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Sexual size differences and colour polymorphism of *Rhynchophorus phoenicis* in the Southwest region of Cameroon

James TANYI TAMBE[1], Paola RIOLO[2], Justin Nambangi OKOLLE[3], Nunzio ISIDORO[2], Pietro Paolo FANCIULLI[1], Romano DALLAI[1]
[1]*Department of Evolutionary Biology, University of Siena, Italy*
[2]*Dipartimento di Scienze Agrarie, Alimentari ed Ambientali, Università Politecnica delle Marche, Ancona, Italy*
[3]*Laboratory of Nematology/Entomology, Carbap, Douala, Cameroon*

Abstract

A total of 174 specimens of the African palm weevil *Rhynchophorus phoenicis* (F.) were sampled during 2010, in eight different localities of the Southwest region of Cameroon. Male and female weevils were measured (body length, abdomen length, abdomen width, pronotum length, pronotum width, head size, and length from tip of rostrum to antennal insertion), and the different pronotum patterns are described. Statistical analysis shows that all morphometric parameters correlate with body length in both males and females, and seven pronotum pattern types are identified, three of which are new. African palm weevil adults show sexual dimorphism: abdomen and head size are significantly greater in females, while pronotum length is significantly greater in males. No statistical differences in the frequencies of pronotum pattern types were seen between males and females, or among localities. A significant difference was seen for the abdomen width between two localities.

Key words: African palm weevil, morphology, pronotum patterns, palm, Cameroon.

Introduction

Rhynchophorus phoenicis (F.) (Coleoptera Curculionidae/Dryophthoridae), otherwise known as the African palm weevil (APW), is a large weevil that is distributed throughout tropical Africa. Its plant hosts are mainly oil palm (*Elaeis guineensis* Jacq.), date palm (*Phoenix dactylifera* L.), raffia palm (*Raphia* spp.) and coconut palm (*Cocos nucifera* L.) (Gries *et al.*, 1994; Bong *et al.*, 2008). Its life cycle is similar to other *Rhynchophorus* species (Wattananpongsiri, 1966, Giblin-Davis and Howard, 1988; Giblin-Davis *et al.*, 1996). The APW is attracted to dying or damaged parts of palms, and can also attack undamaged palms, decaying sugarcane, and palms already damaged by the presence of conspecifics (Gries *et al.*, 1993; 1994; Rochat *et al.*, 1993).

These weevils inflict damage particularly on young palms: boring by the larvae into the crown or root bulb of a young palm causes yellowing of the leaves, while boring close to the growing point is lethal to the palm (Mariau *et al.*, 1981).

The first documented record of this weevil in Cameroon dates back to 1908, from Efulen village (Wattanapongsiri, 1966). In Cameroon, the larvae have different names according to the 270 official spoken dialects and in Pidgin English (the common or universal language). The name ‘tumbu’ or ‘tumbu for palm tree’ is the common name in Pidgin English, the language used in market squares, in the streets, and in unofficial situations. The APW larvae serve as food to the majority of Cameroonians, as inhabitants of the tropical rainforest belt, and they have been included in the national menu. The APW is reared on dead and fallen oil and raffia palm stems, and farmers generate income from this local trade.

There have been a number of studies on the nutritional and medicinal value of *R. phoenicis* larvae (Edijala *et al.*, 2009; Nzikou *et al.*, 2010), while few studies relate to the morphological aspects of the adults. Morphometric parameters and colour pronotum patterns of weevils have been analysed to discriminate between species of the same genus, as seen for instance in the *Aspidiotes* (Sanchez-Ruiz and Sanmartin, 2000), *Hypera* (Cline *et al.*, 2002) and *Rhynchophorus* (Wattanapongsiri, 1966) species.

Several functions have been assigned to insect coloration, including regulation of body temperature (Forsman *et al.*, 2002), mimicry (Turner, 2005) and success in mate choice (Breuker and Brakefield, 2002). Moreover, habitat choice can drive the evolution of body coloration patterns to optimise detection by conspecifics (Théry *et al.*, 2008).

In comparative studies, it is often assumed that sexual size dimorphism has some narrow, species-specific importance, which is reflected in the different selection pressures that act on the male and female body sizes (Stamps, 1993). Moreover, sex-related differences in growth patterns form one of the major proximate determinants of sexual size dimorphism (Shine, 1990).

The aim of the present study was to investigate the sexual differences of *R. phoenicis* adults in the Southwest region of Cameroon, in terms of both morphometric parameters and pronotum colour patterns.

