Advances in Entomology, 2025, 13(1), 152-173
https://www.scirp.org/journal/ae
ISSN Online: 2331-2017
ISSN Print: 2331-1991

Diversity and Morphometrics of Palm Weevils of the Genus *Rhynchophorus* in Maniema Province, Democratic Republic of Congo

Angundji Yumbi Chérif[1,2*], Muhigwa Bahananga Jean-Berckmans[2], Manga Tshomba Joseph[3], Dieudonné Cikwanine[2], Murhabale Cisirika Bertin[2]

[1]Faculty of Agriculture and Environmental Sciences, University of the Mid-Lualaba of Kalima, Kalima, Democratic Republic of Congo
[2]Faculty of Agriculture and Environment, Official University of Bukavu, Bukavu, Democratic Republic of Congo
[3]Faculty of Agriculture and Environment, University of Kindu, Kindu, Democratic Republic of Congo
Email: *angundjicherif@gmail.com

How to cite this paper: Chérif, A.Y., Jean-Berckmans, M.B., Joseph, M.T., Cikwanine, D. and Bertin, M.C. (2025) Diversity and Morphometrics of Palm Weevils of the Genus *Rhynchophorus* in Maniema Province, Democratic Republic of Congo. *Advances in Entomology*, **13**, 152-173.
https://doi.org/10.4236/ae.2025.131011

Received: Decembr 20, 2024
Accepted: January 23, 2025
Published: January 26, 2025

Abstract

An inventory of *Rhynchophorus* species was carried out to determine their diversity, biogeographical variability and morphometrics. A shotgun trapping method was used at nine sites in three districts over a four-month period, identifying three species: *R. quadrangulus*, *R. phoenicis*, *R. ferrugineus* and a probable variant of *R. phoenicis*. Of these species, *R. phoenicis* stands out as the most widespread palm weevil, while the probable variant of *R. phoenicis* is considered the rarest subspecies in the Maniema region. The color of the head and elytra is a criterion for distinguishing the different species of *Rhynchophorus spp*. Morphological criteria indicate that the probable subspecies of *R. phoenicis* is the largest palm weevil in the Maniema region and even globally. It is followed by *R. quadrangulus* and, by far, by *R. phoenicis*. The smallest palm weevil in Maniema is *R. ferrugineus*. Moreover, these criteria reveal that, for all three species identified, the female is generally larger than the male. This study has the merit of extending the distribution of *R. ferrugineus* from the Maghreb to the central East of the DRC, and highlighting a subspecies of *R. phoenicis*. Recognition of the sexes on the basis of the shape of the tip of the abdomen (oval in the male and flat in the female) is an additional contribution.

Keywords

Inventory, Diversity, Morphometrics, Palm Weevils

1. Introduction

Entomophagy or the consumption of insects by humans [1] [2] is currently positioned as an important option for addressing the world's nutritional and environmental problems [3]. Entomophagy is not only a source of nutrients for local communities, but also a significant source of income [4] [5]. Among more than 1,900 species of edible insects, beetles are the most consumed by humans [2]. This preference is said to be due to their delicious taste and high levels of fat and other nutrients [6] [7]. Beetle larvae are high in fat, protein, vitamins, fiber and minerals [8]-[10]. Their nutritional value varies according to species, metamorphic stage, habitat and feed [2]. *Rhynchophorus* are important sources of proteins and essential micronutrients [4] [9] [11]-[13]. Research is now bringing to the forefront the nutritional value and variety of insects, rich in unsaturated fats, proteins, vitamins, fiber and minerals [14].

Worldwide, in Africa and in the Democratic Republic of Congo, several studies have been carried out on the identification and morphometrics of *Rhynchophorus spp* [15]-[22]. Unfortunately, the available information on palm weevils does not cover Maniema Region, including taxonomy and morphometrics, despite the fact that the palm weevil menu, called Mpose, is part of the dietary habits of the communities. So, there is a gap in the basic knowledge of species conservation status. Our research therefore aims to provide information on the species of *Rhynchophorus spp* consumed in this region. Specifically, this article seeks to identify *Rhynchophorus* species consumed and traded in the region. The hypothesis is that Maniema province abounds in a diversity of *Rhynchophorus* species similar to those found in the neighbouring province of Tshopo, 550km away as the crow flies [16]. This paper opens up new knowledge on rearing priorities for the market, regarding the choice of palm weevil species and stresses the need for genetic studies on a variant of *R. phoenicis* which looks like the South American *R. palmarum*. It further sheds light on palm tree ecosystem conservation.

2. Study Area, Materials and Methods

2.1. The Study Area

This study was carried out in the province of Maniema, located in the central East of the Democratic Republic of Congo (**Figure 1**). Maniema province is made up of seven (7) districts/territories: Kailo, Kibombo, Pangi, Kabambare, Punia, Lubutu and Kasongo [23]. *Rhynchophorus* sampling was carried out at nine sites in the following three areas: Kanombe, Kikezi, Mungembe (Pangi district); Katako, Shenge, Lokama (Kailo district); Difuma II, Lowe and Mamba Georges (Kibombo district) in Maniema province. Maniema is characterized by the equatorial warm and humid climate in the north and the humid tropical type in the south, passing through a transition zone in the center. Annual rainfall varies from 1300 mm in the south to 2300 mm in the north; with average temperatures ranging from 23˚C - 25˚C [24]. The pedogenesis presents three types of soils [25] with two main vegetal formations: dense rainforest and savannah. Maniema province has a very rich hydrographic network. It is crossed from south to north by the Congo River, which drains the waters of several tributaries that facilitate river traffic from Kindu to Ubundu to Kisangani, a very important route for supplying the province with manufactured goods [24].

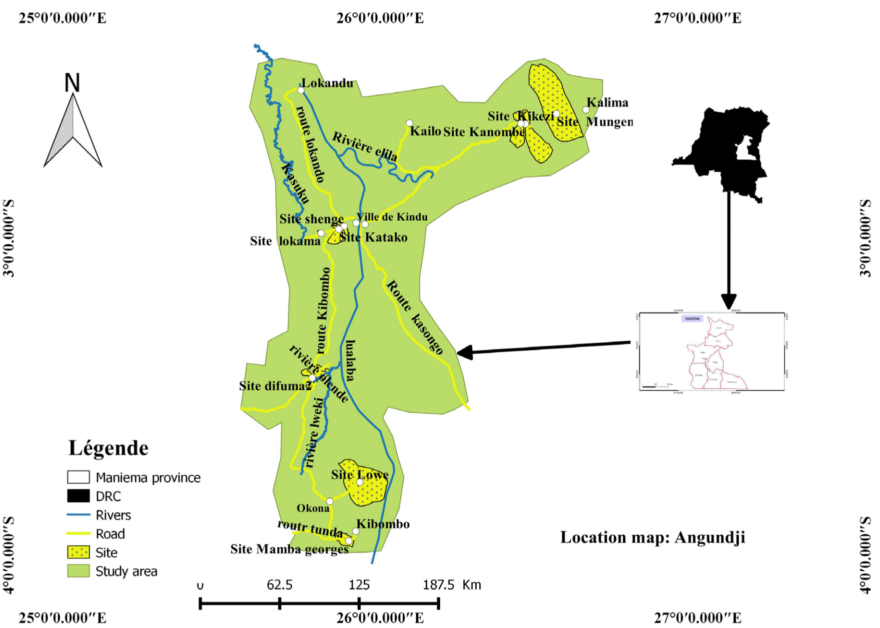

Figure 1. Location map.

2.2. Materials and Methods

2.2.1. Collection of *Rhynchophorus spp.*

To obtain the palm weevils, we used felled trapping (**Figure 2**); which involves cutting the palm tree, followed by covering the snag with pieces of the twigs, while wounding the trunk [16]. Weevils were also collected from palms felled during field opening and palm wine production. Felled palm snags covered with pieces of palm twig and trunks were wounded. At each site, we worked with 5 stakeholders (palm wine producers and/or farmers). As a result, 2177 weevils were collected from 90 palm trees, 10 per site, over a period of 4 months, during 14 visits per site.

Figure 2. Felled trapping.

2.2.2. Identification of *Rhynchophorus spp*. Weevils

The identification of *Rhynchophorus spp* species was based on the publications by [19] [21] [26] and the identification keys of [18] [27]-[29]. Individuals of *Rhynchophorus* species were counted, sexed, measured and pictures taken of the ventral and dorsal parts of each specimen.

