

MORPHOMETRIC ANALYSIS OF *Coptotermes* sp. POPULATION FROM TWO DIFFERENT NESTS

Analisis Morfometik Populasi Coptotermes sp. Dari Dua Sarang yang Berbeda

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ABSTRACT

The aim of this research is to study morphometric variation of external anatomy of subterranean termite (*Coptotermes* sp.). The samples were collected from two different nests, i.e. Laboratory of Forest Product Engineering and Diversification, Hasanuddin University (site A) and Kompleks Perumahan Dosen Unhas, Tamalanrea (site B). Resulted data were statistically analyzed for mean, standard deviation, standard error and coefficient of variability. The mean values of the different population samples were compared by using student 't' test according to SPSS Ver.12. For each individual soldier and worker, 54 variables of external characters were measured. The result showed that some external characters of soldier and worker casts were significantly different with different locations. In soldier casts, eleven of 54 variables were found to be significant different in length and width of caput, length and width metathorax, mesothorax length, length and width of abdomens, scape length, flagellum width, femur width, and width tibia. Whilst, in worker casts, 11 of 54 variables were found to be significant different in mesothorax length, scape length, flagellum width, trochanter width, tibia length, tarsus length, and claw width. However, morph metric of external characters of *Coptotermes* sp. at two locations was generally relative same in terms of coefficient of variability.

Key words: Morphometric analysis, *Coptotermes* sp.

INTRODUCTION

Basically, the balance of the ecosystem can occur because of the close interaction between living things and the environment. Forest, for example, produces environmental conditions (microclimate) which strongly support the development of things living in it, including body-microorganism or microorganisms on and in the ground. Meanwhile, microorganism helps to decompose dead organisms such as litter, plants and animals. The produced nutrient elements are needed by the forest vegetation to grow well. Microorganisms such as termites, mold, bacteria, and other have very important roles in maintaining the stability of this ecosystem.

In an ecosystem, termites have a very important role, namely as decomposer for litter and dead vegetation. Termites (ordo: Isoptera) has high diversity on ecosystem. In the world, it had been found about 2,000 species, which consist of 7 families, 15 sub-families, and 200 genera; while in Indonesia, it had been found about 10% of the total termite of world or around

200 species, including 3 families, 6 subfamily and 14 genera. However, about five percent of the 200 species found in Indonesia are harmful to humans, namely as a pest for most agricultural and plantation crops (Tarumingkeng, 2001).

One of termites types intensively investigated by researchers is subterranean termite. It is well known because of its building nest in the soil, but it can reach the food source by creating a tunnel to keep the humidity. In addition, it can attack without directly contact to the ground as long as they get moisture continuously. Genus *Coptotermes* (Family Rhinotermitidae) is very destructive pest to wood and wooden material in the world (Takematsu *et al*, 2000) and various species of the termite are found in Indonesia, such as in Java, Sulawesi and Sumatra. Takematsu *et.al.* (2006) also mentions that *Coptotermes* found in South Sulawesi had different characteristics to *Coptotermes curvignatus* found in Java and those had been regarded as the same species. Nevertheless, the information about that termites is very limited. The other side, the damage caused by them is very seriously

dangerous and can be found in various habitat conditions, such as resident, government and private buildings. Therefore, data and information on all aspects associated with this termite, including morphometric of external anatomy, are needed to explore in order to the precisely control and prevent its damage. This study was aimed at analyzing the morphometric variations of *Coptotermes* sp. from various locations. The results of this study is expected to contribute to the development of science, by providing data for comparative studies of *Coptotermes* in the future.

MATERIALS AND METHODS

Specimen preparation

The soldiers and workers of *Coptotermes* sp. were collected from the areas of the Engineering and Diversification of Forest Products Laboratory, Forestry Faculty, Hasanuddin University (Site A), and The Resident of Hasanuddin University, Tamalanrea, Makassar, South Sulawesi, Indonesia (Site B). Specimen was prepared in alcohol solution 70% prior to laboratory analysis.

Variable Observations

All specimens were observed with a binocular microscope equipped with a variety of magnification and a calibrated micrometer. The external anatomy of specimens including 54 variabels, i.e., body (2), head without eyes (2), abdomen (2), antenna (6), leg (36), and thorax (6) width, were measured.

Data Analysis

Measurement data of morphometric parameters, such as average, standard deviation, range and coefficient of variance were descriptively analyzed. Student 't' test was conducted to know the different site effects against morphometric respons.