Materials and methods

Insects

The weevils were collected by hand picking from cultivated plots of oil palms in eight different localities in the Southwest region of Cameroon (Africa): Ashum village (5°28'N 9°30'E), Mile 4 Limbe (4°2'N 9°12'E), Mile 14 Dibanda (4°6'N 9°17'E), Mile 16 Bolifamba (4°10'N 9°18'E), Molyko Buea (4°8'N 9°17'E), Mutengene (4°5'N 9°19'E), Ombe (4°5'N 9°18'E) and Soppo Buea (4°9N 9°17'E) (figure 1).

Figure 1. Map of Cameroon and of the Southwest region; black spots and numbers indicate sampling localities: 1) Ashum Village; 2) Mile 4 Limbe; 3) Mile 14 Dibanda; 4) Mile 16 Bolifamba; 5) Molyko Buea; 6) Mutengene; 7) Ombe; 8) Soppo Buea.

The sampling was carried out during March and April 2010. With the help of the farmers, who also served as field guides, cocoons and newly emerged adults were collected from dead and decaying oil palm stems. The collected specimens were counted and divided according to sex. In particular, APW males can be differentiated from the females by the presence of hair in a row on the central anterior dorsal end of the rostrum and at the distal segments of the forelimbs (figure 2B, D). In contrast, the females have a longer, more slender and smooth rostrum that arches ventrally at the anterior end (figure 2A, C) (Wattanapongsiri, 1966). A total of 174 APW specimens were collected, 87 males and 87 females: 10 males and 10 females from each locality, except in Soppo Buea, where 17 males and 17 females were collected.

Morphometric analysis

Measurements were performed on each specimen using a binocular stereo microscope and a pair of callipers. In particular, as shown in figure 3, the measurements were for: body length (l), abdomen length (al), abdomen width (aw), pronotum length (pl), pronotum width (pw), head size (hs), and length from tip of rostrum to antennal insertion (ta) (Mizzi *et al*., 2009).

Colour polymorphism

Variations in the dorsal pronotum patterns of the APW male and female adults were studied. Each adult weevil in the collection was analysed, and the identified pronotum pattern type was drawn.

Statistical analysis

Comparisons in morphometric parameters between APW males and females and among localities were examined by one-way ANOVA, followed by Tukey tests. Regression analysis was performed to define any correlations between body length and the other morphometric parameters. The body length data were log transformed, while an isometric log-ratio transformation was performed on the other morphometric parameters, to meet the assumptions of normality. Contingency table analysis based on chi-square analysis (Zar, 1999) was used to compare males *versus* females, and localities, for the frequencies of pronotum pattern types. All statistical tests were performed using Systat 11 (Systat Software Inc.).

Results

The morphometric parameters of the bodies of the adult weevils are shown in table 1. Measurements of abdomen length ($F = 11.04$, $p < 0.01$), abdomen width ($F = 6.06$, $p < 0.05$), head size ($F = 26.23$, $p < 0.001$) and length from tip of rostrum to antennal insertion ($F = 24.59$, $p < 0.001$) were significantly greater in females; pronotum length was significantly greater in males ($F = 60.92$, $p < 0.001$). No statistical differences between males and females were seen for body length ($F = 1.86$, $p > 0.05$) and pronotum width ($F = 0.03$, $p > 0.05$). We observed a significant difference in the APW adult abdomen width between the localities of Molyko Buea and Mutengene ($p < 0.01$).

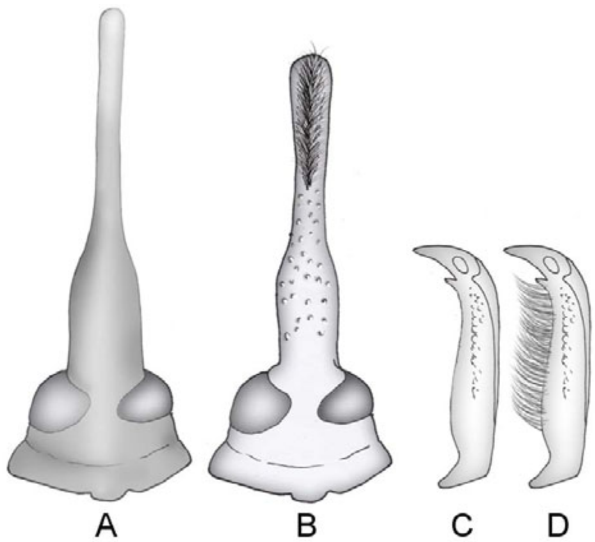

Figure 2. The African palm weevil: dorsal view of the female (A) and male (B) rostrum; left front tibia of female (C) and male (D) (modified from drawings by Wattanpongsiri, 1966).

