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Taxonomic redescription of the red palm weevil (*Rhynchophorus Ferrugineus*)

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Abstract

Taxonomic study was ultimately focused on the 247 specimens of *Rhynchophorus ferrugineus* (247) collected from various region of Kerala. Collected specimens were segregated into different populations (groups) according to the morphological variations within the species. The present study of economically important species had 67 illustrations and 44 line diagrams. Detailed description of all the taxonomic characters like head, rostrum, (dorsal and lateral), antennae, pronotum, elytron, femur, tibia, tarsus, venter and genitalia were studied and presented with line diagrams. Taxonomic description of the species are supplemented with standard taxonomic terminology along with genital characters and loaded with the morphometric ratios. The taxonomic study revealed that, morphological variations present among the groups may be due to environmental conditions, availability of food, and life stage of the plant on which they are feeding on. All the variations within the species were depicted with the differential distinguishing characters along with line diagrams.

Keywords: Taxonomy, redescription, *Rhynchophorus ferrugineus*, Rhynchophorinae, weevil, coconut

Introduction

Coconut (*Cocos nucifera* L.) is grown in more than 90 countries in world with a total annual production of 55 trillion nuts (Jose *et al.*, 2008) [9]. Where 73% of nuts are produced by India, Philippines and Taiwan. Various insect pest attack the crop of which red palm weevil (*Rhynchophorus ferrugineus*) is considered as the key pest of coconut and various other palms and damage of crops ranges from 12-34 percent yield loss of coconut annually (Jose *et al.*, 2008) [9].

The genus *Rhynchophorus* was erected by Herbst in 1795 and included 22 species in the genus, out of which only three species are now valid *viz.*, *palmarum*, *ferrugineus*, and *cruentatus*, but Herbst has not designated the type for the genus. Wattanapongsiri (1966) [18] done extensive work on the morphology and taxonomy of the three genera (*Rhynchophorus*, *Dynamis*, and *Rhynchodynamis*), and provided key to species, for both adults and larval stage of all the three genera. Wattanapongsiri (1966) [18] rearranged and redescribed 10 species under the genus *Rhynchophorus*, of which, *distinctus* and *ritchieri* were the two newly described species. Hallett *et al.*, (2004) [7] synonymized *vulneratus* (Panzer) with the *Rhynchophorus ferrugineus* (Olivier). After Wattanapongsiri (1966) [18], very little work had been carried out on taxonomy of *Rhynchophorus* and no species had been described.

A review work done on the taxonomy of these genera indicates that there are inadequacies which need to be addressed for streamlining the salient aspects. The available taxonomic information on is limited and lacking in essential diagnostic characters especially on genitalia, taxonomic terminology and require redefinition. The morphological variations have not been well documented which leads to confusion in identifying the pests. Even in those where detailed descriptions are available, these are lacking in morphometric ratios and need for more material and information. The genitalia diagrams available are incomplete, descriptions and diagrams are unsatisfactory. Keeping these in view, the present study is proposed to bridge glaring lacuna of taxonomic knowledge for important species *Rhynchophorus ferrugineus*. These weevils were collected from seven different agroecological zones of Kerala and specimens were segregated into different groups owing to their morphological variations. Groups were named in the alphabetical order as Group A, Group B, and Group C as per the number of variations.

Methodology

Live insects were collected from different agroecological zones of Kerala which later pinned, dried and stored for further studies. Collected specimens were run through the keys

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(Wattanapongsiri, 1966) ^[18] and specimens were identified. Further the identified specimens apparently resembling were pooled together according to morphological variations, and thus morphologically different groups were identified within the species. An accession number was allotted to every population (group).

The general morphological characters and genitalia were studied with the help of Leica M80 stereo zoom microscope. Photographs of habitus and genitalia were captured, using software Leica Application Suite (LAS) V4.4. Photographs of habitus of *Rhynchophorus ferrugineus* taken by Nikon L310 digital camera. The total length given in the description is excluding the rostrum, and standard length from anterior margin of pronotum to the end of pygidium. The illustrations were made by using tube fitted with a camera lucida and the scale of magnification are provided in the illustrations. For male and female genitalia study, terminologies of Wattanapongsiri, (1966) ^[18], Supare *et al.*, (1990) ^[15], Thompson (1992) and Davis (2009) were followed. Genitalic studies were carried out by the standard method of Supare *et al.*, (1990) ^[15].