RESULTS AND DISCUSSION

Workers

The results of measurements and statistical analysis of workers morphometrics at two locations can be shown at Appendix 1. The

Student test indicated that almost all external characters of termites from both locations were not significantly different. There were only 7 (seven) body parts of workers found varied beetwen the two locations, namely thorax (mesothoraks length), antenna (scape length and width of the flagellum), legs: the front legs (trochanter width), the middle legs (tibial width and length of tarsus) and the rear legs (width claw). The general characteristics of *Coptotermes* sp. morphometric (Appendix 2.) indicated that the variation of morphometric parameters were relatively similar in term of coefficient of variability (< 30%).

Thorax consists of three segments, namely prothorax, mesothorax, and metathorax. Thorax has a dorsal appearance (notum), ventral appearance (sternum), and lateral side (pleura). The different length of mesothoraks between site A and site B can be used for taxonomic purposes. According to Nandika *et al.* (2003), the dorsal appearance of thorax varied in form and can be used for taxonomic purposes.

Antenna is the sensor tools for insects in detecting environmental changes, supporting insect activities, and looking for their pairs. Termite's antenna has miniliform shape. The first segment (scape) was relatively long. The second segment or pedicel was generally shorter than scape. Other segments behind pedicel formed like-flagellum. The flagellum length was different between site A and site B presumably because of the influence of environmental factors, such as temperature and humidity which can influence the sensitivity level of termites in stimulating of sound or vibration form. Nandika *et al.* (2003) stated that the third segment had large variations among termite species, which can be used as a taxonomic characteristic of proliferation on youth development.

Legs can also become a taxonomic identification tool for insects. Legs consist of several segments, namely: coxa, trochanter, femur, tibia and tarsus. In the last segment (tarsus) was generally equipped with claws. Variation of leg size suppose due to alleged differences in the feeding and cruising activities of termites. Besides for walking, legs were also used for scratching foods.

Soldier

The results of measurements and statistical analysis of workers morphometrics at two locations can be shown at Appendix 3. The Student test indicated that almost all external characters of termites from both locations were not significantly different. There were only 11 (eleven) body parts of soldiers found varied between the two locations, namely head (length and width of caput), thorax (mesothorax length, length and width metathorax), antenna (scape length and flagellum width), abdomen (abdominal length and width); legs: the front legs (femur width) and the rear legs (width tibia). The general characteristics of *Coptotermes* sp. morphometric (Appendix 4.) indicated that the variation of external characters were relatively similar in term of coefficient of variability (< 30%).

The head capsule of reproductive and workers were oval or slightly rounded, while soldiers were often oval and even larger (Nandika *et al.*, 2003). The length and width of caput were found to be significant different between both sites. It indicated that there are environmental factors affecting its variation of head (caput) size. Nandika *et al.* (2003) stated that the head capsule form of soldier was greatly vary and very helpful for termite identification. The head capsule of soldiers had a long form to joint muscles for mandible (Harris, 1971).

The length and width of abdomen were showed to be significant difference between the two nests. According to Nandika *et al.* (2003), the soldier abdomen was smaller than worker because the main function of worker is digesting cellulose and giving it to nymphs, soldiers, and reproductives. The soldier legs were also had the same functions as the workers. But for the soldier legs, there is a noticeable difference on the front legs (femur width) and the rear legs (tibia width).

CONCLUSIONS

Morphometric variation of *Coptotermes* sp. specimens collected from different nests was relatively similar in term of coefficient of variance, eventhough some variabels such as thorax (mesothoraks length), antenna (scape length and width of the flagellum), legs: the front legs

(trochanter width), the middle legs (tibial width and length of tarsus) and the rear legs (width claw) of workers; and head (length and width of caput), thorax (mesothorax length, length and width metathorax), antenna (scape length and flagellum width), abdomen (abdominal length and width); legs: the front legs (femur width) and the rear legs (width tibia) of soldiers were found to be significantly different.

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Appendix 1. Student Test Analysis of *Coptotermes* sp. Worker Morphometric in Site A and B.