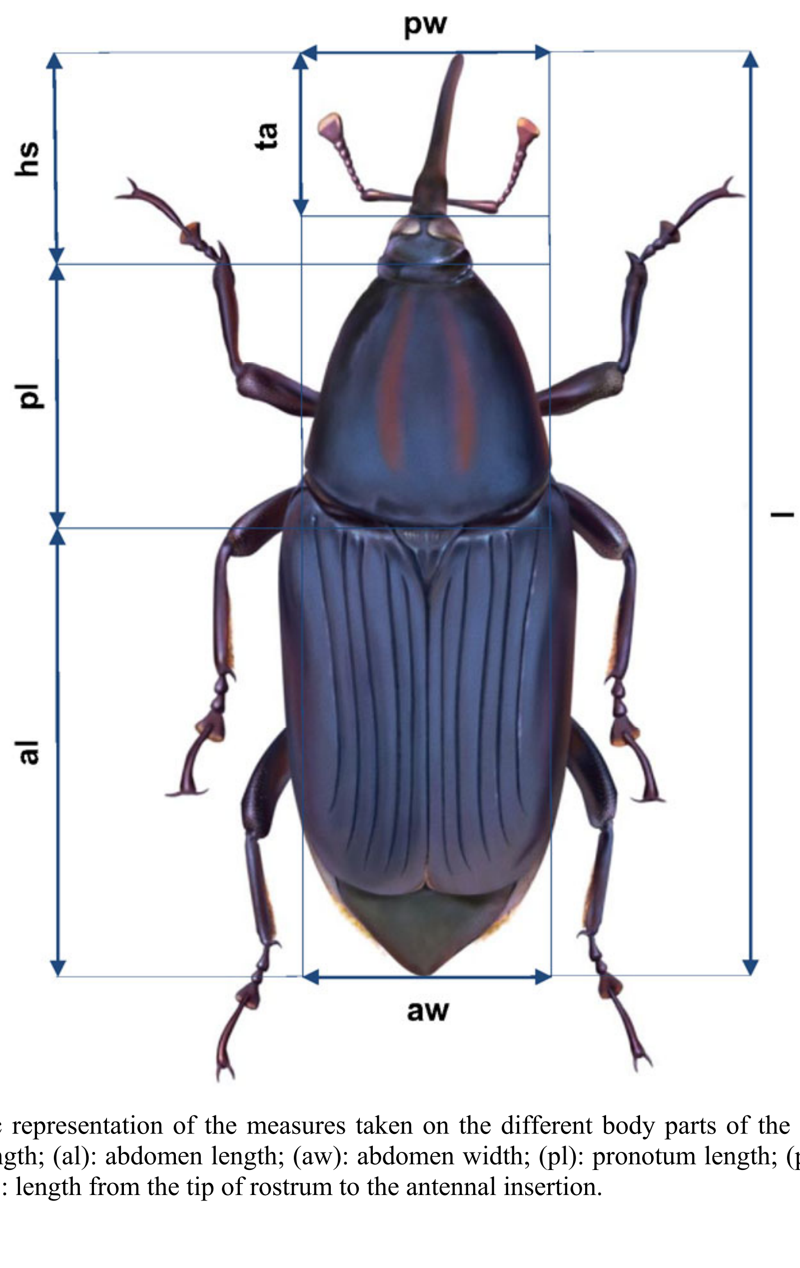

Figure 3. Schematic representation of the measures taken on the different body parts of the African palm weevil. (l): whole body length; (al): abdomen length; (aw): abdomen width; (pl): pronotum length; (pw): pronotum width; (hs): head size; (ta): length from the tip of rostrum to the antennal insertion.

Table 1. Morphological measurements of the different body parts of the African palm weevil males and females in the different localities. Abbreviations see figure 3.