2.2.3. Measurements of *Rhynchophorus spp*. Weevils

For morphometrics, 1,800 individuals of different species, including 200 per site, were measured. The following measurements were taken: fresh weight, total length, pronotum length, elytra length, wing and tibia length, weevil and pronotum width. Measurements were taken using a caliper. Individuals were weighed using a "Digital scale" precision balance (**Figure 3**) with a capacity and accuracy of 500 g × 0.01 g to determine fresh weight (g). The aim was to check if there were any differences between species and sexes.

Figure 3. Weighing facilities.

2.3. Data Archiving and Statistical Analysis

The various data sets collected were entered into an Excel 2013 spreadsheet, then exported and analyzed using Past 4.11 and Jamovi 2.3.28 free softwares. For morphometrics, a discriminant analysis was performed on Past 4.11 to differentiate species or sexes according to all morphometric parameters or their proportions. Means were compared using the non-parametric Kruskal-Wallis test on Jamovi 2.3.28 software, with a significance level of 5%. Morphometric proportions were calculated by dividing the various parameters by the total length for lengths. Descriptive analysis was performed on the morphometric parameters to determine the values of arithmetic means, medians, standard deviation, minimum, maximum and coefficients of variation. Analysis of variance was performed to compare morphometric parameters by species, sex and species/sex interactions, as well as species availability by site. Qualitative parameters were converted into scores to facilitate multivariate quantitative analyses. Principal component analysis (PCA) was performed with Past 4.11 software, while path diagrams on Jasp 0.18.3.0 facilitated graphical representation of PCA, apart from the usual graphs.

3. Results

3.1. Palm Weevil Species Inventory

The palm weevil species of the genus *Rhynchophorus* identified in Maniema province, covering three districts and nine locations, are shown in Figure 4.

Figure 4. Pictures of *Rhynchophorus* species identified in Maniema province.

Maniema province is rich in *Rhynchophorus* species diversity. Three species, namely *R. quadrangulus, R. phoenicis, R. ferrugineus* and a probable variant of *R. phoenicis* were identified. A total of 2,177 palm weevils were caught in the shot traps. The distribution of captures was as follows: 230 weevils at Difuma II location, 268 at Kanombe, 213 at Katako, 222 at Kikezi, 200 at Lokama and Lowe, and 442 at Mamba Georges, as well as 201 at Mungembe and Shenge. All of three species and the probable variant of *R. phoenicis* were present at the following sites: Kanombe, Mungembe, Shenge, Difuma 2 and Mamba Georges. In contrast, the probable variant of *R. phoenicis* was not observed at Kikezi, nor was *R. quadrangulus* collected at Lokama, nor was *R. ferrugineus* found at Lowe and Katako.

Head coloration is an essential distinguishing criterion. The probable variant of

R. phoenicis has a black head and elytra. *R. ferrugineus*, on the other hand, has a red head dotted with black spots. The arrangement of spots on the pronotum varies from one individual to another. *R. phoenicis* has two pronotum color variations. *R. phoenicis* with a black pronotum has two red bands on the pronotum, while *R. phoenicis* with a red pronotum has three black bands. *R. quadrangulus* has a black head with a red stripe running from left to right at the tip of the pronotum. The black coloring of the head also differentiates the probable variant of *R. phoenicis* from the other three species. The black color of the elytra in the probable variant of *R. phoenicis*, *R. phoenicis* and *R. quadrangulus* contrasts in 91% of cases. Red elytra predominate in *R. ferrugineus* (92% of cases), but can also be red/black (8%). In 9% of cases, red/black elytra are also found in *R. phoenicis*. This finding leads us to conclude that *R. phoenicis* and *R. ferrugineus* show color variability in the elytra and pronotum. The color of the belly is red in *R. ferrugineus* (99% of cases) as much as in *R. phoenicis* and *quadrangulus*. The red/black belly is observed in the probable variant of *R. phoenicis*. The morphology of the tip of the abdomen housing the genital organ seems to be determined exclusively by sexual dimorphism; this structure is oval in shape in males and flattened in females in the three species and the probable variant of *R. phoenicis* concerned. Variability in morphometrics was tested as a function of qualitative parameters, namely: elytron and head color; belly color and abdominal tip shape. Both in females and males, the species differed significantly in elytron and head color.

3.1.2. Frequency of *Rhynchophorus* Species in Maniema Province

Figure 5 shows the frequency distribution of *Rhynchophorus* species identified in province.

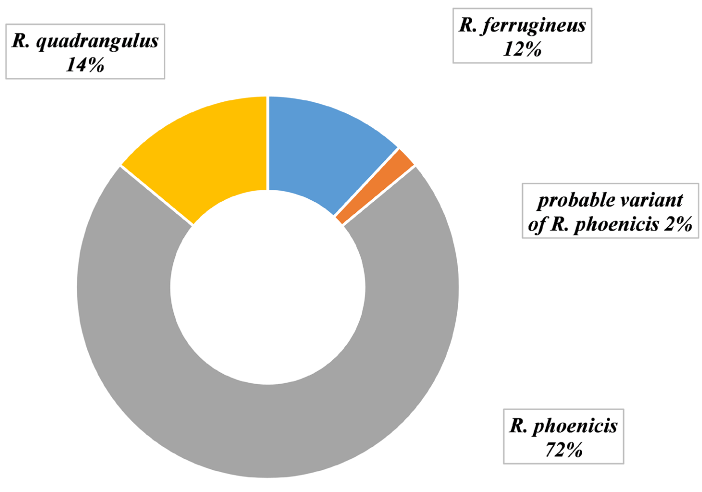

Figure 5. Frequencies of *Rhynchophorus* species in Maniema province.

Among the species identified, *R. phoenicis* stands out as the most widespread palm weevil in the Maniema region, with a frequency of 72%; as opposed to *R. quadrangulus* and *R. ferrugineus*, which account for 14% and 12% respectively. It should be noted that the probable *R. phoenicis* variant is much less frequent, reaching only 2% (**Figure 5**).

3.1.3. Abundance of *Rhynchophorus* Species by Site

Figure 6 shows the means (standard errors bars) of palm weevils caught by species and by area surveyed in Maniema province.

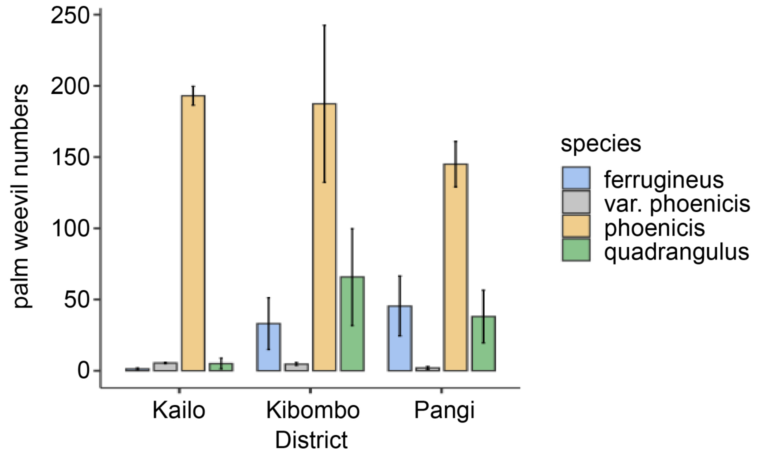

Figure 6. Mean counts of *Rhynchophorus* species by district (n = 3).

All of the three species were present at the following sites (**Table 1**): Kanombe and Mungembe (Pangi district), Shenge (Kailo district), Difuma II and Mamba Georges (Kibombo district). On the other hand, the probable variant of *R. phoenicis* was not observed in Kikezi (Pangi district), nor was *R. quadrangulus* collected in Lokama (Kailo district), nor was *R. ferrugineus* found in Lowe (Kibombo district) and Katako (Kailo district). In the study districts, *R. phoenicis* is generally the most abundant and dominant species. Variations in average counts between

Table 1. Descriptive statistics of *Rhynchophorus* species by district (n = 3).