Results

Rhynchophorus ferrugineus (Olivier) (Plates 1, 2, 3)

Synonyms: *Cossus sanguarius* Rumpf, 1755: 79; Herbst, 1795: 8

Curculio ferrugineus Olivier, 1790: 473; Herbst, 1795: 8

Curculio hemipterus Sulzer, 1776: 39; Csiki, 1936: 16

Cordyle sexmaculatus Thunberg, 1797: 46; Csiki, 1936: 16

Calandra ferruginea Fabricius, 1801: 433; Schoenherr, 1826: 327

Calandra schach Fabricius, 1801: 433; Gyllenhal in Schoenherr, 1838: 827

Curculio vulneratus Panzer in Voet, 1798: 10; Bohemann in Schoenherr, 1845: 218 (*Rhynchophorus*); Hallett *et al.*, 2004: 2863

Rhynchophorus ferrugineus var. *tenuirostris* Chevrolat, 1883: 561; Wattanapongsiri, 1966: 206; Hallett *et al.*, 2004: 2863

Rhynchophorus glabrirostris Schaufuss, 1885: 203; Hallett *et al.*, 2004: 2863

Rhynchophorus indostanus Chevrolat, 1883: 561; Wattanapongsiri, 1966: 151-152

Rhynchophorus pascha Bohemann in Schoenherr, 1845: 218; Wattanapongsiri, 1966: 206; Hallett *et al.*, 2004: 2863

Rhynchophorus pascha var. *cinctus* Faust, 1894: 330; Csiki, 1936: 16

Rhynchophorus signaticollis Chevrolat, 1883: 561; Wattanapongsiri, 1966: 152

Rhynchophorus signaticollis var. *dimidiatus* Faust, 1894: 330; Csiki, 1936: 16

Diagnostic characters

Elongated-oval shaped pre-gular suture, narrowing to the base; tridentate mandible; submentum truncately concave with narrowly elongate median depression, extending throughout its length; body black or ferrugineous, usually with a broad black stripe or spots on pronotum.

Description

General colour ferrugineous to black, legs lighter coloured than body; elytra dark red to black, shining or slightly pubescent, body elongate-oval; black spots on pronotum covers major part, shape may vary (Plate 3, A, B, C). *Head* dull to shining; smooth to finely punctured; basally 2.07× as broad as apex and 3.72× as broad as long. *Rostrum* varying

from ferruginous to black; usually ferruginous; 0.8× as long as head and pronotum combined; base 1.99× as broad as apex; straight, smooth to minutely punctured. in profile; erect, thick, setae apically or subapically; extending 0.38× length of rostrum from apex and not reaching antennal scrobe; rows of tubercles present or not; if present, one row on each side of rostrum starts from scrobe; with central carina; epistoma rounded at apex; very finely punctured ventrally; space between antennal scrobe strongly narrowing (Plate 1, A, B; G, H) posteriorly; gular suture oval at base. *Antenna* inserted at 0.04× of length from base of rostrum; scrobe deep, broad and widely opened ventrally, concave laterally, 4.62× as long as broad; scape elongate, 0.95× as long as funicle and club combined; funicle with six antennomeres; VI antennomeres, 1.07× as long as I and II, 1.32× as long as III, IV and V; antennomeres I and IV subequally broad, antennomeres II and III subequally broad; VI antennomere 1.6× as broad as I and IV, 1.75× as broad as II and III, 1.41× as broad as V; second and third almost rounded; third with one seta, fourth with two; sixth almost triangular with two setae; antennal club large, ferruginous or reddish-brown, club 0.60× glabrous basally, 0.78× as long as broad, broadly triangular with several setae dorsally and ventrally; inner spongy side with eight to fifteen setae, 1.06× as broad as I. (Plate 1, M)

Pronotum with sides gradually curved to apex and abruptly constricted anteriolaterally; slightly pubescent to shining; posterior margin nearly rounded, 1.16× as long as broad basally; base 2.42× as broad as apex; color mostly ferrugineous and varying to dark brown and black; if not, black with extremely variable markings; variation from no markings to more than seven black spots; under side of pronotum mostly ferrugineous or dark brown, may vary to almost black, very minutely punctured (Plate 1, X).