Locality	Sex	APW morphometric parameters (mean ± SE) (cm)						
		L	al	aw	pl	pw	hs	ta
Ashum village	M	3.67±0.12	1.71±0.06	1.22±0.04	1.18±0.05	0.99±0.03	0.92±0.04	0.65±0.03
	F	3.84±0.12	1.85±0.05	1.29±0.05	1.16±0.04	1.02±0.04	1.03±0.03	0.75±0.03
	TOT	3.76±0.12a	1.78±0.06a	1.26±0.05ab	1.17±0.05a	1.01±0.04a	0.98±0.04a	0.70±0.03a
Mile 4 Limbe	M	4.10±0.15	1.94±0.06	1.36±0.05	1.26±0.05	1.10±0.04	1.00±0.04	0.71±0.02
	F	3.98±0.15	1.88±0.09	1.31±0.06	1.20±0.04	1.05±0.05	1.04±0.03	0.76±0.02
	TOT	4.04±0.15a	1.91±0.08a	1.34±0.06ab	1.23±0.05a	1.08±0.05a	1.02±0.04a	0.74±0.02a
Mile 14 Dibanda	M	3.90±0.13	1.83±0.05	1.31±0.05	1.21±0.05	1.05±0.05	1.00±0.03	0.69±0.02
	F	4.01±0.16	1.89±0.09	1.33±0.07	1.17±0.05	1.08±0.05	1.09±0.04	0.79±0.03
	TOT	3.96±0.15a	1.86±0.07a	1.32±0.06ab	1.19±0.05a	1.07±0.05a	1.05±0.04a	0.74±0.03a
Bolifamba	M	4.00±0.14	1.92±0.06	1.33±0.04	1.30±0.05	1.05±0.03	0.98±0.04	0.70±0.01
	F	4.26±0.15	2.14±0.06	1.51±0.06	1.25±0.05	1.15±0.05	1.21±0.04	0.79±0.03
	TOT	4.13±0.15a	2.03±0.06a	1.42±0.05ab	1.28±0.05a	1.10±0.04a	1.10±0.04a	0.75±0.02a
Molyko Buea	M	3.70±0.17	1.76±0.08	1.20±0.06	1.17±0.05	0.94±0.06	0.85±0.04	0.64±0.03
	F	3.85±0.19	1.85±0.07	1.24±0.07	1.11±0.04	1.00±0.03	0.98±0.02	0.67±0.03
	TOT	3.78±0.18a	1.81±0.08a	1.22±0.07a	1.14±0.05a	0.97±0.05a	0.92±0.03a	0.66±0.03a
Mutengene	M	4.01±0.10	1.84±0.07	1.33±0.05	1.26±0.04	1.06±0.04	0.97±0.03	0.70±0.02
	F	4.04±0.17	2.01±0.09	1.48±0.05	1.13±0.03	1.08±0.02	1.01±0.03	0.74±0.04
	TOT	4.03±0.14a	1.93±0.08a	1.41±0.05b	1.19±0.04a	1.07±0.03a	0.99±0.03a	0.72±0.03a
Ombe	M	3.93±0.22	1.85±0.10	1.29±0.08	1.25±0.07	1.04±0.06	0.98±0.05	0.69±0.03
	F	3.99±0.20	1.91±0.09	1.35±0.06	1.18±0.06	1.05±0.05	1.01±0.04	0.78±0.03
	TOT	3.96±0.21a	1.88±0.10a	1.32±0.07ab	1.22±0.07a	1.05±0.06a	1.00±0.05a	0.74±0.03a
Soppo Buea	M	3.80±0.11	1.81±0.05	1.26±0.04	1.22±0.04	1.03±0.03	0.95±0.03	0.67±0.01
	F	3.98±0.12	1.91±0.06	1.34±0.05	1.16±0.03	1.05±0.04	1.05±0.03	0.72±0.02
	TOT	3.89±0.12a	1.86±0.06a	1.30±0.05ab	1.19±0.04a	1.04±0.04a	1.00±0.03a	0.70±0.02a
TOTAL	M	3.88±0.05	1.83±0.02	1.29±0.02	1.23±0.02***	1.10±0.02	0.96±0.01	0.68±0.01
	F	3.99±0.05	1.93±0.03**	1.36±0.02*	1.17±0.01	1.06±0.01	1.05±0.01***	0.75±0.01***
	TOT	3.93±0.05	1.88±0.25	1.33±0.02	1.20±0.15	1.08±0.15	1.01±0.01	0.72±0.01

Asterisks indicate significance in male (M) *versus* female (F) comparisons ($^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; one-way ANOVA); different letters indicate statistical differences among localities ($p < 0.05$, Tukey test).

The other morphometric parameters were not significantly different among the localities (table 1). All of the morphometric parameters were significantly correlated with body length, in both males and females (figure 4).

The body colour of these APW males and females ranged from almost black to reddish brown. Seven different pronotum pattern types were observed (types A-G), as shown in figure 5. The type A specimens (33.9%) show red markings or bands on the pronotum that are arranged in a semi-lunar form, facing one another; types B (21.3 %) and C (14.4 %) have markings that run the entire length of the pronotum, while in type D (16.1%), there is a discontinuity in the markings. Type E specimens (7.5%) show a unique form of pronotum pattern, with the red bands running in straight lines along the pronotum, and with conspicuous red markings on the lateral sides. With type F specimens (5.8%), the red bands form a continuum with the anterior pronotum. In type G specimens (1.2%), the pronotum is entirely black, and is polished and smooth, with little or no red bands along the lateral sides. No statistical differences were found between males and females (χ^2 = 2.53, $p > 0.05$) or among localities (χ^2 = 19.75, $p > 0.05$) for the frequencies of pronotum pattern types.