District	Species	Mean	Median	Sum	SD	Minimum	Maximum
Kailo	*R. ferrugineus*	1.33	2	4	1.155	0	2
	var. *phoenicis*	5.33	5	16	0.577	5	6
	R. phoenicis	193	192	579	11.533	182	205
	R. quadrangulus	5	3	15	6.245	0	12
Kibombo	*R. ferrugineus*	33	36	99	31.607	0	63
	var. *phoenicis*	4.67	5	14	1.528	3	6
	R. phoenicis	187.33	191	562	95.553	90	281
	R. quadrangulus	65.67	74	197	58.943	3	120
Pangi	*R. ferrugineus*	45.33	40	136	36.295	12	84
	var. *phoenicis*	2	3	6	1.732	0	3
	R. phoenicis	145	150	435	27.839	115	170
	R. quadrangulus	38	23	114	32.234	16	75

species appear to be significant from one district to another. Significant disparities in the geographic distribution of species occurred (**Figure 6**). The sex ratio is approximately 1:1 for *R. ferrugineus* and *R. phoenicis*, while it reaches around 2.7:1 for *R. quadrangulus*. Genetic and behavioral differences may explain this discrepancy. For example, there may be a time lag in cocoon hatching between males and females of this species. As for the probable variant *R. phoenicis*, the scarcity of available specimens makes it impossible to estimate this sex ratio.

3.2 Weevil Morphometrics

Figure 7 shows the results of the discriminant analysis of all morphometric parameters for species of the genus *Rhynchophorus* identified in Maniema.

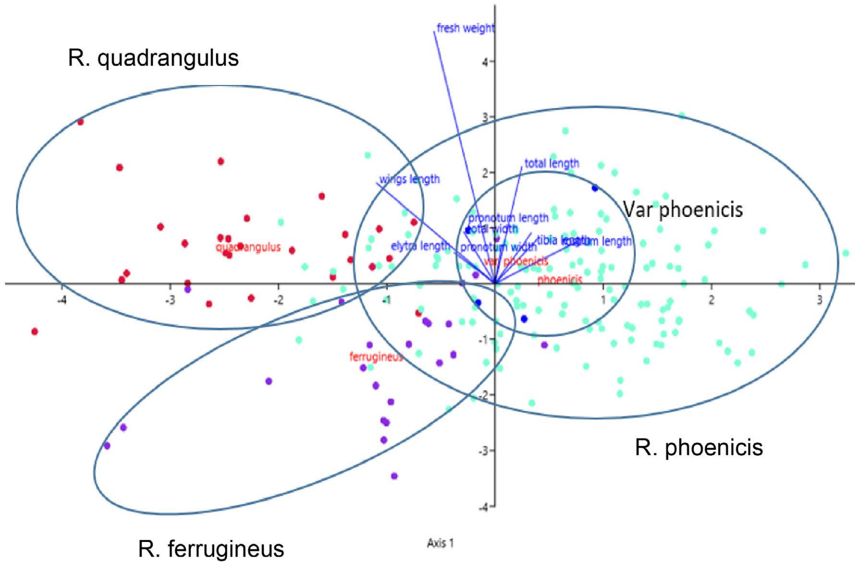

Figure 7. Discriminant analysis of all morphometric parameters of the genus *Rhynchophorus* (specimens of the probable variant of R. phoenicis are completely included within the *R. phoenicis* morphometric span).

The discriminant analysis (**Figure 7**) groups the individuals into three categories of the *Rhynchophorus* genus: *quadrangulus*, *phoenicis*, *ferrugineus* and a probable variant of *R. phoenicis*. The probable variant of *R. phoenicis* (strongly resembling to *R. palmarum*) is completely included in the morphometric distribution of *R. phoenicis*. The very low abundance of this variant is part of this argument, as is the great distance from the known geographical distribution of *R. palmarum* in Central and South America. Initially, we assimilated the black weevil identified in Maniema to *R. palmarum* due to the color of the elytra and pronotum. However, discriminant analysis then associated it morphometrically with *R. phoenicis*. These morphological parameters suggest that the black palm weevil identified in Maniema could be a probable subspecies of *R. phoenicis*. This would require genetic / molecular studies to ascertain whether it is a subspecies of *R. phoenicis*, which, incidentally, shows considerable morphometric variability.

3.2.1. Fresh Weight

Figure 8 shows the means and standard errors of the fresh weight (g) of palm weevils collected in Maniema province.

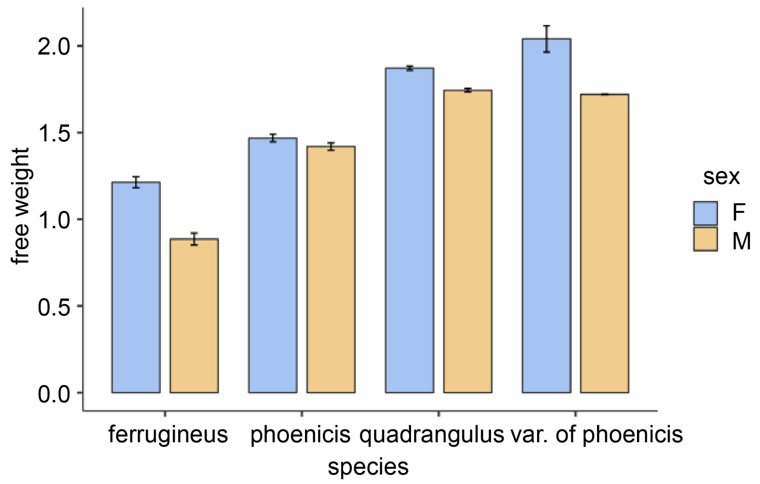

Figure 8. Fresh weight (g) of *Rhynchophorus* species (n = 66 - 667; except var. phoenicis, n = 9 - 27).

Comparison of means reveals that fresh weights differ according to species (Kruskal-Wallis; $X^2 = 7.67$, dl = 1; $p = 0.006$). For *R. ferrugineus*, weights ranged from 0.70 - 1.50 g for females and 0.56 - 1.50 g for males. Mean weights were 1.21 ± 0.32 for females and 0.88 ± 0.35 for males respectively. For *R. phoenicis*, weights ranged from 0.58 - 2.88 g for females and 0.60 - 2.80 g for males. Average weights were 1.46 ± 0.55 g for females and 1.41 ± 0.52 g for males. In *R. quadrangulus*, female weights ranged from 1.69 - 1.98 g, while male weights where 1.42 - 1.92 g. Mean weights were 1.87 ± 0.10 g for females and 1.74 ± 0.13 for males. For the probable *R. phoenicis* variant, female weights ranged from 1.50 - 2.38 g, while males were close to 1.72 g. Average weights for this probable subspecies are 2.04 ± 0.39 for females and 1.72 ± 0.00 for males. In all three weevil species and in the probable *R. phoenicis* variant, the female has a higher fresh weight than the male ($p < 0.05$). ANOVA (Tukey's post hoc test) of weights according to species shows that the probable variant of *R. phoenicis* has a higher mean weight than *R. quadrangulus;* on the other hand, *R. quadrangulus* has a greater mean fresh weight than *R. phoenicis*, and *R. phoenicis* weighs more than *R. ferrugineus* ($p < 0.05$). On the other hand, no significant difference was observed between the weights of the probable variant of *R. phoenicis* and *R. quadrangulus* ($p > 0.05$).

3.2.2. Total Length

Figure 9 shows the means and standard errors of the total length of weevils caught in the field in Maniema province.

The results show that total length averages vary according to species and sex. For *R. ferrugineus*, the minimum total length was 2.80 cm, while the maximum length was 4.1 cm for females and 3.2 - 4 cm for males. The averages observed are

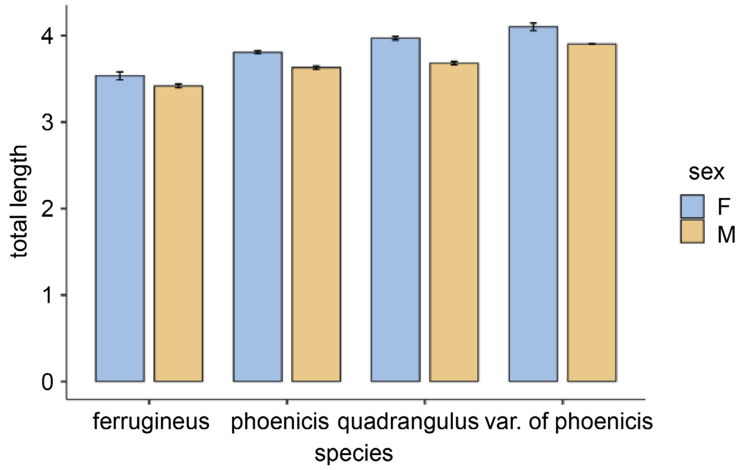

Figure 9. Total length of weevils of the genus *Rhynchophorus* (n = 66 - 667; except var. phoenicis, n = 9 - 27).