Leg punctured on outer edges of femur and tibia; front coxa strongly globose, widely separated; pro, meso and metacoxae apart by 0.25×, 0.59× and 0.47× of breadth, respectively; metafemur, 1.08× and 1.10× as long as pro and mesofemur respectively; profemur subcylindrical; mid and hind femur gradually widened apically, slightly curved outwards, widest at apex with groove (Plate 1, N, O, P); protibia, 1.11× and 1.43× as long as meso and metatibia respectively, tibia moderately straight, grooved beneath and provided with a row of setae on each side of groove, tibiae uncinata with uncus arising from inner apical margin, apically curved downwards, small tooth like spine preceding uncus (Plate 1, Q, R, S); tarsi pseudotramerous, tarsi of all leg subequal, sclerotised extensions of IV tarsal segment distinctly separating bases of claws, III tarsal segment 1.95× as broad as I, II and III tarsal segment; IV tarsal segment as long 2.16× as I and III tarsal segment, 3.86× as long as II tarsal segment; reddish-brown setae beneath I and II tarsal segment, protruding outward on dorsal view; apical 0.3× length of III tarsal segment matted with reddish-brown setae and with two rows, one on each side, of small reddish-brown setae extending to the base; IV tarsal segment with nine to twelve setae ventrally; pair of curved claws, 5.20× as long as broad (Plate 1, T, U, V).

Scutellum varying from reddish-brown to black; pointed posteriorly, 1.85× as long as broad at base, base 3.80× as broad as apex; hump may or may not be present, if present prominent apically, runs parallel to length (Plate 1, b).

Elytra smooth, sometimes pubescent, nearly rectangular; with punctation along outer edges; elytron 2.46× as long as broad basally, base 1.76× and 1.44× as broad as middle and apex respectively; with five deep striae and other four striae not prominent; third to fifth striae sometimes prolonged to base

(Plate 1, W).

Venter usually black, but may vary from ferruginous to almost black; if black, ferruginous spots present on terminal sternites, varying in shape; V abdominal sternite 1.41×, 3.03×, 2.94× and 1.14× as long as I, II, III and IV respectively, sparsely and diffusely punctured medially, strongly punctured laterally; fifth strongly punctured dorsolaterally (Plate, 26, D). *Pygidium* 0.73× as long as broad basally, varying from ferruginous to nearly black, sparsely and minutely punctured posteriorly and dorsolaterally (Plate, 3, a).

Female genitalia. Proximal arm of spermatheca 1.08× as long as distal arm, angle between proximal and distal arms acute; nodulus with many folds towards curvature; ramus broad; cornu bent and blunt and glabrous; well sclerotized, with four deep irregular ventral lobes, with two strongly convex dorsal lobes located near base of spermathecal gland. Spiculum ventrale long-rectangular, 0.74× as long as length of basal plate; spiculum ventrale truncate posteriorly, with two semi-circular sclerotized plates 0.5× as broad as spiculum ventrale (Plate 2, A, D, G, H).

Male genitalia. Aedeagus narrowly oval anteriorly, lateral arms small, slender, and joining aedeagal apodemes; apophyses 0.67× as long as median lobe; pedon sharply truncate posteriorly and gradually curved at outer margins, bearing several setae laterally, membranous area between sclerites rectangular, length: breadth ratio 2.21:1; aedeagal dorsal cleft triangular, sharply pointed anteriorly, extending 0.7× of its length; abruptly concave, divergent posteriorly, joined to manubrium with membrane; manubrium elongate, slender, 3.51× as long as median lobe, (Plate 2, M, N, a, b). Tegmen with dorsal piece 1.0× as broad as basal piece; parameres short, slender, with pointed apices, 0.17× as long as tegminal apodeme; manubrium elongate, slender, 1.77× as long as median lobe; apophyses, uniformly thick, broadened, subrounded apically bearing pointed curved hooks. Tegminal apodeme thick and tapering anteriorly; tegminal plate broadly fan-shaped; more rounded in smaller specimens; dorsal side of tegminal sclerites, parameres with a distinct emargination distally, 0.87× as long as tegminal apodeme; dorsal keel with two branches, extending 0.41× length of plate; in rounded tegminal plate, dorsal keel not branching and extending to posterior end of plate (Plate 2, O, c).

Total length: 15.4–31.92±0.88 mm; *Standard length:* 14.0–27.24±0.69 mm; *Breadth:* 8.1–12.94±0.52 mm.