No	Variable	Mean		Mean difference	95% Confidence interval		Remarks
		Site A	Site B		Lower bound	Upper bound	
1	Body weight (gram)	0.00407	0.00395	0.00012	-0.00029	0.00053	tn
2	Body length (mm)	4.8055	5.005	-0.1995	-0.337	-0.062	tn
Caput (mm)							
1	Caput length	0.79	0.8375	-0.0475	-0.079	-0.016	tn
2	Caput width	1.3875	1.5375	-0.15	-0.199	-0.101	tn
Thoraks (mm)							
1	Prothorax length	0.395	0.348	0.047	0.0301	0.064	tn
2	Prothorax width	0.5425	0.65	-0.1075	-0.136	-0.079	tn
3	Metathorax length	0.316	0.336	-0.02	-0.046	-0.006	tn
4	Metathorax width	0.6525	0.7075	-0.055	-0.091	-0.019	tn
5	Mesothorax length	0.362	0.421	-0.059	-0.081	-0.037	*
6	Mesothorax width	0.8825	1.05	-0.0775	-0.239	-0.096	tn
Abdomen (mm)							
1	Abdomen length	2.9425	3.0625	-0.12	-0.203	0.113	tn
2	Abdomen width	1.405	1.495	-0.09	-0.146	-0.034	tn
Antena (mm)							
1	Scape length	0.15	0.144	0.006	-0.657	0.208	*
2	Scape width	0.082	0.066	0.016	0.0116	0.02	tn
3	Pedice length	0.099	0.062	0.037	0.0298	0.044	tn
4	Pedice width	0.073	0.066	0.007	0.0014	0.013	tn
5	Flagellum length	1.2475	1.07	0.1775	0.1382	0.216	tn
6	Flagellum width	0.098	0.092	0.006	-0.12	0.013	*
Front legs (mm)							
1	Coxa length	0.319	0.311	0.008	-0.013	0.029	tn
2	Coxa width	0.204	0.205	-0.001	-0.021	0.019	tn
3	Trochanter length	0.109	0.092	0.017	0.0001	0.034	tn
4	Trochanter width	0.084	0.079	0.005	0.0039	0.014	*
5	Femur length	0.754	0.705	0.049	0.0162	0.082	tn
6	Femur width	0.208	0.187	0.021	0.009	0.033	tn
7	Tibia length	0.684	0.6855	-0.0015	-0.039	0.036	tn
8	Tibia width	0.128	0.126	0.002	-0.016	0.020	tn
9	Tarsus length	0.272	0.264	0.008	-0.014	0.030	tn
10	Tarsus width	0.055	0.056	-0.001	-0.007	0.005	tn
11	Claw length	0.055	0.048	0.007	0.0007	0.013	tn
12	Claw width	0.023	0.025	-0.002	-0.007	0.003	tn
Middle legs (mm)							
1	Coxa length	0.258	0.286	-0.028	-0.084	0.028	tn
2	Coxa width	0.117	0.119	-0.002	-0.019	0.015	tn
3	Trochanter length	0.111	0.126	-0.015	-0.03	0.0003	tn
4	Trochanter width	0.058	0.065	-0.007	-0.016	0.002	tn
5	Femur length	0.676	0.674	0.002	-0.024	0.028	tn
6	Femur width	0.141	0.148	-0.007	-0.028	0.014	tn
7	Tibia length	0.66	0.671	-0.011	-0.033	0.0011	tn
8	Tibia width	0.123	0.111	0.012	-0.005	0.029	*
9	Tarsus length	0.247	0.253	-0.006	-0.037	0.025	*
10	Tarsus width	0.057	0.06	-0.003	-0.01	0.004	tn
11	Claw length	0.058	0.06	-0.002	-0.01	0.006	tn
12	Claw width	0.024	0.023	0.001	-0.004	0.006	tn

Appendix 1. To be continued

No	Variable	Mean		Mean difference	95% confidence interval		Remarks
		Site A	Site B		Lower bound	Upper bound	
Rear legs (mm)							
1	Coxa length	0.246	0.225	0.021	-0.001	0.043	tn
2	Coxa width	0.098	0.087	0.011	-0.022	0.028	tn
3	Trochanter length	0.102	0.084	0.018	0.0045	0.031	tn
4	Trochanter width	0.061	0.067	-0.006	-0.017	0.005	tn
5	Femur length	0.688	0.727	-0.039	-0.064	-0.014	tn
6	Femur width	0.194	0.168	0.026	0.003	0.049	tn
7	Tibia length	0.894	0.817	0.077	0.0566	0.097	tn
8	Tibia width	0.113	0.119	-0.006	-0.02	0.008	tn
9	Tarsus length	0.281	0.269	0.012	-0.007	0.031	tn
10	Tarsus width	0.063	0.069	-0.006	-0.017	0.005	tn
11	Claw length	0.1	0.09	0.01	0.0052	0.031	tn
12	Claw width	0.025	0.022	0.003	-0.001	0.007	*

Remarks: * significant difference; tn – no significant difference

Appendix 2. General characteristics of *Coptotermes* sp.) worker morphometrics in site A and B.