3.5 ± 0.46 for females and 3.4 ± 0.22 for males. *For R. phoenicis*, total length varies between 2.7 - 4.5 cm in both females and males. Mean total lengths are 3.8 ± 0.42 cm for females and 3.6 ± 0.46 for males. In *R. quadrangulus*, total length varies between 3.7 - 4.3 cm for females, and between 3.2 - 4.2 cm for males. Mean lengths are 3.9 ± 0.17 for females and 3.7 ± 0.26 for males. For the probable *R. phoenicis* variant, the total length of females ranged from 3.8 - 4.3 cm, while that of males was 3.9 cm. Mean lengths are 4.1 ± 0.22 for females and 3.9 ± 0.0 for males. Total length is significantly higher in females than in males for all three weevil species and the probable *R. phoenicis* variant. Means of total length between individuals of the species reveal a highly significant difference (Kruskal-Wallis; $X^2 = 95.74$, dl = 1; $p < 0.001$). Tukey's post-hoc test shows that the probable variant of *R. phoenicis* has a higher mean total length than *R. quadrangulus;* on the other hand, *R. quadrangulus* is longer than *R. phoenicis*; while *R. phoenicis* is longer than *R. ferrugineus* ($p < 0.05$).

3.2.3. Width

Figure 10 shows the results for the mean of the total width (cm) of weevil species identified in Maniema province.

Total widths varied significantly between species (Kruskal-wallis; $X^2 = 16.07$, df = 1, P =< 0.001). The total width of *R. ferrugineus* weevils varied between 0.7 - 1.10 cm for females, and between 0.8 - 1.0 cm for males. Average widths were 0.9 ± 0.14 cm for females and 0.9 ± 0.07 cm for males of *R. ferrugineus*. *For R. phoenicis*, total widths range from 0.6 - 1.4 cm for females, and 0.6 - 1.30 cm for males. The observed averages are 1.0 ± 0.14 in females and 0.97 ± 0.15 cm in males. In *R. quadrangulus*, total width varies from 1.00 to 1.30 cm in females and from 0.90 to 1.30 cm in males. Total width averages 1.1 ± 0.08 cm for females and 1.19 ± 0.11 cm for males. For the probable *R. phoenicis* variant, total widths ranged from 1.0 - 1.20 cm for females and 1.0 cm for males. Total width averages for this variant are 1.1 ± 0.08 cm in females and 1.0 ± 0.00 cm in males. Total width averages are higher for females than males in these 4 weevil species ($p < 0.05$). Tukey's post-hoc test shows that *R. quadrangulus* is wider than the probable variant of *R. phoenicis*; on the other hand, the probable variant of *R. phoenicis* is wider than *R. phoenicis*. *R. phoenicis* is wider than *R. ferrugineus* ($p < 0.05$).

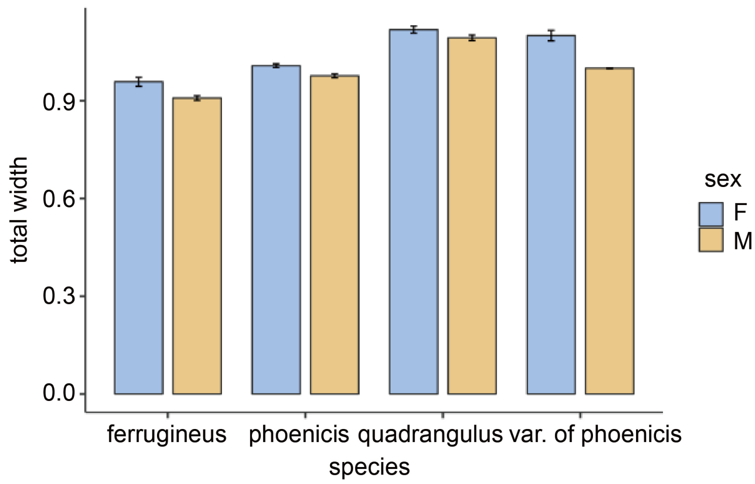

Figure 10. Total weevil width (n = 66 - 667; except var. phoenicis, n = 9 - 27).

3.2.4. Wing Length

Figure 11 shows the means and standard errors of wing length (cm) for *Rhynchophorus* species recorded in Maniema province, Democratic Republic of Congo.

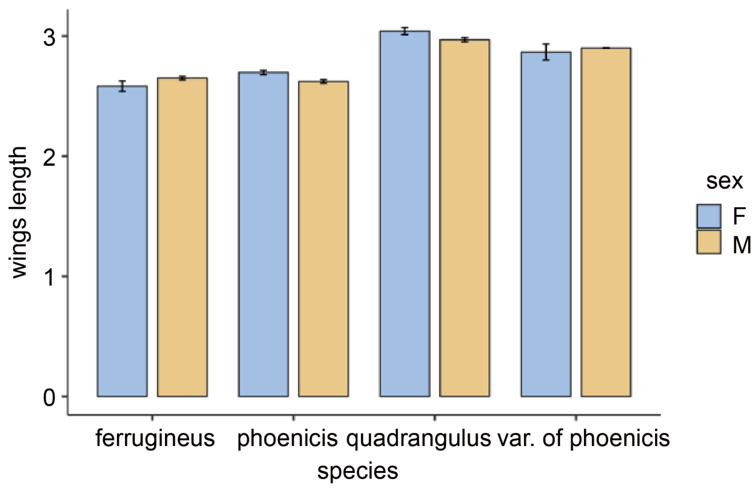

Figure 11. Means and standard errors of weevil wing length.

The wing length of *R. ferrugineus* varies between 2.0 - 3.0 cm for females and 2.5 - 3.0 cm for males. Average wing lengths are 2.6 ± 0.44 cm for females and 2.6 ± 0.15 cm for males. For *R. phoenicis*, female wing lengths range from 1.4 - 3.8 cm, while male wing lengths vary from 2.0 - 3.20 cm. Average wing lengths are 2.7 ± 0.46 cm for females and 2.6 ± 0.36 cm for males. In *R. quadrangulus*, total wing length varies from 2.6 - 3.40 cm in both females and males. The maximum total length is identical for both sexes. The mean total wing lengths are 3.0 ± 0.23 cm for females and 3.0 ± 0.22 cm for males. For the probable *R. phoenicis* variant, total wing length ranges from 2.4 - 3.20 cm in females and 2.9 cm in males. The average wing length is 2.9 ± 0.03 in females and 2.90 ± 0.00 in males. Wings are exceptionally longer in males than in females for *R. ferrugineus* and the probable variant of *R. phoenicis* ($p < 0.05$). Tukey's post-hoc test shows that *R. quadrangulus* has longer wings than the probable variant of *R. phoenicis;* on the other hand, the probable variant of *R. phoenicis* has longer winged than *R. phoenicis*. *R. phoenicis* has longer winged than *R. ferrugineus* ($p > 0.05$). On the other hand, there is no significant difference in wing length between *R. ferrugineus* and *R. phoenicis* ($p > 0.05$).

3.2.5. Length of Elytra

Figure 12 shows the mean elytral length (cm) for weevils identified in Maniema province.

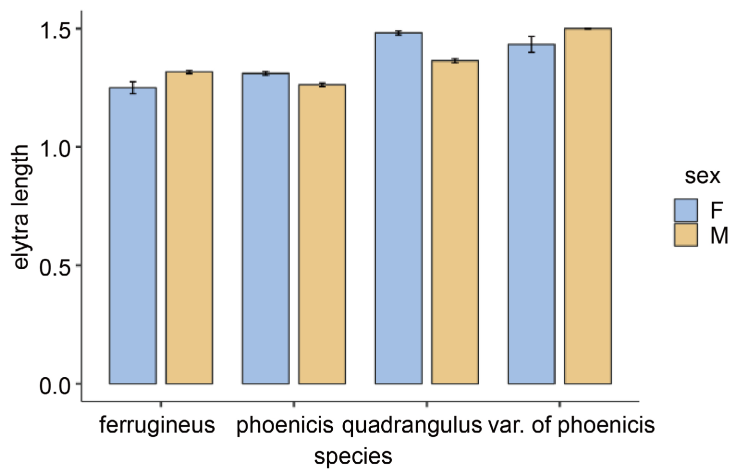

Figure 12. Means and standard errors of weevil elytron length in cm.