Specimens examined: 3♀, 2♂, INDIA: Kerala: Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 13 m, 29.ix.2014, Coll. Ramesha B., Host: *Cocus nucifera* L.; 15♀, 8♂, Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 13 m, 16.xi.2014, Coll. Arun. Singh, Host: *Cocus nucifera* L.; 4♀, 2♂, Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 13 m, 12.x.2014, Coll. Arun. Singh, Host: *Cocus nucifera* L.; 1♀, 3♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 16.vii.2015, Coll. Arun Singh, Pheromone trap; 2♀, 1♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 23.vii.2015, Coll. Arun Singh, Pheromone trap; 1♀, 1♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 29.vii.2015, Coll. Arun Singh, Pheromone trap; 1♀, 1♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 04.viii.2015, Coll. Arun Singh, Pheromone trap; 2♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 18.viii.2015, Coll. Arun Singh, Pheromone trap; 42♀, 31♂, Wayanad: RARS Ambalavayal, N 11°28.160' E 076°29.553', 12.ix.2015, 883 m, Coll. Arun Singh, Pheromone trap; 21♀, 25♂, Palakkad: RARS Pattambi, N 10°48.781' E 76°11.506', 12.ix.2015, 54

m, Coll. Arun Singh, Pheromone trap; 7♀, 4♂, Thrissur: BRS Kannara, N 10°32.250' E 076°19.238', 12.ix.2015, 32 m. Coll. Arun Singh, Pheromone trap; 6♀, 8♂, Kottayam: RARS Kumarakom, N 09°37.650' E 076°25.871', 18.ix.2015, 3 m, Coll. Arun Singh, Pheromone trap; 1♀, 1♂, Alappuzha: ORARS Kayamkulam, N 09°10.57992' E 076°31.03746', 20.ix.2015, 2 m, Coll. Arun Singh; 4♀, 3♂, Trivandrum: RARS Vellayani, N 08°25.74006'; 076°59.17194', 28 m; 23.x.2014, Coll. Arun Singh, Pheromone trap.

Distribution: Albania, Aruba, Australia, Bahrain, Bangladesh, Canary Islands, China, Croatia, Cyprus, Egypt, France, Greece, India, Indonesia, Iran, Iraq, Israel, Italy, Japan, Jordan, Kuwait, Laos, Lebanon, Libya, Malaysia, Malta, Morocco, Myanmar, Netherlands Antilles, Oman, Pakistan, Papua New Guinea, Philippines, Portugal, Qatar, Republic of Georgia, Samoa, Saudi Arabia, Singapore, Slovenia, Solomon Islands, Spain, Sri Lanka, Syria, Taiwan, Thailand, Tunisia, Turkey, United Arab Emirates, Vietnam and Yemen. India: Andaman Islands, Assam, Karnataka, Kerala, Lakshadweep, Madhya Pradesh, Maharashtra, Manipur, Tamil Nadu.

Remarks: Profemur at middle 1.07× as broad as apex; uncus 1.2× as long as apical width of tibia. Adult female, 28 to 45 mm.in length, width 10.4 to 13.1 mm. Very similar to male in body size, color, markings on pronotum, except rostral setae absent; rostrum with three carina dorsally, median carina starts at base of rostrum, lateral one on each side originates at scrobe, parallel to middle carina; additional two carina laterally; upper carina longer, starts near scrobe, lower carina starts at middle of rostrum, joint together near to apex; rostrum longer, slender and more cylindrical; setae on front femur absent; setae on front tibia much shorter (Plate 1, A, G). All collected specimens were segregated into three different groups owing to their morphological variations. Groups were named in the alphabetical order as Group A, Group B and Group C. Above description is based on individuals of Group A. In total 200 specimens studied under this group. Differential distinguishing characters of three groups are compared in Table 4. The variations among these three groups can be discussed as follows:

Variation I (Group B)

Remarks: In total 134 specimens studied under this group. The characters of this group are similar with the Group A in many extents, the variations among the groups are as follows; *General colour* ferruginous to black. Body elongate-oval, shiny (Plate 3, D, E, F) *Head* dull to shining, smooth to finely punctured, black behind eyes, interocular region ferruginous. *Rostrum* dorsally darker or reddish brown, laterally black, row of tubercles not so prominent compared to other two group, median carina light in texture fades in groove of setae, with deep depression in interocular region (Plate 1, B, E, H, K) (median carina prominent and does not fades in groove of setae in Group A and Group C; lateral tubercles may or may not present in Group A, lateral tubercles starts at 0.25× of rostrum length in Group C). *Pronotum* with six black spots scattered in two rows, shape and size may vary (Plate 1, Y) (pronotum small to large black mars in Group A; major area covered by black marks in Group C).