No	Parameters	O.R	Mean \pm SD	C.V (%)	S ²
1	Body weight	0.0034 - 0.0048	0.0040 \pm 0.0004	10.67	0.0000018
2	Body length	4.535 - 5.125	4.9058 \pm 0.1697	3.46	0.028803
3	Caput length	1.3 - 1.6	1.4625 \pm 0.0920	6.29	0.008454
4	Caput width	0.725 - 0.875	0.8138 \pm 0.0409	5.039	0.001676
5	Prothorax length	0.32 - 0.42	0.3715 \pm 0.0298	3.66	0.000887
6	Prothorax width	0.5 - 0.7	0.5963 \pm 0.0625	10.47	0.004153
7	Metathorax length	0.27 - 0.38	0.3260 \pm 0.0286	8.76	0.000815
8	Metathorax width	0.625 - 0.750	0.6800 \pm 0.0470	6.91	0.002211
9	Mesothorax length	0.32 - 0.44	0.3915 \pm 0.0379	9.67	0.001434
10	Mesothorax width	0.75 - 1.175	0.9663 \pm 0.1136	11.76	0.012913
11	Abdomen length	2.85 - 3.175	3.0025 \pm 0.1057	3.52	0.011178
12	Abdomen width	1.25 - 1.575	1.4500 \pm 0.0743	5.13	0.005526
13	Scape length	0.14 - 0.16	0.1470 \pm 0.0066	4.47	0.000043
14	Scape width	0.06 - 0.09	0.0740 \pm 0.0094	12.71	0.000088
15	Pedicel length	0.05 - 0.11	0.0805 \pm 0.0204	25.32	0.000416
16	Pedicel width	0.06 - 0.08	0.0695 \pm 0.0069	9.88	0.000047
17	Flagellum length	1.000 - 1.275	1.1588 \pm 0.0998	8.61	0.009952
18	Flagellum width	0.08 - 0.10	0.0950 \pm 0.0061	6.39	0.000037
19	Front legs				
	Coxa length	0.280 - 0.375	0.3150 \pm 0.0224	7.12	0.000503
	Coxa width	0.17 - 0.24	0.2045 \pm 0.0204	9.98	0.000416
	Trochanter length	0.075 - 0.130	0.1005 \pm 0.0195	19.42	0.000381
	Trochanter width	0.07 - 0.10	0.0815 \pm 0.0096	11.79	0.000092
	Femur length	0.65 - 0.80	0.7295 \pm 0.0422	5.79	0.001784
	Femur width	0.17 - 0.23	0.1975 \pm 0.0164	8.31	0.000270
	Tibia length	0.625 - 0.750	0.6848 \pm 0.0386	5.63	0.001488
	Tibia width	0.10 - 0.16	0.1270 \pm 0.0187	14.70	0.000348
	Tarsus length	0.22 - 0.30	0.2680 \pm 0.0231	8.61	0.000533
	Tarsus width	0.05 - 0.07	0.0555 \pm 0.0061	10.90	0.000037
	Claw length	0.04 - 0.06	0.0515 \pm 0.0075	14.47	0.000056
	Claw width	0.02 - 0.03	0.0240 \pm 0.0050	20.94	0.000025
20	Middle legs				
	Coxa length	0.28 - 0.32	0.2720 \pm 0.0596	21.92	0.003554
	Coxa width	0.12 - 0.15	0.1180 \pm 0.0177	14.96	0.000312

