.2	6.19	18.35	18.34	7.7	7.7	7.95	7.93			
17	L	L	15.67	15.67	5.92	5.92	17.83	17.86	7.31	7.34	7.68	7.71	20		
		R	15.64	15.66	5.95	5.95	17.83	17.84	7.08	7.12	7.71	7.71			
18	L	L	16.1	16.12	6.06	6.07	17.84	17.84	7.68	7.68	7.86	7.85	19	2	22
		R	16.1	16.11	6.07	6.06	17.83	17.84	7.53	7.53	7.88	7.86			
23	H	L	18.86	18.85	6.3	6.32	19.22	19.2	8.46	8.43	8.68	8.7	19	4	28
		R	18.54	18.54	6.2	6.21	19.14	19.13	8.52	8.52	8.72	8.72			
25	H	L	16.99	16.97	5.95	5.93	18.21	18.21	7.71	7.69	8.07	8.05	21	1	30
		R	16.84	16.85	6.02	6.04	18.25	18.23	7.69	7.66	8.04	8.06			
28	H	L	17.15	17.14	6	6	18.71	18.72	7.65	7.66	8.4	8.4	23	1	19
		R	17.2	17.18	5.96	5.94	18.67	18.68	7.7	7.73	8.3	8.29			
32	H	L	19.44	19.43	6.34	6.34	19.17	19.17	8.69	8.71	8.67	8.63	20	3	27
		R	19.32	19.32	6.32	6.31	19.19	19.2	8.71	8.7	8.66	8.65			
33	H	L	19.13	19.11	6.31	6.31	19.38	19.35	8.41	8.41	8.47	8.46	19	4	21
		R	18.75	18.77	6.26	6.25	19.23	19.23	8.5	8.51	8.46	8.47			
35	H	L	17.62	17.62	6.01	6.02	18.47	18.46	7.86	7.85	8.01	8.02	19	2	27
		R	17.5	17.5	6	5.99	18.52	18.5	7.88	7.9	8.02	8.02			
39	H	L			6.12	6.1	19.33	19.32	8.39	8.4	8.59	8.61	20	4	19
		R			6.1	6.1	19.22	19.23	8.43	8.47	8.19	8.2			

Family: 11.9-16

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	13.8	13.8	5.34	5.37	16.31	16.32	6.49	6.5	7.33	7.32	21	2	23
		R	13.52	13.56	5.48	5.46	16.41	16.42	6.55	6.55	7.08	7.08			
3	L	L	12.2	12.18	5.13	5.15	15.29	15.29	5.92	5.88	6.89	6.89	23	3	18
		R	11.95	11.94	5.12	5.14	15.31	15.33	5.9	5.87	6.9	6.92			
5	L	L	13.48	13.47	5.27	5.27	16.05	16.05	6.45	6.47	7.18	7.16	23	3	17
		R	13.27	13.29	5.3	5.27	16.15	16.17	6.42	6.39	7.21	7.24			

7	L	L	18.04	18.05	6.18	6.17	18.38	18.41	7.95	7.99	7.89	7.9	20	2	20
		R	17.69	17.7	6.2	6.17	18.59	18.57	7.99	8.02	8.2	8.23			
8	L	L	13.66	13.63	5.29	5.31	15.69	15.68	6.28	6.27	7.14	7.14	20	2	23
		R	13.4	13.37	5.3	5.26	15.8	15.77	6.24	6.28	7.19	7.18			
11	L	L	12.88	12.88	5.27	5.29	16.24	16.25	6.2	6.23	6.97	6.99	20	2	9
		R	12.65	12.63	5.3	5.28	16.24	16.25	6.45	6.46	6.92	6.94			
12	L	L	16.81	16.81	6.23	6.23	17.93	17.91	7.56	7.6	8.08	8.05	21	3	19
		R	16.65	16.67	6.2	6.18	18.03	18.01	7.5	7.53	8.06	8.07			
14	L	L	18.06	18.05	6.03	6.03	18.36	18.34	8.04	8.06	8.1	8.08	21	2	25
		R	17.78	17.78	6.01	5.98	18.38	18.37	7.95	7.92	8.09	8.09			
17	L	L	15.84	15.84	5.79	5.79	17.46	17.45	7.3	7.3	7.74	7.73	20	2	28
		R	15.4	15.4	5.81	5.8	17.51	17.52	7.33	7.34	7.76	7.74			
16	L	L	16.17	16.18	5.88	5.9	17.92	17.94	7.51	7.5	7.88	7.87	20	4	19
		R	16.01	16.01	5.92	5.9	17.96	17.96	7.5	7.5	7.86	7.85			
19	L	L	15.71	15.68	5.82	5.83	17.77	17.76	7.18	7.18	7.38	7.36	21	2	21
		R	15.43	15.45	5.81	5.84	17.76	17.77	7.17	7.17	7.48	7.47			
22	L	L	17.67	17.67	5.88	5.87	18	17.99	7.74	7.75	8.15	8.14	20	2	22
		R	17.52	17.53	5.92	5.9	18.02	18.03	7.73	7.76	8.16	8.16			
25	H	L	16.59	16.58	5.97	5.98	18.62	18.6	7.5	7.5			21	3	26
		R	16.59	16.59	6.03	6	18.62	18.62	7.47	7.49					
27	H	L	19.43	19.44	6.31	6.3	19.25	19.26	8.4	8.43	8.18	8.19	20	2	25
		R	19.1	19.1	6.31	6.31	19.27	19.29	8.4	8.42	8.34	8.33			
30	H	L	17.47	17.46	5.89	5.86	18.09	18.08	7.75	7.78	7.83	7.81	20	3	29
		R	17.23	17.23	5.87	5.91	18.09	18.09	7.62	7.63	8.07	8.07			
32	H	L	19.69	19.7	6.35	6.39	19.4	19.39	8.4	8.41	8.64	8.64	21	2	26
		R	19.42	19.41	6.38	6.41	19.45	19.44	8.51	8.5	8.67	8.68			
33	H	L	18.28	18.27	6.01	5.98	18.36	18.34	8.02	8.04	8.28	8.31	20	2	23

		R	18.11	18.13	5.93	5.93	18.35	18.39	8.03	8.06	8.32	8.33			
34	H	L	17.51	17.49	6.01	6.01	18.35	18.38	8.01	7.99	8.28	8.28	20	3	25
		R	17.21	17.21	5.91	5.9	18.54	18.53	7.91	7.89	8.28	8.29			
38	H	L	19.34	19.35	6.19	6.18	19.3	19.27	8.43	8.41	8.83	8.81	19	3	22
		R	19.15	19.17	6.31	6.3	19.4	19.41	8.42	8.42	8.82	8.8			
43	H	L	16.4	16.4	5.76	5.76	17.75	17.76	7.42	7.4	7.99	8.01	22	2	27
		R	16.31	16.32	5.74	5.73	17.85	17.85	7.33	7.37	8.03	8.06			
44	H	L	17.35	17.34	6.27	6.27	18.73	18.75	7.9	7.89	8.22	8.2	21	1	22
		R	17.22	17.21	6.29	6.28	18.74	18.75	7.85	7.84	8.33	8.31			
45	H	L	15.35	15.38	5.79	5.79	17.51	17.51	6.91	6.92	7.65	7.64	19	3	25
		R	15.21	15.23	5.79	5.8	17.58	17.54	6.93	6.95	7.66	7.63			
4	L	L											19	3	26
		R													
28	H	L											20	2	32
		R													
36	H	L											22	2	25
		R													

Family: 11.9-20

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
5	L	L	10.24	10.24	5.07	5.07	15.33	15.33	5.49	5.5	6.62	6.63		2	20
		R	10.17	10.14	5.02	5.01	15.34	15.34	5.53	5.55	6.66	6.67			
6	L	L	12.69	12.7	5.27	5.3	16.26	16.25	6.26	6.27	7.14	7.15		2	25
		R	12.43	12.4	5.31	5.31	16.19	16.2	6.27	6.27	7.08	7.08			
8	L	L	13.49	13.47	5.41	5.44	16.3	16.29	6.26	6.27	7.06	7.04		2	21
		R	13.14	13.15	5.4	5.41	16.4	16.43	6.27	6.28	7.04	7.04			
10	L	L	10.66	10.68	5.25	5.25	15.75	15.71	5.73	5.72	6.64	6.64		3	25
		R	10.64	10.61	5.23	5.21	15.86	15.82	5.71	5.69	6.88	6.88			