The Kruskal-Wallis test shows that elytral length differs significantly ($X^2 = 19.86$, df = 1, P =< 0.001) between species. Elytral length in *R. ferrugineus* varies between 0.8 - 1.6 cm for females, and between 1.20 cm and 1.40 cm for males. Average elytral lengths are 1.3 ± 0.26 for females and 1.3 ± 0.06 for males. For *R. phoenicis*, elytra lengths fluctuate between 0.90 - 1.60 cm in both females and males. Average elytral lengths are 1.31 ± 0.19 for females and 1.26 ± 0.19 for males. In *R. quadrangulus*, elytra length varies from 1.4 - 1.6 cm in females and from 1.1 - 1.6 cm in males. Mean values for elytral length are 1.48 ± 0.07 for females and 1.36 ± 0.11 for males. For the probable *R. phoenicis* variant, elytral length ranges from 1.2 - 1.6 cm in females, while in males it is 1.5 cm, with identical minimum and maximum values. Elytral length averaged 1.43 ± 0.17 in females and 1.50 ± 0.00 in males. Females of *R. quadrangulus* and *R. phoenicis* had higher mean elytral lengths than males, while males of the other species had higher mean elytral lengths than females. Tukey's post-hoc test shows that the probable variant of *R. phoenicis* has longer elytra than *R. quadrangulus* ($p > 0.05$); on the other hand, *R. quadrangulus* has longer elytra than *R. phoenicis* ($p < 0.05$). In turn, *R. phoenicis* has longer elytra than *R. ferrugineus*. There was no significant difference in elytral length between *R. ferrugineus* and *R. phoenicis* ($p > 0.05$).

3.2.6. Length of Tibia

Figure 13 shows the means of tibial length (cm) by species and sex.

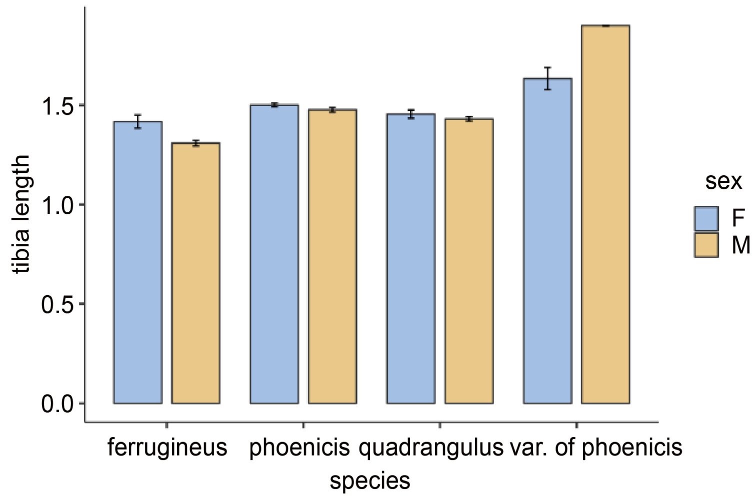

Figure 13. Means and standard errors of tibial length (cm).

Non-parametric Kruskal-Wallis analysis shows a highly significant difference in tibial length between species ($X^2 = 9.71$, dl = 1, $P = 0.002$). Tibial length in *R. ferrugineus* ranged from 1.0 - 1.8 cm for females and 0.1 - 1.8 cm for males. The averages are 1.4 ± 0.34 cm for females and 1.3 ± 0.15 for males. For *R. phoenicis*, tibial length ranged from 1.0 to 1.90 cm for females, and from 0.9 to 2.0 cm for males. Average tibia lengths are 1.0 ± 0.23 for females and 1.5 ± 0.30 for males. In *R. quadrangulus*, female tibial lengths range from 1.1 to 1.8 cm, while male tibia lengths range from 1.2 - 1.8 cm. Average tibial length is 1.45 ± 0.16 in females and 1.43 ± 0.14 in males. For the probable *R. phoenicis* variant, tibial length in females ranged from 1.3 - 2.0 cm, while in males it was around 1.90 cm. Average tibial lengths are 1.6 ± 0.29 in females and 1.9 ± 0.00 in males. Average tibial lengths are generally higher in females, with the exception of the probable *R. phoenicis* variant. Tukey's post-hoc test shows that the probable *R. phoenicis* variant has a longer tibia than *R. phoenicis;* however, *R. phoenicis* has a longer tibia than *R. quadrangulus* and *R. quadrangulus* has a longer tibia than *R. ferrugineus* ($p < 0.05$). There was no difference between *R. phoenicis* and *R. quadrangulus* ($p > 0.05$).

3.2.7. Length of Rostrum (cm)

The means (with standard error bars) of rostrum length are shown in **Figure 14**.

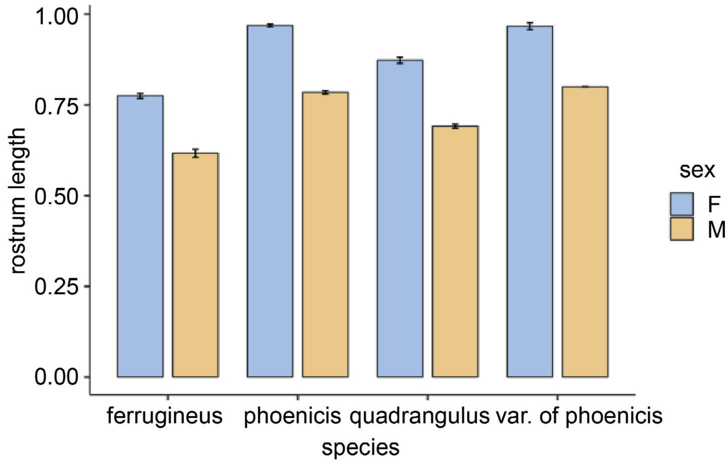

Figure 14. Means and standard errors of rostrum length.

The Kruskal-Wallis test for rostrum length reveals a highly significant difference ($X^2 = 71108$, df = 1, P =< 0.001) between species. R. *ferrugineus* rostrum length ranged from 0.7 - 0.9 cm in females and 0.3 - 0.7 cm in males. Mean values are 0.8 ± 0.07 cm for females and 0.6 ± 0.11 cm for males. For *R. phoenicis*, rostrum length ranged from 0.7 - 1.2 cm in females, and 0.5 - 1.1 cm in males. The observed averages are 1.0 ± 0.11 for females and 0.8 ± 0.11 for males. In *R. quadrangulus*, rostrum length varies from 0.8 - 1.0 cm in females and 0.6 - 0.9 cm in males. Average rostrum lengths are 0.9 ± 0.06 for females and 0.7 ± 0.06 for males. For the probable *R. phoenicis* variant, rostrum length ranged from 0.9 - 1.0 cm in females, while it reached 0.8 cm in males. Average rostrum lengths are 1.0 ± 0.04 cm in females and 0.8 ± 0.00 cm in males. The rostrum is longer in females than in males in these palm weevil species. *R. phoenicis* and the probable variant of *R. phoenicis* have a longer rostrum than the other species ($p < 0.05$). Tukey's post-hoc test shows that the probable variant of *R. phoenicis* has a longer rostrum than *R. phoenicis*; and *R. phoenicis* has a longer rostrum than *R. quadrangulus*. On the other hand, *quadrangulus* has a longer rostrum than *R. ferrugineus* ($p < 0.05$).

3.2.8. Length of Pronotum

Results for average total pronotum length are shown in Figure 15.

The Kruskal-Wallis test shows that total pronotum length differs significantly between species ($X^2 = 17.86$, dl = 1, p = 0.001). The pronotum length of *R. ferrugineus* ranges from 0.6 - 0.9 cm in females, and from 0.7 - 0.9 cm in males. Mean pronotum lengths are 0.8 ± 0.11 cm in females and 0.8 ± 0.06 cm in males. For *R. phoenicis*, pronotum length varies between 0.6 - 1.2 cm in both females and males. Mean pronotum lengths are 0.9 ± 0.12 cm for females and 0.9 ± 0.13 cm for males. In *R. quadrangulus*, pronotum length varies from 0.8 - 1.1 cm for females and 0.8 - 1.0 cm for males. Mean pronotum lengths are 0.9 ± 0.08 for females and 0.9 ± 0.06 for males respectively. For the probable *R. phoenicis* variant, pronotum length for females ranged from 0.8 - 1.2 cm, while that for males was 1.0 cm. Pronotum length averages are identical for both sexes, at 1.0 ± 0.16. Average pronotum lengths for females *of R. ferrugineus*, *R. phoenicis* and *R. quadrangulus* exceed those of males. In contrast, pronotum length in the probable variant of *R. phoenicis* is identical for males and females. The probable variant of *R. phoenicis* has a longer pronotum than *R. phoenicis* ($p = 0.05$). On the other hand, *R. phoenicis* has a longer pronotum than *R. quadrangulus* ($p > 0.05$). In turn, *R. quadrangulus* has a longer pronotum than *R. ferrugineus* ($p < 0.05$).