Appendix 2. to be continued

No	Parameters	O.R	Mean \pm SD	C.V (%)	S ²
	Trochanter length	0.10 - 0.15	0.1185 \pm 0.0755	14.81	0.000308
	Trochanter width	0.05 - 0.08	0.0615 \pm 0.0099	16.07	0.000098
	Femur length	0.63 - 0.72	0.6750 \pm 0.0274	4.06	0.000753
	Femur width	0.10 - 0.18	0.1445 \pm 0.0216	14.97	0.000468
	Tibia length	0.62 - 0.70	0.6655 \pm 0.0231	3.46	0.000531
	Tibia width	0.09 - 0.15	0.1170 \pm 0.019	16.19	0.000359
	Tarsus length	0.2 - 0.3	0.2500 \pm 0.0323	12.91	0.001042
	Tarsus width	0.05 - 0.07	0.0585 \pm 0.0075	12.74	0.000056
	Claw length	0.05 - 0.07	0.0590 \pm 0.0079	13.36	0.000062
	Claw width	0.02 - 0.03	0.0235 \pm 0.0049	20.82	0.000024
21	Rear legs				
	Coxa length	0.2 - 0.3	0.2355 \pm 0.0252	10.71	0.000637
	Coxa width	0.07 - 0.14	0.0925 \pm 0.0159	17.14	0.000251
	Trochanter length	0.07 - 0.13	0.0930 \pm 0.0166	17.82	0.000275
	Trochanter width	0.05 - 0.09	0.0640 \pm 0.0114	17.85	0.000131
	Femur length	0.65 - 0.77	0.7075 \pm 0.0324	4.58	0.001051
	Femur width	0.13 - 0.22	0.1810 \pm 0.0273	15.09	0.000746
	Tibia length	0.79 - 0.92	0.8555 \pm 0.0448	5.23	0.002005
	Tibia width	0.10 - 0.14	0.1160 \pm 0.0147	12.63	0.000215
	Tarsus length	0.24 - 0.31	0.2750 \pm 0.0209	7.60	0.000437
	Tarsus width	0.05 - 0.08	0.0660 \pm 0.0114	17.31	0.000131
	Claw length	0.06 - 0.12	0.0910 \pm 0.0162	17.79	0.000262
	Claw width	0.02 - 0.03	0.0235 \pm 0.0049	20.82	0.000024

Appendix 3. Student Test Analysis of *Coptotermes* sp. Soldier Morphometric in Site A and B.

No	Parameters	Mean		Mean difference	95% confidence intervals		Remarks
		Site A	Site B		Lower bound	Upper bound	
1	Body weight (gram)	0.003	0.003	-0.00021	-0.00056	0.0001385	tn
2	Body length (mm)	5.233	5.638	-0.405	-0.70042	0.5042039	tn
Caput							
1	Caput length	1.95	2.015	-0.065	-0.11646	-0.013534	*
2	Caput width	0.978	0.913	0.065	-0.0079	0.1379043	*
3	Mandible length	0.905	0.973	-0.0675	-0.11265	-0.022352	tn
4	Mandible width	0.285	0.265	0.02	-0.01266	0.0526602	tn
Thorax							
1	Prothorax length	0.403	0.425	-0.022	-0.04237	-0.00163	tn
2	Prothorax width	0.77	0.725	-0.1075	0.014879	0.0751214	tn
3	Metathorax length	0.343	0.302	0.0405	0.009321	0.7167941	*
4	Metathorax width	0.725	0.692	0.033	-0.02806	0.0940554	*
5	Mesothorax length	0.339	0.313	0.026	0.000952	0.0089519	*
6	Mesothorax width	0.788	0.845	-0.0575	-0.09167	-0.023326	tn
Abdomen							
1	Abdomen length	2.32	2.63	-0.31	-0.43615	-0.183847	*
2	Abdomen width	1.203	1.258	-0.055	-0.11933	0.0093273	*
Antennae							
1	Scape length	0.156	0.11	0.0455	0.20521	0.070479	*
2	Scape width	0.083	0.073	0.0095	-0.00151	0.0205118	tn
3	Pedice length	0.084	0.075	0.0085	-0.00451	0.0215123	tn
4	Pedice width	0.061	0.064	-0.003	-0.01044	0.0044444	tn
5	Flagellum length	1.28	1.265	0.015	-0.06446	0.0944625	*
6	Flagellum width	0.098	0.079	0.019	0.000952	0.0089519	tn