11	L	L	13	12.99	5.41	5.42	16.22	16.23	6.33	6.3	7.06	7.05	2	24
		R	12.83	12.84	5.4	5.36	16.21	16.22	6.42	6.45	7.12	7.13		
13	L	L	11.29	11.27	5.1	5.09	15.2	15.2	5.64	5.64	6.72	6.7	2	39
		R	11.17	11.16	5.11	5.09	15.25	15.22	5.65	5.65	6.75	6.73		
15	L	L	12.17	12.13	5.39	5.4	16	16.01	6.05	6.08	6.99	6.98	3	27
		R	11.78	11.76	5.04	5.04	15.78	15.77	6.17	6.18	6.24	6.22		
26	H	L	16.72	16.7	5.91	5.9	18.12	18.14	7.58	7.62	7.95	7.97	3	30
		R	16.48	16.47	5.76	5.75	18.1	18.08	7.56	7.55	7.98	7.98		
29	H	L	13.39	13.39	5.44	5.47	16.73	16.71	6.49	6.48	7.29	7.31	2	25
		R	13.19	13.2	5.36	5.38	16.64	16.68	6.5	6.47	7.23	7.22		
32	H	L	17.72	17.71	5.73	5.73			7.74	7.73	8.09	8.08	3	12
		R	17.99	17.99	5.86	5.88			7.94	7.9	8.24	8.21		
33	H	L	14.8	14.81	5.58	5.57	17.26	17.24	6.72	6.69	7.25	7.25	2	17
		R	14.69	14.66	5.68	5.66	17.29	17.28	6.69	6.67	7.62	7.63		
34	H	L	17.42	17.42	6.05	6.07	18.72	18.7	7.88	7.85	8.46	8.49	3	28
		R	17.55	17.54	5.97	6	18.85	18.87	7.96	7.98	8.49	8.49		
39	H	L	15.39	15.39	5.89	5.92	18	18.01	7.12	7.1	7.85	7.86	3	23
		R	15.24	15.27	5.72	5.7	17.84	17.86	7.25	7.23	7.9	7.9		
42	H	L	16.02	16.03	5.7	5.71	17.45	17.47	7.38	7.4	7.68	7.67	2	30
		R	15.75	15.75	5.69	5.68	17.46	17.48	7.36	7.36	7.72	7.72		
43	H	L	15.08	15.07	5.95	5.93			6.96	6.96	7.87	7.87	2	16
		R	14.82	14.86	5.93	5.91			7.01	6.98	7.96	7.96		

Family: 11.9-24

Number	Treatment	Side	Mandible		Thorax		Elytra		Head		Leg		Larval	Pupae	Adult
1	L	L	12.52	12.51	5.18	5.19	15.98	15.96	6.2	6.22	6.94	6.96		2	20
		R	12.18	12.14	5.09	5.06	15.97	15.96	6.23	6.24	6.85	6.89			
3	L	L	12.11	12.09	5.18	5.18	15.65	15.62	5.85	5.81	6.97	6.97			

		R	11.82	11.84	5.2	5.2	15.68	15.7	5.91	5.93	6.97	6.94		
4	L	L	13.83	13.82	5.55	5.55	16.95	16.98	6.64	6.62	7.29	7.32	3	22
		R	13.51	13.49	5.45	5.44	16.85	16.89	6.82	6.79	7.03	7.01		
6	L	L	13.18	13.19	5.34	5.34	16.41	16.41	6.43	6.45	7.23	7.22	3	22
		R	13.22	13.18	5.42	5.4	16.39	16.43	6.45	6.42	7.29	7.28		
8	L	L	11.77	11.77	5.43	5.4	16.13	16.17	6.01	6.01	7.11	7.09		
		R	11.71	11.72	5.4	5.38	16.19	16.18	6.05	6.08	7.02	7.02		
9	L	L	14.6	14.61	5.47	5.48	17.05	17.06	6.72	6.74	7.46	7.46	2	23
		R	14.58	14.56	5.46	5.44	17.15	17.16	6.62	6.63	7.54	7.54		
10	L	L	12.36	12.38	5.36	5.38	16	16	6.18	6.18	7.03	7.04	2	19
		R	12.11	12.1	5.24	5.24	16.11	16.13	6.21	6.19	7.12	7.11		
11	L	L	13.34	13.37	5.44	5.44	16.64	16.61	6.46	6.48	7.26	7.29	2	31
		R	13.36	13.37	5.46	5.46	16.72	16.71	6.52	6.48	7.35	7.37		
12	L	L	13.95	13.94	5.51	5.49	16.97	16.98	6.5	6.5	7.39	7.39	2	20
		R	14.02	14.01	5.41	5.39	16.85	16.86	6.52	6.56	7.3	7.32		
13	L	L	15.11	15.09	5.66	5.67	17.14	17.15	6.78	6.78	7.47	7.45	2	18
		R	15.11	15.09	5.68	5.66	17.12	17.12	6.76	6.75	7.3	7.32		
14	L	L	12.45	12.47	5.45	5.44	16.74	16.73	6.1	6.07	7.15	7.13	3	20
		R	12.41	12.41	5.44	5.44	16.61	16.64	6.14	6.1	7.11	7.14		
17	L	L	12.73	12.74	5.43	5.42	16.43	16.43	6.27	6.25	7.04	7.03	3	22
		R	12.67	12.65	5.42	5.4	16.47	16.5	6.33	6.34	7.02	7.04		
18	H	L	16.14	16.13	5.67	5.69	17.57	17.57	7.15	7.19	7.73	7.75	2	24
		R	15.84	15.82	5.62	5.61	17.66	17.63	7.16	7.16	7.72	7.72		
19	H	L	17.86	17.85	5.88	5.86	18.32	18.34	8.06	8.02	8.32	8.3	2	26
		R	17.83	17.82	5.78	5.76	18.32	18.35	8.22	8.21	8.36	8.36		
22	H	L	16.58	16.58	5.86	5.87	18.05	18.04	7.52	7.54	8.04	8.04	2	19
		R	16.47	16.47	5.77	5.76	18	18.01	7.58	7.62	7.97	7.98		

26	H	L	18.28	18.28	6.09	6.1	19	19.01	8.01	8.01	8.49	8.5	3	17
		R	18.02	18.05	6.03	6	19.03	18.99	8.02	8.03	8.43	8.43		
28	H	L	15.68	15.68	6	5.99	18.56	18.58	7.37	7.36	8.13	8.14	2	22
		R	15.51	15.5	5.99	5.96	18.63	18.66	7.43	7.45	8.23	8.24		
30	H	L	14.74	14.74	5.73	5.72	17.52	17.53	7.15	7.18	7.66	7.68	3	18
		R	14.81	14.8	5.71	5.7	17.59	17.59	7.11	7.09	7.81	7.8		
32	H	L	17.76	17.77	5.95	5.98	18.65	18.66	8.05	8.06	8.44	8.43	4	22
		R	17.71	17.7	5.95	5.98	18.72	18.74	8.05	8.05	8.46	8.46		
33	H	L	16.44	16.44	5.85	5.86	18.26	18.24	7.51	7.5	8.02	8.01	2	27
		R	16.29	16.28	5.93	5.93	18.44	18.4	7.46	7.5	8.07	8.07		

Appendix 7. The morphological measurements of females for 2010 generation.