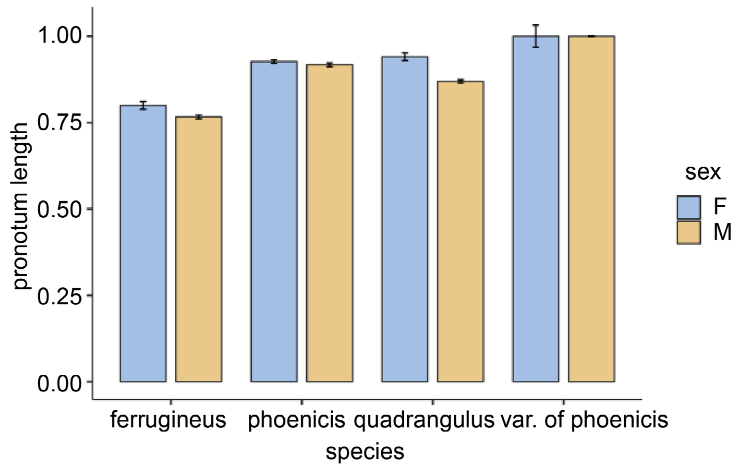

Figure 15. Means (with standard errors) for pronotum length.

3.2.9. Width of Pronotum

Figure 16 shows the results for average pronotum width by species and sex of palm weevil.

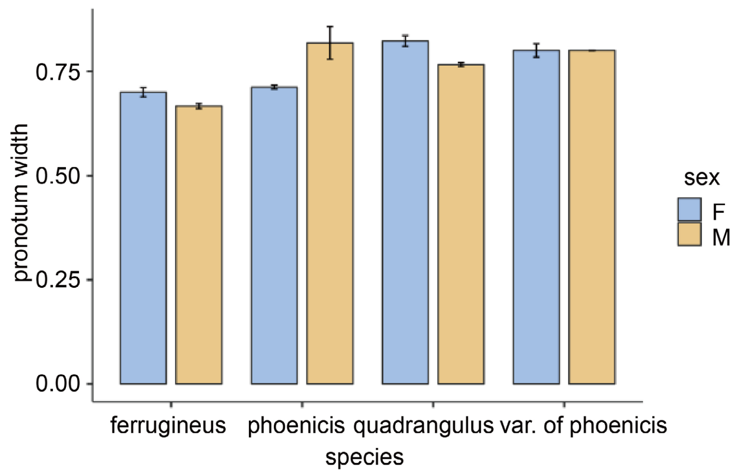

Figure 16. Means and standard errors for pronotum width.

There was no significant difference in pronotum width between species. The width of R. *ferrugineus* varies between 0.5 and 0.8 cm for females, and between 0.6 and 0.8 cm for males. Average pronotum widths are 0.70 ± 0.11 cm for females and 0.66 ± 0.06 cm for males. For *R. phoenicis*, pronotum width ranged from 0.4 - 0.9 cm for both females and males. Average pronotum widths for R. phoenicis are 0.71 ± 0.12 cm for females and 0.81 ± 0.98 cm for males. In *R. quadrangulus*, pronotum width varies from 0.7 - 1.0 cm for females and also remains between 0.7 - 1.0 cm for males. Average pronotum widths are 0.82 ± 0.10 for females and 0.76 ± 0.06 for males. For the probable *R. phoenicis* variant, pronotum width varies from 0.7 - 0.9 cm in females, and 0.8 cm in males. The mean pronotum width was identical in males and females, at 0.8 ± 0.08. Mean pronotum widths were significantly greater in females of *R. ferrugineus* and *R. quadrangulus* than in males ($p > 0.05$). In contrast, pronotum width in the probable variant of *R. phoenicis* is similar for both sexes, while in *R. phoenicis* it is higher in males.

4. Discussion

4.1. Weevil Inventory

Our results revealed three species of the genus *Rhynchophorus* in Maniema province, namely: *R. quadrangulus*, *R. phoenicis*, *R. ferrugineus* and a probable variant of *R. phoenicis*. Similarly, in the equatorial climate around Kisangani, 550km away as the crow flies, three species of the *Rhynchophorus* genus were also observed: *R. phoenicis*, *R. ferrugineus* and *R. quadrangulus* [16]. There are currently ten (10) species belonging to the genus *Rhynchophorus* worldwide, including: *R. ferrugineus* Olivier (Asia), *R. palmarum* L in Central and South America; *R. cruentatus* Fabricius, (America), *R. phoenicis* Fabricius, (Africa), *R. quadrangulus* (*Africa*), *R. vulneratus* (*Asia*), *R. bilineatus* (Asia), *R. distinctus* Wattanapongsiri (Asia), *R. lobatus* Wattanapongsiri (Asia) and *R. ritcheri* New species [18]. All of the three species and the probable variant of *R. phoenicis* were present at the following sites: Kanombe and Mungembe (Pangi territory), Shenge (Kailo territory), Difuma II and Mamba Georges (Kibombo territory). In contrast, the probable variant of *R. phoenicis* was not observed in Kikezi (Pangi territory), nor was *R. quadrangulus* collected in Lokama (Kailo territory), nor was *R. ferrugineus* found in Lowe (Kibombo territory) and Katako (Kailo territory). In Maniema province, *R. phoenicis* is the most abundant and frequent palm weevil species. According to [18], *R. phoenicis* is the most abundant species in the three study sites in Kisangani too, a region 550 km away from Kindu. There, *R. ferrugineus* is a rare species, while *R. quadrangulus* is relatively absent. The Tshopo and Lubunga sites each had three species, while the Bangboka site had only one (*R. phoenicis*).

The sex ratios of the *R. ferrugineus* and *R. phoenicis* species are almost equivalent, with a ratio of around 1:1. In contrast, for the *R. quadrangulus* species, the ratio is around 2.7:1; which could be explained by genetic or behavioral differences. It is conceivable that this disparity is associated with a different cocoon hatching time between males and females of this species [30] [31]. As for the probable *R. phoenicis* variant, the scarcity of specimens makes it hard to assess this ratio. It is important to note that these species of the genus *Rhynchophorus* are characterized by their high proliferation. According to [16], the development of the *Rhynchophorus spp* community is proving beneficial for Kisangani, as the sex ratio was 0.5 in 2012, whereas in 2013 it reached 0.6, characterizing a rapidly expanding population.

Regarding species coloration, the color of the head and elytra is an important criterion for distinguishing species. The probable variant of *R. phoenicis* has a black head. *R. ferrugineus*, on the other hand, has a red head dotted with black spots. It should be noted that the arrangement of spots on the pronotum can vary from one individual to another. [32] demonstrated that *R. ferrugineus* shows variations in the color pattern of its pronotum, these differences being closely linked to host plants. According to [33], in the past, color variations in adult *R. ferrugineus* led to numerous taxonomic changes. Molecular research suggests that *R. ferrugineus* may be a species complex composed of at least two cryptic species. According to [18], the pronotum of *R. phoenicis* shows a diversity of colors. When the pronotum is red, it has three black stripes, while when it is black, there are only two red stripes along the length of the pronotum. *R. quadrangulus* has a black head, with a red stripe running horizontally from left to right at the tip of the pronotum.