From this study, we also noted that the adults in the infested palms showed a balanced sex ratio.

Discussion

Wattanapongsiri (1966) reported that the APW male and female are very uniform in body size, except for the rostrum length. In the present study, we observed a sexual size dimorphism in the APW adults. The APW females are larger than the males for abdomen length and width, total head size, and the length from tip of rostrum to antennal insertion. In general, the larger length of the females is associated with reproductive features. Abdomen dimorphism might be the result of selection pressures on increased female fecundity, a hypothesis that is supported by the correlation of fecundity with female abdomen size in the common water strider *Aquarius remigis* (Say) (Preziosi *et al.*, 1996). Head size and rostrum dimorphism is generally attributed to selection pressure upon the rostrum of the female for increased length. Indeed, the use of the rostrum in the excavation and preparation of oviposition sites by adult females fulfils the role of an ovipositor, and appears to have been an important, if not integral, factor in their success (Danforth and Asher, 1999). Furthermore, pronotum length and width are higher in the APW males than females. The meaning of these latter differences is not clear, but they represent the expression of sexual dimorphism. Moreover, all morphometric parameters are correlated with the body

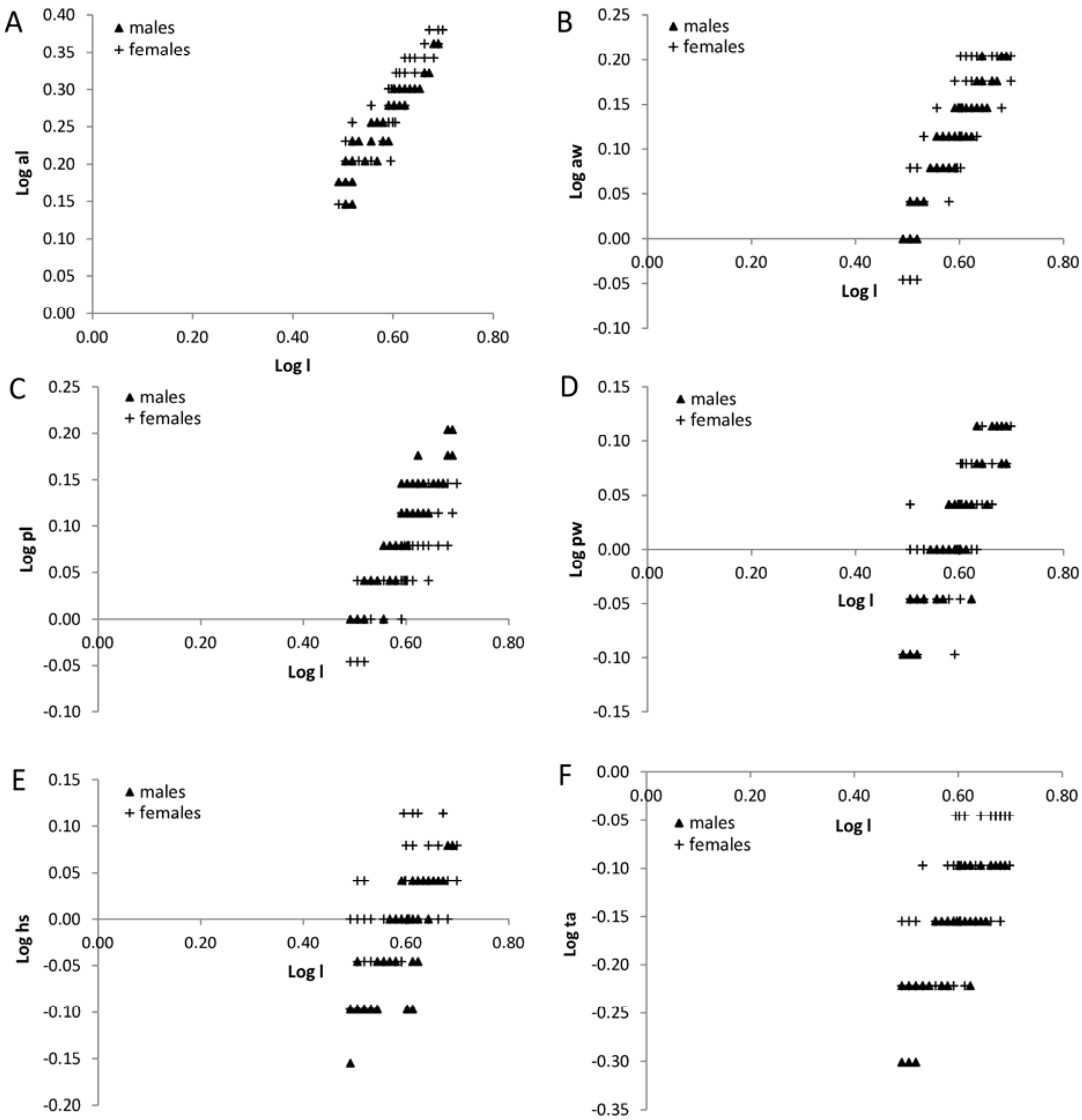