Family: (I)(6)♂Lvs(28)♀H：(5)♂ VS (F)(20)♀Lvs(24)♂L：(14)♀						
Number	Treatment	Side	Elytra		Leg	
10	L	L	14.78	14.75	4.83	4.83
		R	14.77	14.77	4.84	4.86
2	L	L	14.97	14.98	4.96	4.96
		R	14.96	14.98	4.96	4.99
1	L	L	14.88	14.88	4.83	4.82
		R	14.91	14.92	4.82	4.82
16	L	L	14.97	14.97	4.87	4.87
		R	14.99	14.98	4.87	4.88
7	L	L	14.63	14.63	4.9	4.9
		R	14.87	14.83	4.89	4.89
17	L	L	14.73	14.69	4.88	4.88
		R	14.72	14.72	4.9	4.9
11	L	L	14.69	14.69	4.91	4.87
		R	14.73	14.74	4.89	4.9
3	L	L	14.74	14.75	4.87	4.88
		R	14.74	14.76	4.89	4.89
19	H	L	15.18	15.17	4.99	5.01
		R	15.17	15.17	5	5.02
36	H	L	14.74	14.73	4.92	4.94
		R	14.71	14.73	4.9	4.93
20	H	L	15.17	15.17	4.9	4.9
		R	15.26	15.26	4.88	4.87
33	H	L	14.89	14.92	4.92	4.92
		R	14.93	14.92	4.92	4.95
25	H	L	14.87	14.88	4.97	4.97
		R	14.81	14.82	4.96	4.96
31	H	L	14.56	14.59	4.83	4.81
		R	14.59	14.57	4.8	4.78
30	H	L	15.17	15.15	5	5.01
		R	15.11	15.13	4.99	4.98
32	H	L	14.91	14.92	5	4.99
		R	14.94	14.96	4.93	4.96
Family: (A)(28)♂vs(20)♀：(29)♂ VS (H)(17)♂Lvs(4)♀H：(5)♀						
Number	Treatment	Side	Elytra		Leg	
2	L	L	14.87	14.86	4.95	4.93
		R	14.95	14.92	4.97	4.94
10	L	L	15.25	15.24	5.15	5.13
		R	15.33	15.32	5.19	5.19
7	L	L	15.24	15.25	5.08	5.1
		R	15.06	15.09	5.09	5.11
12	H	L	15.54	15.52		
		R	15.66	15.63		
18	H	L	15.76	15.77	5.26	5.23
		R	15.74	15.76	5.24	5.24
15	H	L	15.47	15.47	5.16	5.15
		R	15.47	15.46	5.19	5.16
22	H	L	16.06	16.06	5.36	5.36
		R	16.07	16.08	5.38	5.35
17	H	L	15.51	15.51	5.27	5.24

		R	15.61	15.6	5.27	5.24
Family: (D)(14)♀Lvs(5)♂H：(2)♂ VS (G)(6)H♂vs(5)L♀：(18)♀						
Number	Treatment	Side	Elytra		Leg	
2	L	L	14.87	14.86	4.95	4.93
		R	14.95	14.92	4.97	4.94
10	L	L	15.25	15.24	5.15	5.13
		R	15.33	15.32	5.19	5.19
7	L	L	15.24	15.25	5.08	5.1
		R	15.06	15.09	5.09	5.11
12	H	L	15.54	15.52		
		R	15.66	15.63		
18	H	L	15.76	15.77	5.26	5.23
		R	15.74	15.76	5.24	5.24
15	H	L	15.47	15.47	5.16	5.15
		R	15.47	15.46	5.19	5.16
22	H	L	16.06	16.06	5.36	5.36
		R	16.07	16.08	5.38	5.35
17	H	L	15.51	15.51	5.27	5.24
		R	15.61	15.6	5.27	5.24
Family: (E)(9)♀Lvs(8)♂H：(9)♂ VS No coding♀(2009)						
Number	Treatment	Side	Elytra		Leg	
13	L	L	15.09	15.12	4.96	4.97
		R	15.09	15.11	4.96	4.97
11	L	L	15.1	15.13	4.96	4.97
		R	15.15	15.13	4.97	4.96
5	L	L	14.87	14.9	4.83	4.83
		R	14.84	14.88	4.81	4.78
9	L	L	15.31	15.34	5.03	5.04
		R	15.35	15.32	4.99	5
8	L	L	14.31	14.3	4.71	4.72
		R	14.38	14.38	4.73	4.74
12	L	L	14.71	14.68	4.78	4.78
		R	14.69	14.66	4.81	4.81
3	L	L	14.78	14.77	4.86	4.86
		R	14.8	14.8	4.86	4.87
6	L	L	14.17	14.2	4.65	4.65
		R	14.17	14.19	4.64	4.62
10	L	L	14.49	14.5		
		R	14.52	14.51		
18	H	L	14.48	14.49	4.78	4.78
		R	14.5	14.53	4.77	4.76
15	H	L	14.93	14.9	4.86	4.86
		R	14.91	14.87	4.86	4.87
26	H	L	15.59	15.58	5.02	5.04
		R	15.62	15.59	5.04	5.05
16	H	L	15.54	15.55	5.04	5.04
		R	15.53	15.53	4.99	4.99
25	H	L	15.24	15.23	5.01	5.01
		R	15.24	15.21	4.98	4.96
19	H	L	14.69	14.7	4.78	4.78
		R	14.7	14.7	4.78	4.78
Family: (A)(28)♂vs(20)♀：(18)♀ VS (G)(6)H♂vs(5)L♀：(1)♂L						
Number	Treatment	Side	Elytra		Leg	
5	L	L	14.74	14.76	4.94	4.92

		R	14.73	14.76	4.97	4.94
8	L	L	14.14	14.13	4.72	4.72
		R	14.17	14.14	4.72	4.69
1	L	L	14.91	14.9	4.83	4.83
		R	14.84	14.81	4.85	4.85
4	L	L	14.37	14.41	4.85	4.84
		R	14.4	14.38	4.87	4.86
18	H	L	15.01	15.03	5.05	5.03
		R	15	15.04	5.05	5.05
19	H	L	14.98	14.98	4.99	4.99
		R	14.96	14.97	4.97	4.97
16	H	L	15.14	15.15	5.05	5.08
		R	15.14	15.13	5.09	5.08
14	H	L	15.18	15.2	5.06	5.04
		R	15.2	15.2	5.03	5.02

Family: (B)(13)♂Hvs(5)♀L：(14)♂ VS (A)(28)♂vs(20)♀：(7)♀

Number	Treatment	Side	Elytra		Leg	
21	L	L	14.5	14.49	4.8	4.77
		R	14.48	14.45	4.79	4.79
10	L	L	14.39	14.37	4.62	4.61
		R	14.43	14.45	4.65	4.61
16	L	L	14.51	14.5	4.78	4.76
		R	14.5	14.53	4.8	4.78
14	L	L	14.61	14.64	4.8	4.81
		R	14.6	14.64	4.8	4.8
7	L	L	14.57	14.58	4.73	4.73
		R	14.59	14.59	4.74	4.74
24	L	L	13.98	14.01	4.39	4.37
		R	13.8	13.82	4.37	4.37
19	L	L	14.75	14.75		
		R	14.76	14.78		
3	L	L	14.91	14.9	4.91	4.9
		R	14.81	14.82	4.92	4.92
5	L	L			4.6	4.6
		R			4.64	4.63
12	L	L	15.15	15.16	4.85	4.83
		R	15.12	15.16	4.88	4.86
22	L	L	14.32	14.35	4.69	4.68
		R	14.42	14.39	4.7	4.69
8	L	L	14.16	14.17	4.46	4.45
		R	14.14	14.14	4.43	4.42
17	L	L	13.96	14	4.62	4.61
		R	13.97	13.99	4.63	4.62
6	L	L			4.74	4.73
		R			4.73	4.73
1	L	L	10.49	10.49	3.42	3.44
		R	10.48	10.5	3.45	3.45
33	H	L	15.6	15.61	5.04	5.05
		R	15.58	15.62	5.02	5.02
38	H	L	14.2	14.21	4.57	4.56
		R	14.17	14.16	4.6	4.58
40	H	L	15.15	15.18	4.83	4.82
		R	15.13	15.11	4.81	4.81
39	H	L	14.29	14.27	4.59	4.57

		R	14.37	14.39	4.6	4.58
29	H	L			4.76	4.76
		R			4.75	4.76
37	H	L	14.9	14.93	4.9	4.89
		R	14.99	15.02	4.91	4.91
31	H	L	15.06	15.06	4.92	4.92
		R	15.29	15.29	4.95	4.94

Family: (F)(20)♀Lvs(24)♂L：(2)♂ VS (G)(6)H♂vs(5)L♀：(20)♀

Number	Treatment	Side	Elytra		Leg	
12	L	L	14.82	14.79	4.78	4.8
		R	14.84	14.86	4.8	4.8
16	L	L	15.63	15.63	5.12	5.15
		R	15.63	15.61	5.16	5.17
13	L	L	15.65	15.67	4.98	5
		R	15.64	15.65	4.92	4.93
11	L	L	15.02	15.06	4.91	4.9
		R	15.02	15.01	4.87	4.89
14	L	L	15.06	15.07	4.88	4.89
		R	15.05	15.07	4.88	4.9
17	L	L	15.22	15.21	5.01	5.03
		R	15.29	15.32	5	5.03
18	L	L				
		R				
9	H	L	15.08	15.06	4.97	4.98
		R	15.08	15.11	4.96	4.96
6	H	L	15.59	15.61	5.02	5.03
		R	15.56	15.57	5.06	5.03
3	H	L	15.56	15.57	5.09	5.11
		R	15.52	15.51	5.08	5.1
4	H	L	15.48	15.49	5.09	5.07
		R	15.48	15.49	5.08	5.07