4.2. Weevil Morphometrics

There is little information on the morphometrics of weevils of species of the genus *Rhynchophorus* in the scientific literature. Most publications restrict to body length and width, generally focusing on individuals, without mentioning sex in other cases. The morphometric parameters of our results show that the female is larger: its fresh weight, total length, total width and rostrum length are all larger than those of the male. The average elytral and wing lengths are larger in females of *R. quadrangulus* and *R. phoenicis* species. Wings are exceptionally longer in males than in females of *R. ferrugineus* and the probable variant of *R. phoenicis*. The mean pronotum lengths are identical for both sexes of the probable variant of *R. phoenicis*. Pronotum width averages are higher in females of *R. ferrugineus* and *R. quadrangulus* than in males. In contrast, pronotum width in the probable *R. phoenicis* variant is identical for both sexes, while in *R. phoenicis* it is higher in males. [26] shows that, on average, males have longer tibiae than females. On the other hand, females have longer elytra. This is probably linked to the size of the abdomen, which is filled with eggs. It is also possible that this is linked to better flight capabilities. According to [34], *Rhynchophorus* adults observed in Meghalaya (India) measure between 33 - 34 mm in length and between 11 - 13 mm in width. Furthermore, according to [35], adult male body length varies from 19 to 42 mm, with a width ranging from 8 - 16 mm. Adult females range from 26 - 40 mm in length, with a width of 10 - 16 mm. An earlier study by [18] revealed that males and females of palm weevil species are notably homogeneous in terms of body size, with the exception of rostrum length. Males average between 31 - 39 mm in length, while females range from 29 - 40 mm. In terms of width, males are between 11 - 15 mm, compared with 12 - 14 mm for females. In addition, [36] observed clear sexual dimorphism in *R. ferrugineus*. [19] observed sexual dimorphism in terms of adult size, with females showing greater dimensions than males, both for the length and width of the abdomen and pronotum, as well as for the length of the rostrum. This difference is probably linked to the reproductive characteristics of the females. Indeed, the dimorphism observed in rostrum size is generally attributed to selection pressure exerted in favor of increasing rostrum length in females. The rostrum is used by adult females to excavate and prepare spawning sites. It also acts as an ovipositor and seems to have been a crucial factor in the evolutionary process [37]. According to the work of [26], no significant differences were observed between males and females of the species identified in Kisangani concerning several morphometric measurements such as total length, total width, wing length and total weight. In contrast, females had slightly longer elytra than males, while males have longer tibiae than females.

The means and standard deviations of the measurements of black weevils identified in Maniema are as follows: 41.0 ± 0.22 mm for total length; 10.00 ± 0.16 mm for pronotum length and 8.00 ± 0.08 mm for pronotum width. In contrast, the black weevil (*R. bilineatus*) identified in Indonesia by [32] has the following average measurements: total length (30.393 ± 2.229 mm), pronotum length (10.834 ± 0.910 mm) and pronotum width (9.919 ± 0.810 mm). According to [38], the morphometric values for *R. palmarum:* total length (31.39 ± 1.15 mm), pronotum length (12.29 ± 0.51 mm) and pronotum width (10.38 ± 0.40 mm).

In this research, the black weevil identified in Maniema is similar to *R. palmarum* and *R. bilineatus* in several respects, with a larger body size than *R. bilineatus* and *R. palmarum*. On the other hand, pronotum length and width are inferior to those of *R. bilineatus* and *R. palmarum*. Initially, we assimilated the black weevil identified in Maniema to *R. palmarum* due to the color of the elytra and pronotum. However, discriminant analysis then associated it morphometrically with *R. phoenicis*. These morphological differences suggest that the large black palm weevil, probably the largest in the world, identified in Maniema, could be a probable variant or subspecies of *R. phoenicis*.

We found the likely variant of *R. phoenicis* at various sites in Maniema region, including Kanombe, Mungembe, Shenge, Difuma 2, Lokama and Mamba Georges. This weevil is hosted by raphia palm trees in Kanombe and Mungembe, and it colonizes oil palms in Shenge, Difuma 2, Lokama and Mamba Georges. Its head and elytra are black. It is likely the largest palm weevil. Rearing may grant its conservation.

5. Conclusions

The aim of our study was to identify the number of species of the genus *Rhynchophorus spp* present in Maniema province, assess their abundance and characterize their morphometrics. Nine sites were selected: Mungembe, Kikezi and Kanombe in Pangi district; Katako, Shenge and Lokama in Kailo district; and Difuma II, Lowe and Mamba Georges in Kibombo district. Three species of *Rhynchophorus* were identified: *quadrangulus*, *phoenicis*, *ferrugineus* and a probable variant of *R. phoenicis*. Of all the species identified, *R. phoenicis* is the most predominant palm weevil and the rarest species is a probable variant of *R. phoenicis* in this region of Maniema. On the other hand, the probable variant of *R. phoenicis* is completely included in the morphometrics distribution of *R. phoenicis*. This would require genetic studies to reassure us that it is a variant of *R. phoenicis* which, incidentally, shows high morphometrics variability. Its very low abundance is part of this argument, as is the considerable distance from the known geographical distribution of *R. palmarum*. Head color is a consistent feature for differentiating species. This is the case with *R. phoenicis* and *R. ferrugineus* color variability in the elytra and the pronotum. Overall, morphological criteria (fresh weight, total length, total width, pronotum length, wing length, elytral length) show that the probable variant of *R. phoenicis* is the largest species in Maniema. It is followed by *R. quadrangulus* and, by far, by *R. phoenicis*. The smallest palm weevil in Maniema province is *R. ferrugineus*. These criteria also show that the female is larger than the male in these three species and the probable variant of *R. phoenicis*. Tibial length is not such a clear indicator of sexual dimorphism and difference between these species. On the other hand, rostrum length is the strongest indicator of sexual dimorphism, being significantly longer in females. The dimorphism observed in rostrum size in palm weevils is generally attributed to selection pressure: it is used in the excavation and preparation of oviposition sites by adult females. The rostrum is significantly longer in *R. phoenicis* than in *R. quadrangulus*. It remains, however, smaller in the small weevil *R. ferrugineus*. The shape of the tip of the abdomen, where the genital organ is located, seems to be purely a matter of sexual dimorphism. It is oval in the males and flat in the females of these three species and the probable subspecies *of R. phoenicis*.

Perspectives mainly include a molecular study to check the taxonomic status of the probable variant of *R. phoenicis* and its phylogenetic relationships with other palm weevil species, in particular, *R. palmarum*. Rearing priorities should be defined for the entomophagous communities, as well as for palm tree ecosystem conservation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Abou, S. (2021) Entomophagie et Risques sanitaire. Thèse de doctorat, Université Mohammed V de Rabat.

[2] Benaissa, F. (2022) Insectes d'intérêt socio-économique'. Mémoire Master. Université des Frères Mentouri Constantine, République Algérienne Démocratique et Populaire 80p.

[3] Christiane Eunice, B.A. and Djédoux Maxime, A. (2021) Evaluation de L'entomophagie dans Quatre Grandes Villes de Côte d'Ivoire. *European Scientific Journal*, **17**, 119-136. https://doi.org/10.19044/esj.2021.v17n37p119

[4] Miankeba, N. (2012) Contribution à l'étude de l'entomophagie à KINSHASA, Mémoire de Master. Faculté Universitaire des Sciences Agronomiques de Gembloux.

[5] Angundji, Y. (2023) Contribution à l'étude socio-économique des chenilles comestibles dans la ville de Lubumbashi, R.D. Congo. Mémoire DEA. Université de Lubumbashi, Faculté des sciences Agronomiques, Département de Gestion des Ecosystèmes et Biodiversité.

[6] Boullaud, R. (2018) Les Nouveaux comportements alimentaires. La consommation des insectes et des arachnides. Thèse de doctorat Université de Limoges.

[7] Philippe, L.G. (2016) Les coléoptères dans l'alimentation de l'homme. In: *Savoureux insectes*: *De l'aliment traditionnel à l'innovation gastronomique*, Tours, Rennes, Marseille PUFR; PUR; IRD, 223-236.

[8] Gbangboche, A.B., Tognibo, B.A.C., Kayode, P., Zannou, E.T. and Codjia, J.T.C. (2016) Croissance et valeur alimentaire des larves de *Oryctes monoceros*. *International Journal of Biological and Chemical Sciences*, **10**, 983-992. https://doi.org/10.4314/ijbcs.v10i3.6

[9] Ehounou, G.P., Ouali-N'goran, S.M., Soro, D. and Bedikou, M.E. (2019) Nutrient Contributions of *Rhynchophorus Phoenicis* Fabricius, 1801 (Coleoptera: Curculionidae), Very Appreciated Larvae in Côte D'ivoire Compared with Beef (N'dama Breed) and Thon (*Thunnus thynnus*). *International Journal of Biological and Chemical Sciences*, **13**, 2092-2103. https://doi.org/10.4314/ijbcs.v13i4.16

[10] Malaisse, F. (2004) Ressources alimentaires non conventionnelles. https://www.academia.edu/66379257/Ressources_alimentaires_non_conventionnelles

[11] Mashindji, R.L., Ndongala Kimongoli, K. and Nsevolo, P. (2023) Contribution à la détermination de la teneur protéique et lipidique de *Rhynchophorus phoenicis* et Augosoma centaurus. *Private University Products and News*, **95**, 15-22.