Appendix 3. To be continued

No	Parameters	Mean		Mean difference	95% confidence intervals		Remarks
Front Legs							
1	Coxa length	0.293	0.301	-0.008	-0.0211	0.0051016	tn
2	Coxa width	0.18	0.178	0.002	-0.01005	0.0140485	tn
3	Trochanter length	0.158	0.171	-0.013	-0.02253	-0.003475	tn
4	Trochanter width	0.061	0.062	-0.001	-0.01	0.0079956	tn
5	Femur length	0.809	0.758	0.051	0.029245	0.0727547	tn
6	Femur width	0.216	0.232	-0.016	-0.03102	-0.00098	*
7	Tibia length	0.766	0.744	0.022	0.005606	0.0383977	tn
8	Tibia width	0.122	0.146	-0.024	-0.04144	-0.006562	tn
9	Tarsus length	0.236	0.286	-0.05	0.066394	-0.033606	tn
10	Tarsus width	0.053	0.056	-0.003	0.007698	0.0016978	tn
11	Claw length	0.106	0.103	0.003	-0.00483	0.0108297	tn
12	Claw width	0.027	0.028	-0.001	-0.00526	0.0032598	tn
Middle legs							
1	Coxa length	0.305	0.304	0.001	-0.01064	0.0146444	tn
2	Coxa width	0.19	0.183	0.007	-0.00899	0.0022985	tn
3	Trochanter length	0.178	0.2	-0.022	-0.03851	-0.005487	tn
4	Trochanter width	0.07	0.079	-0.009	-0.02049	0.0024859	tn
5	Femur length	0.775	0.699	0.076	0.053264	0.0987357	tn
6	Femur width	0.193	0.206	-0.013	-0.0281	0.0021013	tn
7	Tibia length	0.722	0.716	0.006	-0.01101	0.0250049	tn
8	Tibia width	0.109	0.104	0.005	-0.00614	0.0161391	tn
9	Tarsus length	0.248	0.243	0.005	-0.05786	0.057813	tn
10	Tarsus width	0.054	0.062	-0.008	-0.01343	-0.002575	tn
11	Length Claw	0.101	0.105	-0.004	-0.01601	0.008777	tn
12	Width claw	0.024	0.025	-0.001	-0.0059	0.0039022	tn
		Site A	Site B		Lower bound	Upper bound	
Rear legs							
1	Coxa length	0.309	0.302	0.007	-0.0044	0.0184002	tn
2	Coxa width	0.204	0.198	0.006	-0.00653	0.0185275	tn
3	Trochanter length	0.183	0.192	-0.009	-0.02107	0.0030689	tn
4	Trochanter width	0.069	0.057	0.012	0.004015	0.0199847	tn
5	Femur length	0.924	0.896	0.028	0.009105	0.0468953	tn
6	Femur width	0.238	0.216	0.022	0.006341	0.0376594	tn
7	Tibia length	0.946	0.931	0.015	0.011878	0.0418776	tn
8	Tibia width	0.144	0.108	0.036	0.02387	0.0481297	*
9	Tarsus length	0.294	0.304	-0.01	-0.02415	0.0041455	tn
10	Tarsus width	0.058	0.051	0.007	0.001354	0.0126461	tn
11	Claw length	0.113	0.135	-0.022	-0.03464	-0.009356	tn
12	Claw width	0.026	0.025	0.001	-0.0039	0.0059022	tn

Remarks: * significant difference; tn – no significant difference

Appendix 4. General characteristics of *Coptotermes* sp. workers morphometric in site A and B.