Family: (G)(6)H♂vs(5)L♀：(2)♂ VS (B)(13)♂Hvs(5)L♀：(19)♀

Number	Treatment	Side	Elytra		Leg	
1	L	L	15.3	15.27	5.06	5.08
		R	15.33	15.36	5.08	5.1
3	L	L	14.22	14.21	4.69	4.71
		R	14.18	14.18	4.71	4.7
2	L	L	14.88	14.88	4.9	4.93
		R	14.83	14.81	4.9	4.91
11	H	L	14.22	14.23	4.83	4.83
		R	14.23	14.21	4.85	4.84

Family: (E)(9)♀Lvs(8)♂H：(29)♂ VS (H)(17)♂Lvs(4)♀H：(2)♀

Number	Treatment	Side	Elytra		Leg	
7	L	L	15.24	15.26	5.03	5.05
		R	15.25	15.24	5.03	5.05
10	L	L	14.98	14.99	5.01	4.97
		R	14.97	14.99	4.97	4.98
3	L	L	15.24	15.24	5.1	5.09
		R	15.3	15.33	5.1	5.09
1	L	L	14.6	14.61	4.82	4.83
		R	14.63	14.64	4.83	4.83
12	L	L	15.33	15.31	5.08	5.09
		R	15.4	15.36	5.09	5.11
11	L	L	15.2	15.23	5.1	5.08

		R	15.22	15.24	5.06	5.07
4	L	L	15.21	15.19	5.07	5.08
		R	15.22	15.23	5.07	5.08
9	L	L	15.15	15.18	4.96	4.95
		R	15.16	15.13	5.01	5.01
5	L	L	14.63	14.61	4.84	4.83
		R	14.63	14.65	4.86	4.86
2	L	L	15.26	15.27	5.07	5.06
		R	15.28	15.28	5.1	5.1
18	H	L	14.99	14.97	4.98	4.99
		R	15.02	15.01	4.97	4.98
13	H	L	14.67	14.7	4.78	4.78
		R	14.69	14.69	4.79	4.78
17	H	L	14.67	14.68	4.92	4.93
		R	14.6	14.64	4.96	4.95

Family: (D)(14)♀Lvs(5)♂H：(6)♂H VS (G)(6)H♂vs(5)L♀：(6)♀L

Number	Treatment	Side	Elytra		Leg	
15	L	L	14.31	14.31	4.81	4.82
		R	14.4	14.39	4.82	4.83
13	L	L	14.52	14.56	4.76	4.77
		R	14.71	14.72	4.77	4.77
4	L	L	14.39	14.42	4.79	4.78
		R	14.27	14.27	4.81	4.78
10	L	L	14.66	14.69	4.87	4.88
		R	14.6	14.61	4.91	4.9
9	L	L	14.52	14.54	4.92	4.92
		R	14.54	14.56	4.92	4.92
29	H	L	14.76	14.75	4.86	4.87
		R	14.75	14.73	4.9	4.91
18	H	L	15.47	15.52	5.05	5.08
		R	15.41	15.44	5.13	5.13
25	H	L	14.5	14.48		
		R	14.48	14.48		
24	H	L	15.03	15.05	4.97	4.98
		R	14.97	14.96	4.95	4.95
21	H	L	14.59	14.63	4.88	4.86
		R	14.61	14.65	4.87	4.87
17	H	L	15.15	15.14	4.97	4.97
		R	15.18	15.15	4.98	4.99
30	H	L	14.91	14.9	4.94	4.92
		R	14.9	14.94	4.91	4.9
28	H	L	14.52	14.55	4.8	4.8
		R	14.2	14.22	4.8	4.8

Family: (J)(3)♂vs(4)♀：(4)♂ VS (A)(28)♂vs(20)♀：(13)♀

Number	Treatment	Side	Elytra		Leg	
4	L	L	14.23	14.22	4.75	4.74
		R	14.23	14.24	4.74	4.76
14	H	L	14.34	14.29	4.72	4.73
		R	14.33	14.29	4.73	4.75
12	H	L	14.6	14.63	4.85	4.85
		R	14.62	14.65	4.85	4.85
13	H	L	13.98	13.98	4.72	4.74
		R	13.97	14.01	4.73	4.74

Appendix 8. The morphological measurements of females for 2011 generation.

Family: 11.9-1						
Number	Treatment	Side	Elytra		Leg	
2	L	L	14.81	14.81	4.76	4.76
		R	14.8	14.78	4.77	4.76
3	L	L	15.18	15.2	5.01	4.98
		R	15.24	15.21	4.95	4.94
9	L	L	15.23	15.24	4.76	4.79
		R	15.24	15.25	4.78	4.8
10	L	L	14.73	14.72	4.83	4.79
		R	14.79	14.76	4.82	4.8
11	L	L	15.01	15.01	4.92	4.91
		R	15.02	15.03	4.9	4.89
24	L	L	12.91	12.9	4.16	4.18
		R	12.87	12.89	4.14	4.17
31	L	L	14.91	14.93	4.86	4.86
		R	15.11	15.12	4.86	4.86
32	L	L	14.86	14.87	4.99	4.97
		R	14.91	14.89	4.96	4.98
12	H	L			4.84	4.83
		R			4.87	4.88
15	H	L	14.59	14.59	4.73	4.74
		R	14.63	14.65	4.72	4.73
16	H	L	15.82	15.84	5.07	5.07
		R	15.78	15.77	5.09	5.1
17	H	L			4.97	4.98
		R			4.99	4.96
18	H	L	15.37	15.36	5.06	5.08
		R	15.27	15.26	5.09	5.08
21	H	L	15.5	15.53	4.92	4.92
		R	15.47	15.47	4.91	4.93
22	H	L	15.57	15.58	5.12	5.1
		R	15.61	15.65	5.1	5.09
35	H	L	15.54	15.53	4.97	4.98
		R	15.57	15.54	4.95	4.94
36	H	L	14.7	14.71	4.86	4.86
		R	14.85	14.85	4.86	4.86
38	H	L	15.22	15.2	4.96	4.97
		R	15.37	15.37	4.97	4.97
39	H	L	15.06	15.08	4.94	4.92
		R	15.09	15.07	4.95	4.93
Family: 11.9-7						
Number	Treatment	Side	Elytra		Leg	
2	L	L	14.54	14.55	4.98	4.95
		R	14.63	14.63	4.94	4.94
6	L	L	13.85	13.85	4.65	4.66
		R	13.84	13.85	4.67	4.68
12	L	L	14.35	14.37	4.73	4.73
		R	14.51	14.49	4.74	4.76
19	L	L	14.18	14.19	4.77	4.77
		R	14.13	14.11	4.8	4.81
20	L	L	14.11	14.09	4.82	4.83

		R	13.92	13.93	4.8	4.79
21	L	L	13.92	13.9	4.71	4.7
		R	13.93	13.92	4.69	4.69
26	L	L	14.56	14.56	4.82	4.82
		R	14.55	14.55	4.84	4.82
27	L	L	14.37	14.35	4.84	4.83
		R	14.35	14.35	4.79	4.77
28	L	L	14.96	14.97	4.93	4.95
		R	14.98	14.97	4.92	4.95
29	L	L	14.15	14.15	4.69	4.68
		R	14.09	14.11	4.64	4.66
31	H	L	14.37	14.38	4.78	4.78
		R	14.41	14.41	4.77	4.81
33	H	L	15.12	15.12	4.9	4.89
		R	15.1	15.13	4.88	4.88
34	H	L	14.09	14.12	4.7	4.7
		R	14.17	14.18	4.7	4.7
36	H	L	14.99	15	4.79	4.82
		R	14.89	14.88	4.87	4.86
37	H	L	14.98	14.97	4.98	4.97
		R	14.99	14.97	4.97	4.96
40	H	L	14.62	14.62	4.78	4.78
		R	14.68	14.66	4.81	4.81
46	H	L	14.7	14.72	4.86	4.84
		R	14.7	14.7	4.87	4.86
48	H	L	15.18	15.18	4.96	4.96
		R	15.16	15.17	4.99	4.98
49	H	L	13.94	13.93	4.76	4.78
		R	13.91	13.88	4.77	4.77
50	H	L	14.97	14.97	5	5.01
		R	14.99	14.96	4.97	4.95
51	H	L	14.21	14.2	4.72	4.71
		R	14.21	14.2	4.7	4.7
52	H	L	14.3	14.29	4.81	4.81
		R	14.36	14.37	4.81	4.81
59	H	L	14.78	14.78	4.82	4.82
		R	14.81	14.8	4.84	4.83