[12] Lenga, A., Kezetah, C. and Kinkela, T. (2012) Conservation et étude de la valeur nutritive des larves de *Rhynchophorus phoenicis* (Curculionidae) et *Oryctes rhinoceros* (Scarabeidae), deux coléoptères d'intérêt alimentaire au Congo-Brazzaville. *International Journal of Biological and Chemical Sciences*, **6**, 1718-1728. https://doi.org/10.4314/ijbcs.v6i4.28

[13] Ngono, N.N.S.E., Fogang, R.A.M., Mounjouenpou, P. and Kansci, G. (2024) Nutritional, Functional Properties and Estimated Shelf-Life of Defatted *Rhynchophorus phoenicis* (Fabricius, 1801) Larvae Flours. *International Journal of Biological and Chemical Sciences*, **17**, 2439-2455. https://doi.org/10.4314/ijbcs.v17i6.24

[14] FAO (2013) Insectes comestibles Perspectives pour la sécurité alimentaire et l'alimentation animale. Section Publications Foresty Paper No. 171. https://bibliolp.itaq.ca/notice?id=p::usmarcdef_0000127183

[15] Dounias, E., Motte-Florac, E. and Jacqueline M.C. (2003) L'exploitation méconnue d'une ressource connue: La collecte des larves comestibles de charançons dans les palmiers raphias au sud Cameroun. In: *Les insectes dans la tradition orale*, Peeters-SELAF, 205-226.

[16] Bolondo, M. and Thierry, B.G. (20022) Palm Weevils, *Rhynchophorus* sp. (Coleoptera: Dryophthoridae): Species Inventory and Population Dynamics in the Kisangani Region of DR Congo. *African Journal of Tropical Entomology Research*, **1**, 28-33.

[17] Morin, J., Lucchini, F., de Araujo, J. and Ferreira, M. (1986) Le contrôle de *Rhynchophorus palmarum* par piégeage à l'aide de morceaux de palmier. *Oléagineux*, **41**, 57-62.

[18] Wattanapongsiri, A. (1966) A Revision of the Genera *Rhynchophorus* and Dynamis (Coleoptera: Curculionidae). https://ir.library.oregonstate.edu/downloads/5h73q005b

[19] Attia, S., Abdennour, N., Chaabane, H., Khchine, K., Kallel, S. and Jamaa, M.L.B. (2022) Évaluation de différents traits d'histoire de vie du charançon rouge *Rhynchophorus ferrugineus* (Olivier, 1790). *Bulletin de la Société Royale des Sciences de Liège*, **91**, 44-58. https://doi.org/10.25518/0037-9565.10891

[20] Tutondele, J.M., Kiata, I.N., Mangeye, H.K. and Bolokango, G.K. (2023) Evaluation de la croissance de *Rhynchophorus phoenicis* en milieu contrôlé sur les produits et sous-produits agricoles à Mbanza-Ngungu dans la province du Kongo Central en République Démocratique du Congo. *Revue Africaine d'Environnement et d'Agriculture*, **6**, 124-129.

[21] Rozziansha, T.A.P., Hidayat, P. and Harahap, I.S. (2021) Morphological Characters of *Rhynchophorus* spp. (Coleoptera: Curculionidae) Associated with Sago, Coconut, and Oil Palm in Indonesia. *IOP Conference Series: Earth and Environmental Science*, **694**, Article 012051. https://doi.org/10.1088/1755-1315/694/1/012051

[22] Schmidt-Buesser, D., Couzi, P. and Renou, M. (2010) Comparative Locomotory Response of the Red Palm Weevil, *Rhynchophorus ferrugineus* Oliv. (Coleoptera, Curculionidae) to Biogenic Odours Presented Alone or Combined. In: *Actes du 26e congrès annuel de la Société Internationale d'Écologie Chimique* (*ISCE*), *Tours*, *France*, 264.

[23] Anonyme (2023) Statistique de la ville de Kindu. Rapport Mairie de kindu.

[24] N'sanda Buleli, L., Kalombo, V., Akilimali, C., Kabala, K., Omaka, T., *et al.* (2011) Maniema espace et vies. Musée royal de l'afrique centrale.

[25] Makumbi, L. and Herbillon, A.J. (1973) Description d'une chaîne de sols sur roches vertes de Gangila (République du Zaïre).

[26] Monzenga, J.-C. (2015) Ecologie appliquée de *Rhynchophorus phoenicis* Fabricius (Dryophthoridae : Coleoptera) : Phénologie et optimisation des conditions d'élevage à Kisangani, R.D.Congo. Thèse de doctorat, Université Catholique de Louvain.

[27] Mignon, J. and Haubruge, E. (1989) Clé d'identification des principales familles d'insectes d'Europe. Les Presses agronomiques de Gembloux, A.S.B.L. Passage des Déportés 2-B-5030 Gembloux (Belgique). Centre Technique de Coopération Agricole et Rurale (CTA), Postbus 380-NI-6700J Wageningen (Pays-Bas). https://orbi.uliege.be/bitstream/2268/195169/1/D%C3%A9but%20Cl%C3%A9%20Famille%20Insectes.pdf

[28] Deet, G. (1989) Les insectes d'Afrique et d'Amerique tropicale. Clés pour la reconnaissance des Familles, Laboratoire de Fauneistique Acridologie opérationnelle. https://agritrop.cirad.fr/375765/

[29] Hoddle, M.S., Antony, B., El-Shafie, H.A.F., Chamorro, M.L., Milosavljević, I., Löhr, B., *et al.* (2024) Taxonomy, Biology, Symbionts, Omics, and Management of *Rhynchophorus* Palm Weevils (Coleoptera: Curculionidae: Dryophthorinae). *Annual Review of Entomology*, **69**, 455-479. https://doi.org/10.1146/annurev-ento-013023-121139

[30] Aldhafer, H.M., Alahmadi, A.Z. and Alsuhaimadi, A.M. (1998) Biological Studies on the Red Palm Weevil, *Rhynchophorus ferrugineus* Oliv. (Coleoptera, Curculionidae) in Riyadh, Saudi Arabia. *Journal of the Saudi Society of Agricultural Sciences*, **75**, 30-32.

[31] El-Deeb, M., Abbas, M., El-Zohairy, M. and Arafa, O. (2019) Biological Studies on Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier) Reared on Semi—Artificial Diet in Egypt. *Egyptian Journal of Agricultural Research*, **97**, 77-88. https://doi.org/10.21608/ejar.2019.68566

[32] Rozziansha, T.A.P., Hidayat, P. and Harahap, I.S. (2021) Morphological Characters of *Rhynchophorus* spp. (Coleoptera: Curculionidae) Associated with Sago, Coconut,

and Oil Palm in Indonesia. *IOP Conference Series: Earth and Environmental Science*, **694**, Article 012051. https://doi.org/10.1088/1755-1315/694/1/012051

[33] FAO (2007) Conseils pour la prospection de *Rhynchophorus ferrugineus*. International Plant Production Conventio Secretariat, African Union, USDA, Food and Agriculture Organisation of the United Nations Rome, Italy. https://assets.ippc.int/static/media/files/publication/fr/2023/10/Rhynchophorus_ferrugineus_African_Survey_Guidelines-FR.pdf

[34] Dutta, R. (2010) New Record of Red Palm Weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) on Arecanut (Areca Catechu) from Meghalaya, India. *Florida Entomologist*, **93**, 446-448. https://doi.org/10.1653/024.093.0320

[35] EPPO (2007) *Rhynchophorus ferrugineus* and *Rhynchophorus palmarum*. *European and Mediterranean Plant Protection Organization*, **37**, 571-579.

[36] Mizzi, S., Dandria, D., Mifsud, D. and Longo, S. (2009) The Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier, 1790) in Malta (Coleoptera: Curculionoidea). *Bulletin of the Entomological Society of Malta*, **2**, 111-121.

[37] Danforth, B.N. and Ascher, J. (1999) Flowers and Insect Evolution. *Science*, **283**, 143-143. https://doi.org/10.1126/science.283.5399.143a

[38] Hoddle, M.S., Hoddle, C.D. and Milosavljević, I. (2020) How Far Can *Rhynchophorus palmarum* (Coleoptera: Curculionidae) Fly? *Journal of Economic Entomology*, **113**, 1786-1795. https://doi.org/10.1093/jee/toaa115