No	Parameters	O.R	Mean±SD	C.V (%)	S ²
1	Body weight	0.0025 - 0.0036	0.0031 ± 0.0004	12.25	0.000000142
2	Body length	5.025 - 5.75	5.4340 ± 0.2442	4.49	0.059632000
3	Caput length with mandible	1.850 - 2.125	1.9925 ± 0.0689	3.46	0.004743352
4	Caput width	0.85 - 1.20	0.9450 ± 0.0826	8.74	0.006815823
5	Mandible length	0.825 - 1.050	0.9388 ± 0.0582	6.20	0.003386518
6	Mandible width	0.225 - 0.350	0.2750 ± 0.0356	12.93	0.001264179
7	Prothorax length	0.37 - 0.45	0.4140 ± 0.0240	5.78	0.000572645
8	Prothorax width	0.700 - 0.825	0.7475 ± 0.0389	5.20	0.001509323
9	Metathorax length	0.26 - 0.40	0.3223 ± 0.0384	11.92	0.001474944
10	Metathorax width	0.575 - 0.825	0.7085 ± 0.0655	9.24	0.004287107
11	Mesothorax length	0.3 - 0.4	0.3260 ± 0.0274	8.41	0.000751582
12	Mesothorax width	0.725 - 0.875	0.8163 ± 0.0461	5.65	0.002123366
13	Abdomen length	2.125 - 2.875	2.9400 ± 0.2248	7.65	0.050552576
14	Abdomen width	1.050 - 1.375	1.2300 ± 0.0724	5.88	0.005236838
15	Scape length	0.080 - 0.225	0.1328 ± 0.0349	26.25	0.001214383
16	Scape width	0.05 - 0.09	0.7775 ± 0.0241	3.09	0.000578000
17	Pedicel length	0.05 - 0.125	0.0793 ± 0.0142	17.88	0.000201000
18	Pedicel width	0.05-0.07	0.0625 ± 0.0079	12.58	0.000061840
19	Flagellum length	1.0 - 1.4	1.2725 ± 0.0827	6.50	0.006800000
20	Flagellum width	0.07 - 0.10	0.0810 ± 0.0055	6.82	0.000030530
21	Front legs:				
	Coxa length	0.27 - 0.32	0.2970 ± 0.0142	4.77	0.00020104
	Coxa width	0.16 - 0.2	0.1790 ± 0.0125	6.99	0.00015684
	Trochanter length	0.14 - 0.18	0.1655 ± 0.0119	7.20	0.00014184
	Trochanter width	0.05 - 0.08	0.0615 ± 0.0093	15.18	0.00008711
	Femur length	0.73 - 0.85	0.7835 ± 0.0345	4.41	0.00119237
	Femur width	0.20 - 0.26	0.2240 ± 0.0176	7.85	0.00030947
	Tibia length	0.72 - 0.80	0.7550 ± 0.0204	2.70	0.00041579
	Tibia width	0.10 - 0.17	0.1340 ± 0.0219	16.31	0.00047789
	Tarsus length	0.2 - 0.3	0.2610 ± 0.0308	11.79	0.00094632
	Tarsus width	0.05 - 0.06	0.0545 ± 0.0051	9.37	0.00002605
	Claw length	0.09 - 0.12	0.1045 ± 0.0083	7.90	0.00006816
	Claw width	0.02 - 0.03	0.2750 ± 0.0044	1.62	0.00001974
22	Middle legs:				
	Coxa length	0.28-0.33	0.3040 ± 0.0131	4.32	0.00017263
	Coxa width	0.16-0.22	0.1865 ± 0.0169	9.09	0.00028711
	Trochanter length	0.15-0.22	0.1890 ± 0.0205	10.84	0.00042000
	Trochanter width	0.05-0.09	0.0745 ± 0.0128	17.13	0.00016289
	Femur length	0.65-0.8	0.7370 ± 0.0456	6.18	0.00207474
	Femur width	0.17-0.23	0.1995 ± 0.0170	8.52	0.00028920
	Tibia length	0.69-0.76	0.7185 ± 0.0190	2.64	0.00036077
	Tibia width	0.09-0.013	0.1065 ± 0.0118	11.10	0.00013974
	Tarsus length	0.22-0.3	0.2590 ± 0.0229	8.85	0.00052528
	Tarsus width	0.05-0.07	0.0580 ± 0.0070	11.99	0.00004843
	Claw length	0.08-0.12	0.1030 ± 0.0126	12.24	0.00015894
	Claw width	0.02-0.03	0.0245 ± 0.0051	20.83	0.00002605
23	Rear legs:				
	Coxa length	0.28 - 0.33	0.3055 ± 0.0123	4.04	0.00015237
	Coxa width	0.18 - 0.22	0.2010 ± 0.0133	6.63	0.00017779
	Trochanter length	0.16 - 0.21	0.1875 ± 0.0133	7.11	0.00017764
	Trochanter width	0.05 - 0.08	0.0630 ± 0.0103	16.37	0.00010632
	Femur length	0.90 - 0.97	0.9100 ± 0.0243	2.67	0.00058947
	Femur width	0.20 - 0.26	0.2270 ± 0.0198	8.71	0.00039054

Appendix 4. To be continued

No	Parameters	O.R	Mean±SD	C.V (%)	S ²
	Tibia length	0.90 - 0.99	0.9385 ± 0.0289	3.08	0.00083446
	Tibia width	0.10 - 0.17	0.1260 ± 0.0223	17.73	0.00049894
	Tarsus length	0.27 - 0.32	0.2990 ± 0.0155	5.19	0.00024106
	Tarsus width	0.04 - 0.06	0.0545 ± 0.0069	12.59	0.00004710
	Claw length	0.09 - 0.15	0.1240 ± 0.0173	13.94	0.00029894
	Claw width	0.02 - 0.03	0.0255 ± 0.0051	20.02	0.00002605