Family: 11.9-8

Number	Treatment	Side	Elytra		Leg	
2	L	L	14.91	14.88	4.85	4.87
		R	14.92	14.91	4.89	4.9
4	L	L	13.95	13.93	4.71	4.72
		R	13.95	13.97	4.69	4.72
7	L	L	13.52	13.52	4.49	4.5
		R	13.53	13.54	4.5	4.51
8	L	L	14.24	14.25	4.63	4.61
		R	14.28	14.31	4.63	4.64
10	L	L	14.09	14.09	4.66	4.66
		R	14.08	14.09	4.66	4.65
15	L	L	14.52	14.5	4.7	4.7
		R	14.37	14.38	4.69	4.7
16	L	L	13.9	13.89	4.59	4.58
		R	13.93	13.92	4.61	4.62
17	L	L	14.28	14.28	4.69	4.69

		R	14.31	14.34	4.7	4.69
18	L	L	14.28	14.28	4.64	4.64
		R	14.31	14.31	4.63	4.65
20	L	L	14.09	14.09	4.72	4.74
		R	14.07	14.1	4.75	4.73
24	L	L	14.42	14.43	4.8	4.79
		R	14.45	14.43	4.8	4.79
25	H	L	14.2	14.22	4.57	4.57
		R	14.23	14.27	4.62	4.62
26	H	L	15.27	15.28	5.01	4.99
		R	15.29	15.27	5.02	5
27	H	L	14.91	14.91	4.97	4.97
		R	14.85	14.84	4.95	4.94
30	H	L	14.99	14.98	4.84	4.82
		R	15.09	15.06	4.87	4.85
33	H	L	14.59	14.58	4.74	4.7
		R	14.61	14.63	4.68	4.71
37	H	L	13.53	13.52	4.49	4.49
		R	13.57	13.6	4.44	4.47
40	H	L	14.91	14.95	4.96	4.92
		R	14.93	14.95	4.95	4.93
41	H	L	14.59	14.61	4.84	4.81
		R	14.68	14.69	4.85	4.85
43	H	L	13.74	13.73	4.52	4.51
		R	13.73	13.73	4.54	4.51
45	H	L	14.45	14.43	4.63	4.65
		R	14.38	14.4	4.66	4.67
46	H	L	14.5	14.5	4.75	4.78
		R	14.51	14.51	4.78	4.79

Family: 11.9-9

Number	Treatment	Side	Elytra		Leg	
3	L	L	14.25	14.26		
		R	14.34	14.31		
5	L	L	14.85	14.84	5.02	5.02
		R	14.83	14.85	5.02	5.02
7	L	L	14.93	14.92	4.94	4.93
		R	14.99	15.01	4.97	4.97
9	L	L	14.48	14.48	4.89	4.92
		R	14.45	14.46	4.9	4.91
10	L	L	14.16	14.2	4.84	4.84
		R	14.2	14.24	4.83	4.85
12	L	L	14.04	14.06	4.79	4.77
		R	13.96	13.96	4.8	4.76
14	L	L	14.6	14.59	4.74	4.7
		R	14.59	14.6	4.76	4.73
15	L	L	14.46	14.47	4.79	4.81
		R	14.53	14.53	4.78	4.77
16	L	L	14.71	14.73	4.84	4.85
		R	14.82	14.83	4.95	4.96
20	L	L	14.22	14.22	4.82	4.83
		R	14.19	14.2	4.8	4.83
21	L	L	14.37	14.35	4.93	4.91
		R	14.33	14.34	4.84	4.86
23	L	L	14.21	14.22	4.7	4.71

		R	14.23	14.26	4.7	4.71
28	L	L	14.7	14.69	4.95	4.93
		R	14.83	14.84	4.92	4.94
30	L	L	15.37	15.37	5.02	5.04
		R	15.35	15.37	5.02	5.02
34	L	L	13.4	13.42	4.61	4.6
		R	13.44	13.45	4.62	4.6
36	H	L	14.67	14.65	4.82	4.84
		R	14.49	14.48	4.86	4.86
37	H	L	15.02	15.02	5.08	5.06
		R	15.13	15.15	5.05	5.07
39	H	L	14.62	14.63	4.95	4.91
		R	14.64	14.66	4.93	4.91
42	H	L	15.1	15.11	4.99	5.01
		R	15.05	15.07	5.02	5.02
44	H	L	14.93	14.94	4.94	4.94
		R	14.89	14.93	5.02	5.01
45	H	L	14.23	14.21	4.91	4.88
		R	14.22	14.23	4.97	4.98
51	H	L	15.03	15.01	4.87	4.89
		R	14.92	14.96	4.87	4.86
55	H	L	14.48	14.49	4.82	4.8
		R	14.45	14.46	4.87	4.88
56	H	L	14.32	14.33	4.78	4.8
		R	14.32	14.35	4.77	4.78
60	H	L	13.95	13.95	4.66	4.65
		R	13.96	14	4.7	4.66
64	H	L	15.31	15.29	5.09	5.09
		R	15.28	15.26	5.11	5.09
66	H	L	14.8	14.81	4.9	4.86
		R	14.87	14.87	4.92	4.91

Family: 11.9-15

Number	Treatment	Side	Elytra		Leg	
5	L	L	14.88	14.89	4.88	4.86
		R	14.88	14.92	4.86	4.9
6	L	L	14.69	14.67	4.75	4.75
		R	14.67	14.65	4.76	4.76
7	L	L	14.62	14.62	4.77	4.79
		R	14.6	14.6	4.76	4.76
9	L	L	14.06	14.05	4.72	4.71
		R	14.14	14.17	4.71	4.67
10	L	L	14.75	14.74	4.94	4.94
		R	14.74	14.76	4.94	4.96
13	L	L	14.43	14.43	4.84	4.83
		R	14.55	14.52	4.83	4.83
14	L	L	14.41	14.42	4.78	4.79
		R	14.43	14.44	4.81	4.79
19	L	L	14.38	14.39	4.77	4.78
		R	14.4	14.38	4.77	4.79
21	H	L	15.05	15.02	4.85	4.86
		R	15.02	15.04	4.85	4.84
22	H	L	14.96	14.98	4.86	4.88
		R	14.97	15	4.89	4.91
24	H	L	15.32	15.33	5.07	5.05

		R	15.35	15.33	5.08	5.07
26	H	L	14.37	14.4	4.83	4.82
		R	14.42	14.41	4.8	4.81
27	H	L	14.79	14.83	4.81	4.79
		R	14.86	14.89	4.72	4.74
29	H	L	14.99	15	5.02	4.99
		R	14.88	14.91	5.01	5
31	H	L	14.92	14.94	4.83	4.85
		R	14.85	14.81	4.84	4.85
34	H	L	15.1	15.11	4.92	4.93
		R	15.12	15.12	4.91	4.94
37	H	L	14.65	14.66	4.87	4.85
		R	14.54	14.55	4.88	4.88
38	H	L	14.75	14.78	4.78	4.75
		R	14.57	14.59	4.78	4.77