Female genitalia. Spermatheca 'C' shaped with more curve. (Plate 2, B, E, I, J) (Group A and Group C with less curved spermatheca).

Male genitalia: There are no variations in male genitalia observed (Plate 2, P, Q, R, d, e).

Total length: 16.4–26.58±0.581 mm; *Standard length:* 15.2–25.5±0.41 mm; *Breadth:* 9.1–11.83±0.36 mm.

Specimens examined: 3♀, 2♂, INDIA: Kerala: Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 23 m, 29.ix.2014, Coll. Ramesha B., Host: *Cocus nucifera* L.; 6♀, 5♂, Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 23 m, 16.xi.2014, Coll. Arun. Singh, Host: *Cocus nucifera* L.; 5♀, 1♂, Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 23 m, 12.x.2014, Coll. Arun. Singh, Host: *Cocus nucifera* L.; 2♀, 6♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 16.vii.2015, Coll. Arun Singh, Pheromone trap; 1♀, 1♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 23.vii.2015, Coll. Arun Singh, Pheromone trap; 1♀, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 04.viii.2015, Coll. Arun Singh, Pheromone trap; 1♀, 1♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 18.viii.2015, Coll. Arun Singh, Pheromone trap; 2♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 08.ix.2015, Coll. Arun Singh, Pheromone trap; 36♀, 17♂, Wayanad: RARS Ambalavayal, N 11°28.160' E 076°29.553', 12.ix.2015, 883 m, Coll. Arun Singh, Pheromone trap; 11♀, 7♂, Palakkad: RARS Pattambi, N 10°48.781' E 76°11.506', 12.ix.2015, 54 m, Coll. Arun Singh, Pheromone trap; 3♀, 2♂, Thrissur: BRS Kannara, N 10°32.250' E 076°19.238', 12.ix.2015, 32 m. Coll. Arun Singh, Pheromone trap; 11♀, 6♂, Kottayam: RARS Kumarakom, N 09°37.650' E 076°25.871', 18.ix.2015, 3 m, Coll. Arun Singh, Pheromone trap; 1♀, Alappuzha: ORARS Kayamkulam, N 09°10.57992' E 076°31.03746', 20.ix.2015, 2 m, Coll. Arun Singh; 1♀, 2♂, Trivandrum: RARS Vellayani, N 08°25.74006'; 076°59.17194', 28m; 23.x.2014, Coll. Arun Singh, Pheromone trap.

Remarks: Interocular space 0.26× as broad as rostrum at base. Adult female very similar to male in body size, color, markings on pronotum, except rostral setae absent; three carina on dorsal of rostrum; middle one, starts at base of rostrum, lateral one on each side originates at scrobe, parallel to middle carina; additional two carina laterally; upper carina longer, starts near scrobe, lower carina starts at middle of rostrum, join together before apical end; rostrum longer, slender and more cylindrical (two carina laterally, upper longer carina originate at 0.20× of rostrum length in Group A; one carina laterally, originate at 0.35× of rostrum length in Group C) (Plate 1, B, H).

Variation II (Group C)

Remarks: In total 93 specimens studied under this Group. Characters of this group are similar with the Group A in many extents, the variations among the groups are as follows;

General colour ferrugineous to black. Body elongate-oval, shiny (Plate 3, G, H, I). *Head* dull to shining; smooth to finely punctured, basally black in colour. *Rostrum* dorsally ferrugineous, laterally black, row of tubercles on each side, median carina light in texture, with deep depression in interocular region. *Rostrum*, tubercles starts at 0.25× of rostrum length (Plate 1, C, F) (Group A with prominent median carina, lateral tubercles may or may not present; Group B with laterally black, row of tubercles not so prominent compared to other two group, median carina light in texture fades in groove of setae). *Pronotum* with three

black spots covering major part, shape may vary (Plate 1, Z) (Group A with small to large black mars on pronotum; Group C with six black spots scattered in two rows).