Figure 4. Size-related changes in morphometric parameters of African palm weevil males and females, plotted as log of body length (x-axis) *versus* log of each morphometric parameter (y-axis) (for abbreviations, see figure 3). (A) males R^2 = 0.894, p < 0.001; females R^2 = 0.835, p < 0.001; (B) males R^2 = 0.898, p < 0.001; females R^2 = 0.743, p < 0.001; (C) males R^2 = 0.845, p < 0.001; females R^2 = 0.718, p < 0.001; (D) males R^2 = 0.852, p < 0.001; females R^2 = 0.675, p < 0.001; (E) males R^2 = 0.719, p < 0.001; females R^2 = 0.371, p < 0.001; (F) males R^2 = 0.659, p < 0.001; females R^2 = 0.456, p < 0.001.

length, with some differences between males and females that are probably due to the sexual dimorphism in the growing rate of each of these body part (Stamps, 1993). The body length of the APW females is not significantly greater than that of the males, maybe due to number of specimens analysed. Johnson (1920) reported that no sexual dimorphism in size was observed in *Rhynchophorus cruentatus* (F.), while Mizzi *et al.* (2009) found a clear size dimorphism in *R. ferrugineus*.

We observed a significant difference in the APW adult abdomen width between two of the localities, which could be due to different environmental conditions during their juvenile development, such as variations with respect to food availability or quality, larval density, abiotic factors, or some other aspects.

In terms of the pronotum pattern, we describe here seven APW types of red markings, in contrast to the four types previously illustrated by Wattanapongsiri (1966). The most common APW type was the one with red bands on the black pronotum that are arranged in a semi-lunar form, facing one another, with 33.9% occurrence (type A). The pronotum was entirely black for 1.2% of the APW specimens, with little red bands along the lateral sides.