Figure 1

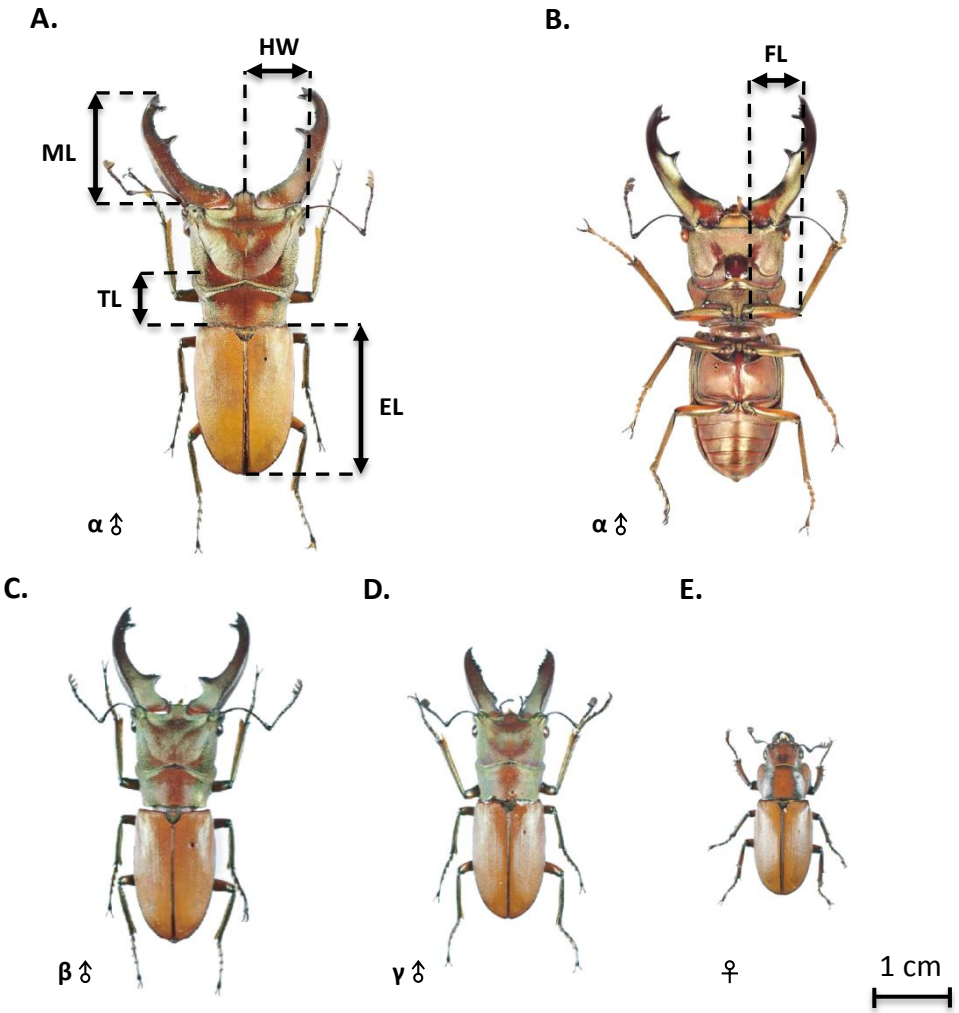


Figure 2

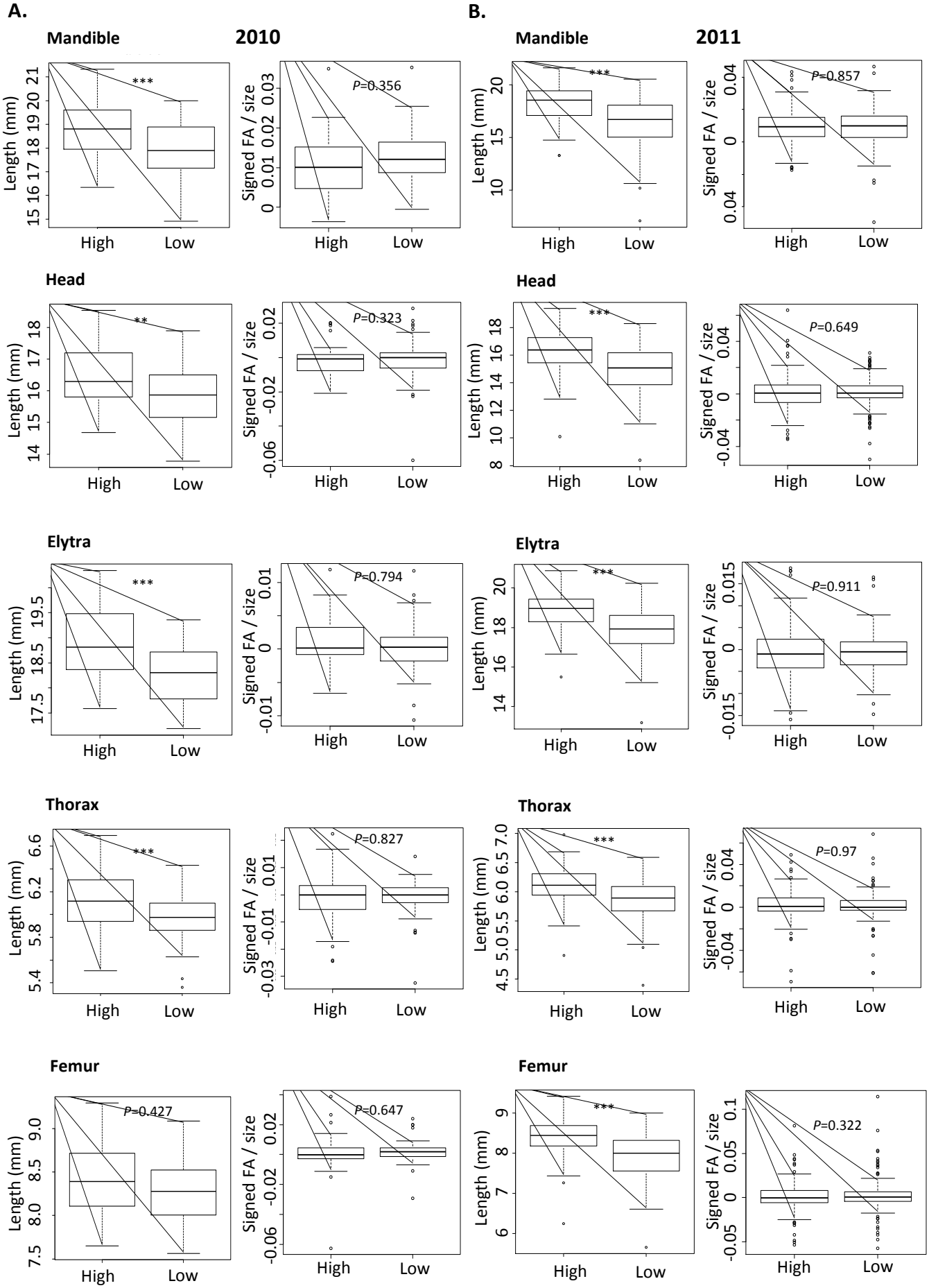

A.
B.
Mandible
2010
Mandible
2011
Head
Head
Elytra
Elytra
Thorax
Thorax
Femur
Femur
Length (mm)
Signed FA / size
***
**
P=0.356
P=0.857
P=0.323
P=0.649
P=0.794
P=0.911
P=0.827
P=0.97
P=0.427
P=0.647
P=0.322
High
Low

Figure 3

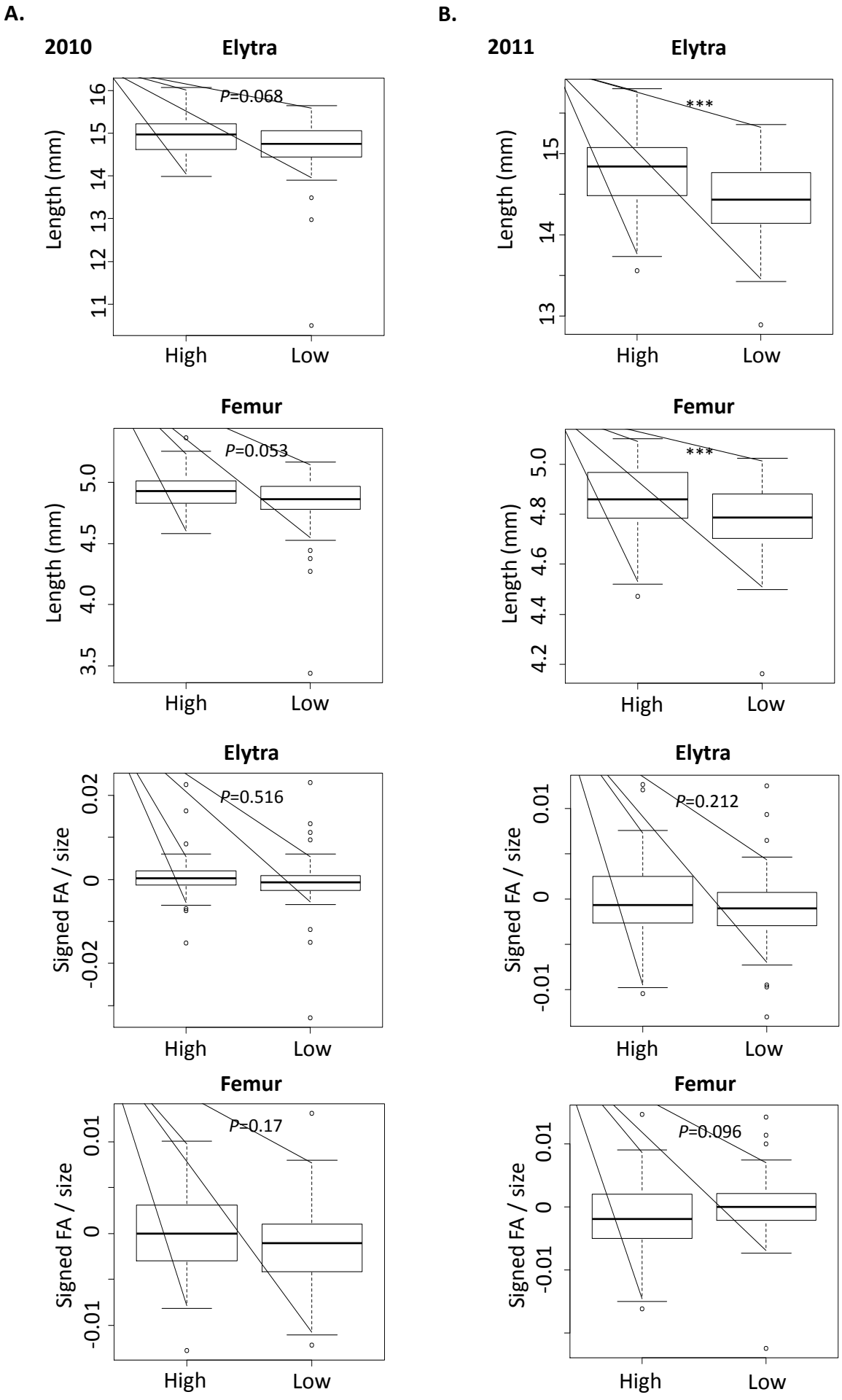

A.
B.
2010
2011
Elytra
Femur
Length (mm)
Signed FA / size
P=0.068
***
P=0.053
***
P=0.516
P=0.212
P=0.17
P=0.096
High
Low

Figure 4

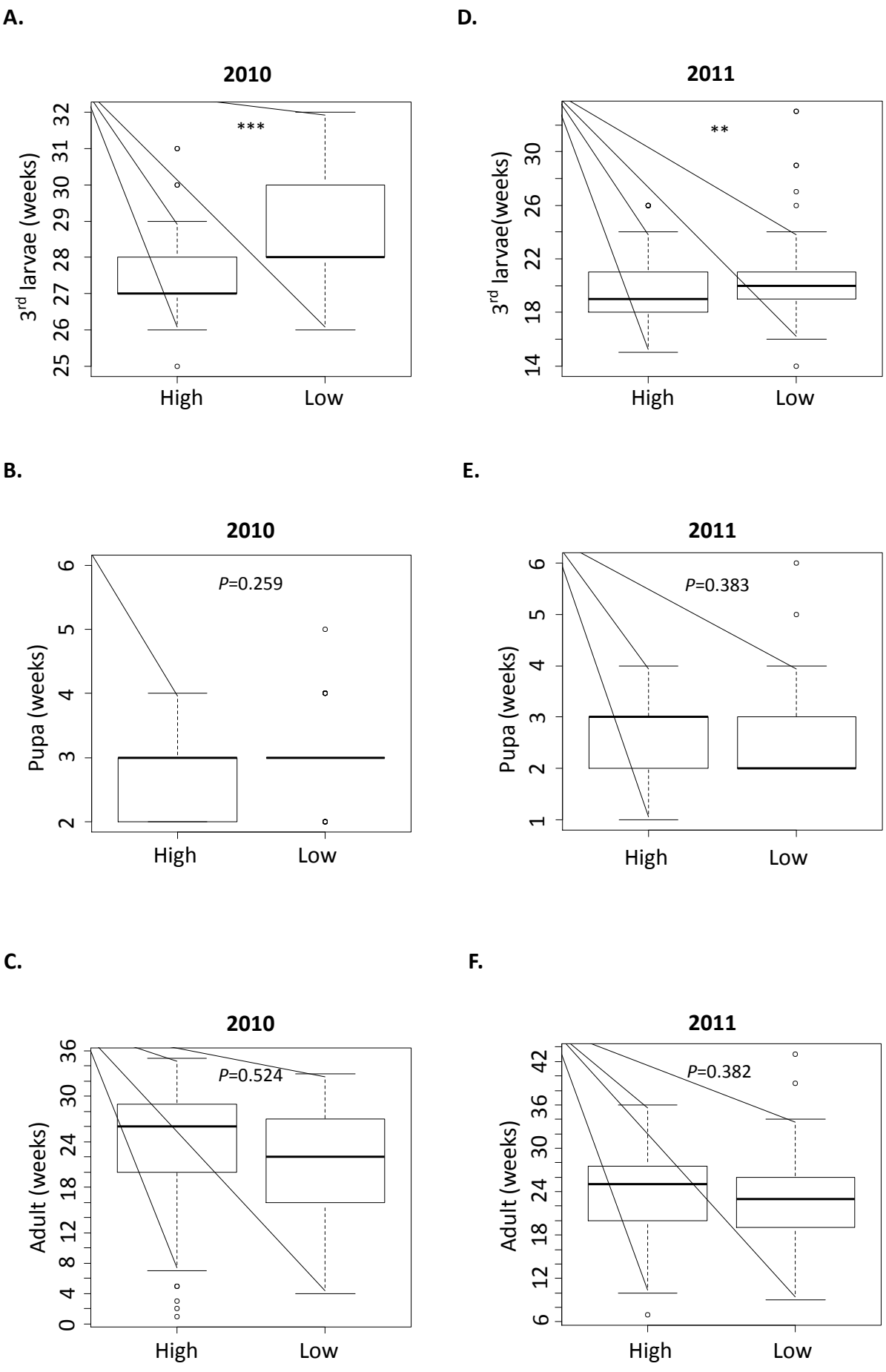

A.
2010
***
3rd larvae (weeks)
25 26 27 28 29 30 31 32
High
Low
D.
2011
**
3rd larvae(weeks)
14 18 22 26 30
High
Low
B.
2010
P=0.259
Pupa (weeks)
2 3 4 5 6
High
Low
E.
2011
P=0.383
Pupa (weeks)
1 2 3 4 5 6
High
Low
C.
2010
P=0.524
Adult (weeks)
0 4 8 12 18 24 30 36
High
Low
F.
2011
P=0.382
Adult (weeks)
6 12 18 24 30 36 42
High
Low