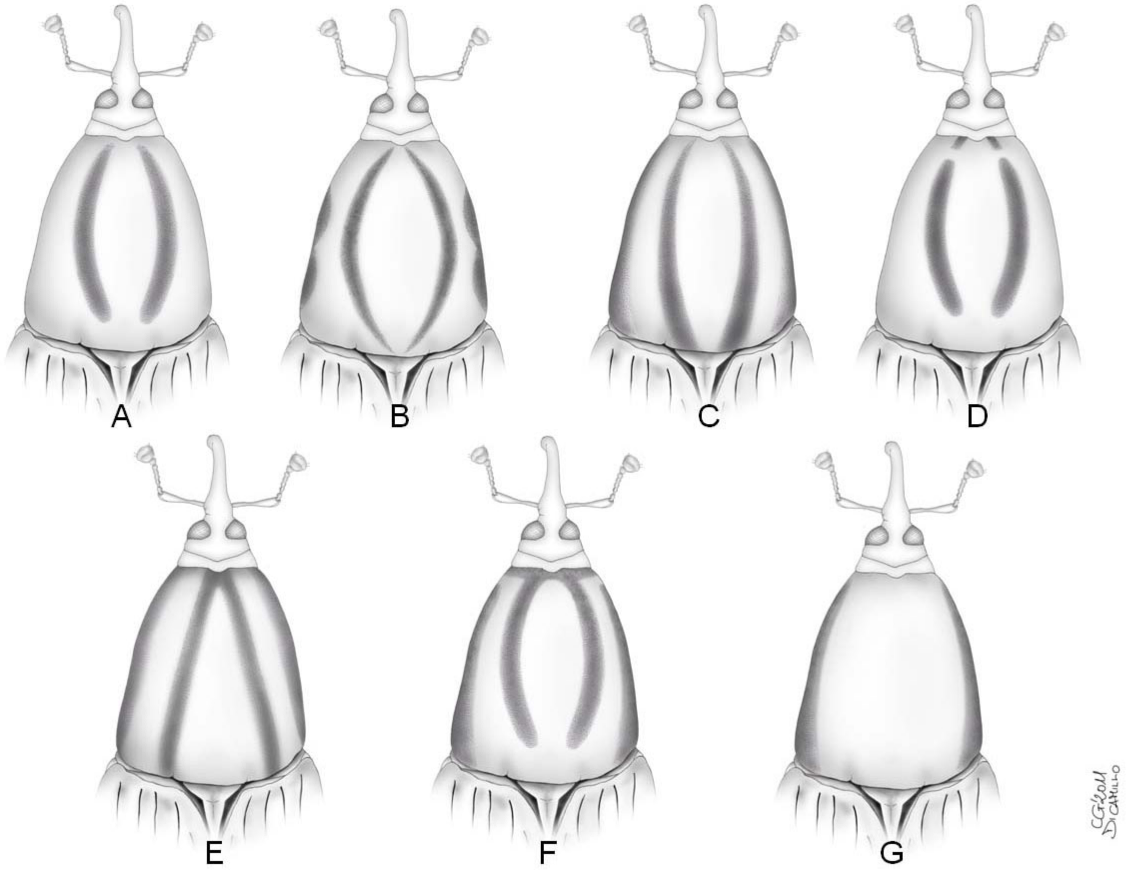

Figure 5. Variations of the pronotum dorsal view of the African palm weevil. Letters A-G represent the different African palm weevil morphological patterns.

This study has thus revealed a more diversified range of APW dorsal pronotum patterns, which is probably due to the larger sample size compared to the previous study by Wattanpongsiri in 1966, where four APW pronotum patterns were observed in 11 males and 12 females.

We can conclude also that the APW pronotum patterns are not sex related, as observed also by Johnson (1920) for *Rhynchophorus cruentus* (F.). However, for *R. ferrugineus* in Sicily (Longo, 2006) and Malta (Mizzi *et al*., 2009), the pronotum patterns have been reported to be different between the sexes.

The results of the morphometric analysis and the pronotum patterns improves our knowledge of the morphological characteristics of this weevil, and can be used for the discrimination between sexes and for differentiation of the several *Rhynchophorus* species.

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References

BONG C. J., ER C., YIU P., RAJAN A., 2008.- Growth performance of the red-stripe weevil *Rhynchophorus schach* Oliv. (Insecta: Coleoptera: Curculionidae) on meridic diets.- *American Journal of Agricultural and Biological Sciences*, 3 (1): 403-409.

BREUKER C. J., BRAKEFIELD P. M., 2002- Female choice depends on size but not symmetry of dorsal eyespots in the butterfly *Bicyclus anynana*.- *Proceedings of the Royal Society of London B*, 269: 1233-1239.

CLINE A. R., FLOYD W. S., PUTTLER B., 2000.- Description of surface swimming by *Hypera eximia* LeConte (Coleoptera: Curculionidae): Behavioral, morphological, and phylogenetic implications.- *Annals of the Entomological Society of America*, 95 (5): 637-645.

DANFORTH B. N., ASCHER J. 1999.- Flowers and insect evolution.- *Science*, 283 (5399): 143-143.

EDIJALA J. K., EGBOGBO O., ANIGBORO A. A., 2009.- Proximate composition and cholesterol concentrations of *Rhynchophorus phoenicis* and *Oryctes monoceros* larvae subjected to different heat treatments.- *African Journal of Biotechnology*, 8 (10): 2346-2348.