Figure 5

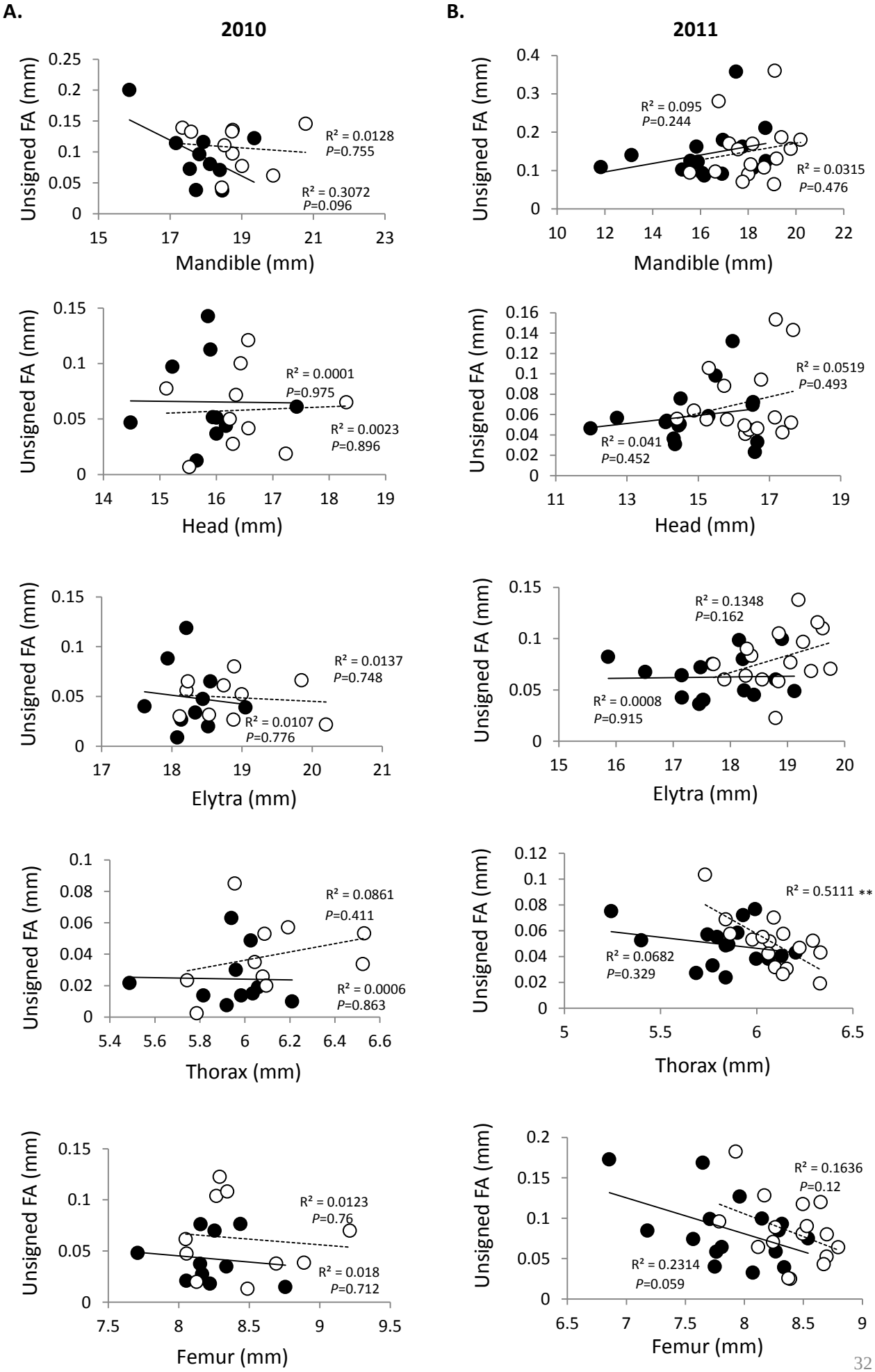

A.
2010
B.
2011
Unsigned FA (mm)
Mandible (mm)
R² = 0.0128
P=0.755
R² = 0.3072
P=0.096
R² = 0.095
P=0.244
R² = 0.0315
P=0.476
Head (mm)
R² = 0.0001
P=0.975
R² = 0.0023
P=0.896
R² = 0.041
P=0.452
R² = 0.0519
P=0.493
Elytra (mm)
R² = 0.0137
P=0.748
R² = 0.0107
P=0.776
R² = 0.1348
P=0.162
R² = 0.0008
P=0.915
Thorax (mm)
R² = 0.0861
P=0.411
R² = 0.0006
P=0.863
R² = 0.0682
P=0.329
R² = 0.5111 **
Femur (mm)
R² = 0.0123
P=0.76
R² = 0.018
P=0.712
R² = 0.2314
P=0.059
R² = 0.1636
P=0.12

Figure 6

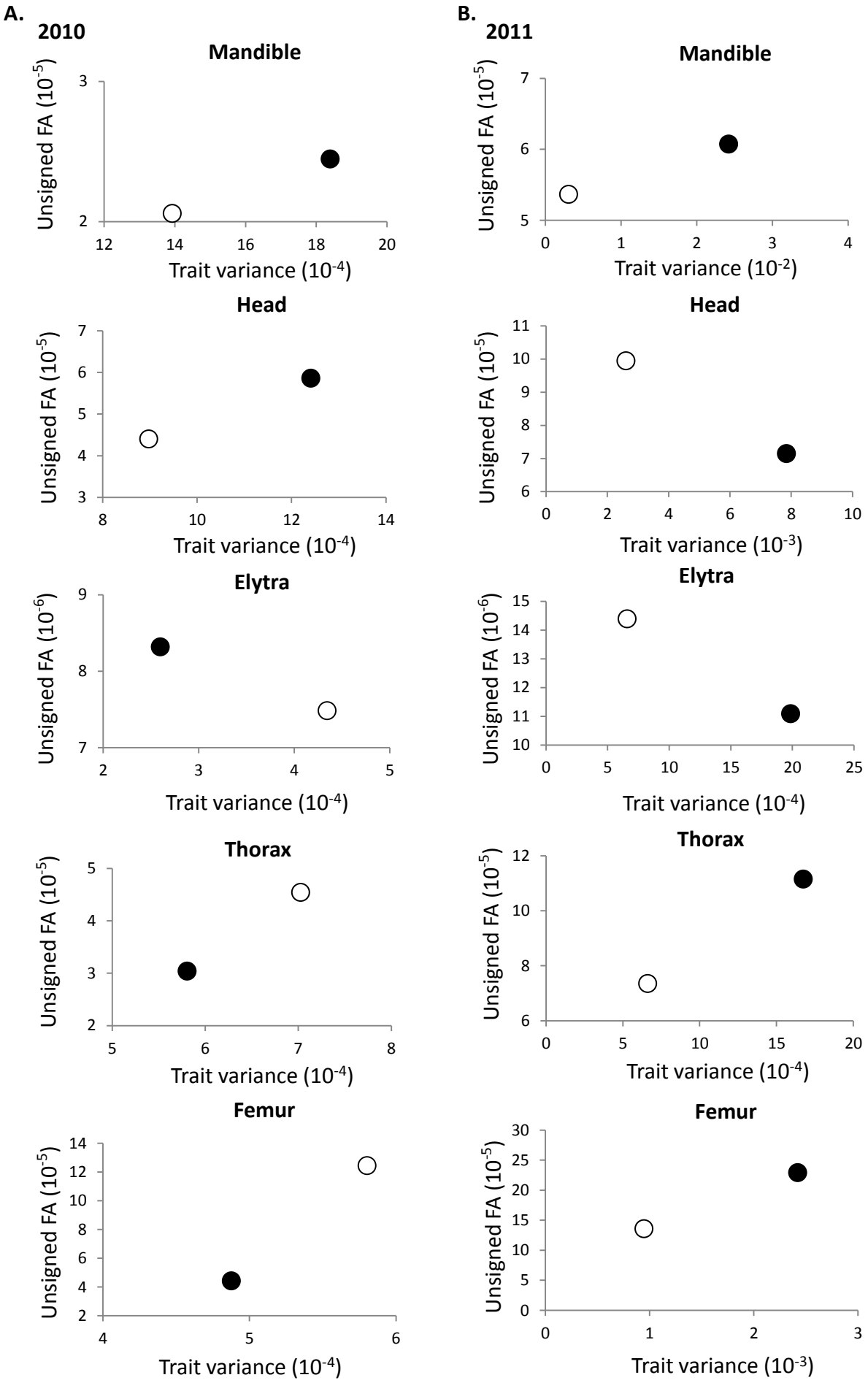
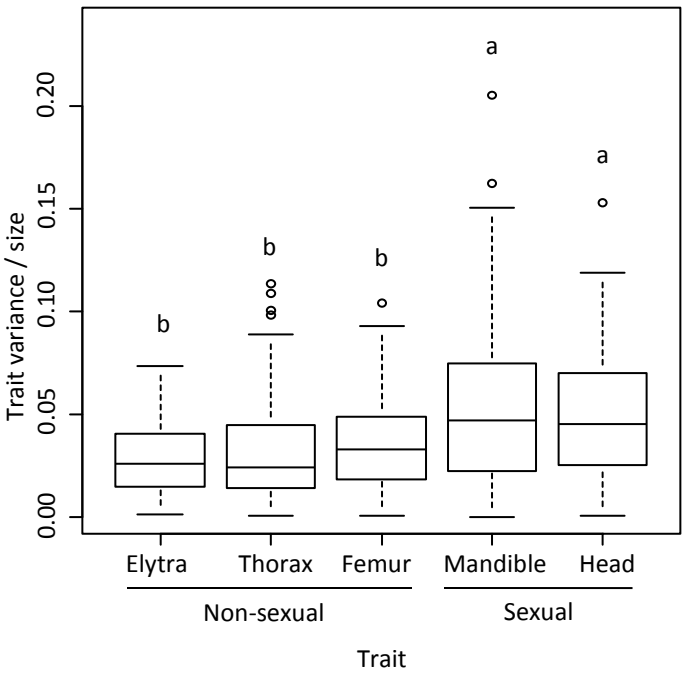

A.
2010
Mandible
Unsigned FA (10-5)
Trait variance (10-4)
Head
Unsigned FA (10-5)
Trait variance (10-4)
Elytra
Unsigned FA (10-6)
Trait variance (10-4)
Thorax
Unsigned FA (10-5)
Trait variance (10-4)
Femur
Unsigned FA (10-5)
Trait variance (10-4)
B.
2011
Mandible
Unsigned FA (10-5)
Trait variance (10-2)
Head
Unsigned FA (10-5)
Trait variance (10-3)
Elytra
Unsigned FA (10-6)
Trait variance (10-4)
Thorax
Unsigned FA (10-5)
Trait variance (10-4)
Femur
Unsigned FA (10-5)
Trait variance (10-3)

Figure 7

A.

2010



B.

2011