FORSMAN A., RINGBLOM K., CIVANTOS E., AHNESJÖ J., 2002.- Coevolution of color pattern and thermoregulatory behavior in polymorphic pygmy grasshoppers *Tetrix undulata*.- *Evolution*, 56: 349-360.
GIBLIN-DAVIS R. M., HOWARD F. W., 1988.- Notes on the palmetto weevil, *Rhynchophorus cruentatus* (Coleoptera: Curculionidae).- *Proceedings of the Florida State Horticultural Society*, 101: 101-107.
GIBLIN-DAVIS R. M., OEHLSCHLAGER A. C., PEREZ A., GRIES G., GRIES R., WEISSLING T. J., CHINCHILLA C. M., PENA J. E., HALLETT R. H., PIERCE JR H. D., GONZALEZ L. M., 1996.- Chemical and behavioural ecology of palm weevils (Curculionidae: Rhynchophorinae).- *Florida Entomologist*, 79 (2): 153-167.
GRIES G., GRIES R., PEREZ A. L., OEHLSCHLAGER A. C., GONZALEZ L. M., PIERCE H. D., KOUDA I., ZEBEYOU M., NANOU N., 1993.- Aggregation pheromone of the African palm weevil, *Rhynchophorus phoenicis* F.- *Naturwissenschaflen*, 80: 90-91.
GRIES G., GRIES R., PEREZ A. L., GONZALEZ L. M., PIERCE JR H. D., OEHLSCHLAGER A. C., RHAINDS M., ZEBEYOU M., KOUAME B., 1994.- Ethyl proprionate: synergistic kairomone for African palm weevil, *Rhynchophorus phoenicis* L. (Coleoptera: Curculionidae).- *Journal of Chemical Ecology*, 20 (4): 889-897.
JOHNSON C. W., 1920.- Variation of the palm weevil, and the meaning of continuous variation in color.- *Journal of Heredity*, 11 (2): 84-86.
LONGO S., 2006.- Ulteriori acquisizioni sul Punteruolo rosso asiatico, dannoso alla Palma delle Canarie in Sicilia.- *Informatore Fitopatologico*, 56 (10): 40-44.
MARIAU D., CHENON R., JULIA J. F., PHILIPPE R., 1981.- Oil palm and coconut pests in West Africa.- *Oleagineux*, 36 (4): 169-227.
MIZZI S., DANDRIA D., MIFSUD D., 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.
MURPHY S. T., BRISCOE B. R., 1999.- The red palm weevil as an alien invasive: biology and the prospects for biological as a component of IPM.- *Biocontrol*, 20: 35-46.
NZIKOU J. M., MBEMBA F., MVOULA-TSIÉRI M., DIABANGOUAYA-BATÉLA B., MALELA K. E., KIMBONGUILA A., NDANGUI C. B., PAMBOU-TOBI N. P., SILOU T., DESOBRY S., 2010.- Characterisation and nutritional potentials of *Rhynchophorus phoenicis* larva consumed in Congo-Brazzaville.- *Current Research Journal of Biological Sciences*, 2 (3): 189-194.
PREZIOSI R. E, FAIRBAIRN D. J., ROFF D. A., BRENNAN. J. M. 1996.- Body size and fecundity in the waterstrider *Aquarius remigis*: A test of Darwin's fecundity advantage model.- *Oecologia*, 108: 424-431.
ROCHAT D., DESCOIN C., MALOSSE C., NAGNAN, P., ZAGATTI P., AKAMOU F., MARIAU D., 1993.- Ecologic chimique des charancons des palmiers, *Rhynchophorus* spp. (Coleoptera).- *Oleagineux*, 48: 225-236.
SANCHEZ-RUIZ M., SANMARTIN I., 2000.- Separation of *Aspidiotes* species using morphometric analysis (Coleoptera: Curculionidae).- *European Journal of Entomology*, 97 (1): 85-94.
SHINE R., 1990.- Proximate determinants of sexual differences in adult body size.- *The American Naturalist*, 135: 278-283.
STAMPS J. A., 1993.- Sexual size dimorphism in species with asymptotic growth after maturity.- *Biological Journal of the Linnean Society*, 50: 123-145.
THÉRY M., PINCEBOURDE S., FEER F., 2008.- Dusk light environment optimizes visual perception of conspecifics in a crepuscular horned beetle.- *Behavioral Ecology*, 19 (3): 627-634.
TURNER J. R. G., 2005.- Mimicry, pp. 1-9. In: *Encyclopedia of life sciences* (JANSSON R., Ed.).- John Wiley & Sons Ltd., Chichester, UK.
WATTANAPONGSIRI A., 1966.- A revision of the genera *Rhynchophorus* and *Dynamis* (Coleoptera: Curculionidae).- *Department of Agricultural Science Bulletin*, 1: 1-329.
ZAR J. H., 1999.- *Biostatistical analysis*.- Prentice-Hall, Upper Saddle River, USA.

Authors' addresses: Paola RIOLO (corresponding author, e-mail: p.riolo@univpm.it), Nunzio ISIDORO, Dipartimento di Scienze Agrarie, Alimentari ed Ambientali, Università Politecnica delle Marche, via Brecce Bianche, 60131 Ancona, Italy; James TANYI TAMBE, Pietro Paolo FANCIULLI, Romano DALLAI, Department of Evolutionary Biology, University of Siena, via Aldo Moro 2, 53100 Siena, Italy; Justin Nambangi OKOLLE, Laboratory of Nematology/Entomology, Carbap, P.O. Box 832, Douala, Cameroon.

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