Genitalia: There are no variations in genitalia observed (Plate 2, C, F, K, L, S, T, U, f, g, h).

Total length: 20.4–28.43±0.68 mm; *Standard length:* 18.4–26.0±0.74 mm; *Breadth:* 9.2–12.5±0.51 mm.

Specimens examined: 5♀, 1♂, INDIA: Kerala: Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 13 m, 29.ix.2014, Coll. Ramesha B., Host: *Cocus nucifera* L.; 2♀, 5♂, Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 13 m, 16.xi.2014, Coll. Arun. Singh, Host: *Cocus nucifera* L.; 2♀, Kasargod: Padannakad, N 12° 15.423' E 075° 07.018', 13 m, 12.x.2014, Coll. Arun. Singh, Host: *Cocus nucifera* L.; 1♀, 4♂, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 16.vii.2015, Coll. Arun Singh, Pheromone trap; 1♀, Kasargod: RARS Pilicode, N 12°12.09420' E 075°09.78282', 25 m, 23.vii.2015, Coll. Arun Singh, Pheromone trap; 12♀, 26♂, Wayanad: RARS Ambalavayal, N 11°28.160' E 076°29.553', 12.ix.2015, 883 m, Coll. Arun Singh, Pheromone trap; 9♀, 13♂, Palakkad: RARS Pattambi, N 10°48.781' E 76°11.506', 12.ix.2015, 54 m, Coll. Arun Singh, Pheromone trap; 2♀, 1♂, Thrissur: BRS Kannara, N 10°32.250' E 076°19.238', 12.ix.2015, 32 m. Coll. Arun Singh, Pheromone trap; 1♀, 6♂, Kottayam: RARS Kumarakom, N 09°37.650' E 076°25.871', 18.ix.2015, 3 m, Coll. Arun Singh, Pheromone trap; 2♀, Trivandrum: RARS Vellayani, N 08°25.74006'; 076°59.17194', 28 m; 23.x.2014, Coll. Arun Singh, Pheromone trap.

Remarks: Markings on pronotum covers major area. Adult female very similar to male in body size, color, markings on pronotum, except rostral setae absent; three carina on dorsal of rostrum; middle one, starts at base of rostrum, lateral one on each side originates at scrobe, parallel to middle carina; additional one carina laterally, originate at 0.35× of rostrum length, extends upto apex; rostrum longer, slender and more cylindrical; setae on front femur absent; setae on front tibia much shorter (two carina laterally, upper longer carina originate at 0.20× of rostrum length in Group A; two carina laterally, upper longer carina originate at 0.28× of rostrum length in Group B) (Plate 1, C, I).

Sexual dimorphism

Two sexes can easily be identified by the rostral characters. Males of this species have thick erect setae, apically or subapically on rostrum; rostrum with one median carina dorsally, median carina starts at base of rostrum, laterally row of tubercles may or may not present, if present one on each side originates at scrobe, parallel to median carina (Plate 1, D, E, F, J, K, L). Females does not have erect setae on rostrum, whereas bears three carina dorsally, one median and two lateral, running parallel to median carina. Additional one or two carina laterally; if two carina, upper carina longer, starts near scrobe, lower carina starts at middle of rostrum, joint together near to apex; rostrum longer, slender and more cylindrical; setae on front femur absent; setae on front tibia much shorter (Plate 1, A, B, C, G, H, I).

Table 1: Comparison between differential distinguishing characters of three population of *Rhynchophorus ferrugineus* (Olivier).

Characters	Population A	Population B	Population C
<i>Rostrum carina</i>	Median and tubercles prominent in male and median carina fades in groove of setae. Female with two carina laterally, one on each side.	Median and tubercles not prominent in male and median carina fades in groove of setae. Female with two carina laterally, one on each side.	Prominent median carina and does not fades in groove of setae. In male median carina and does not fades in groove of setae. Laterally less prominent row of tubercles. Female with one carina laterally, on each side.
<i>Pronotum vittae</i>	Six smaller black markings arranged in two rows.	Six black markings larger in size, arranged in two rows.	Three large markings covering the major area dorsally.
<i>Spermatheca</i>	'C' shaped with less curvature and four folds in nodulus region.	'C' shaped with less curvature and few folds in nodulus region	'C' shaped with more curvature and many folds in nodulus region

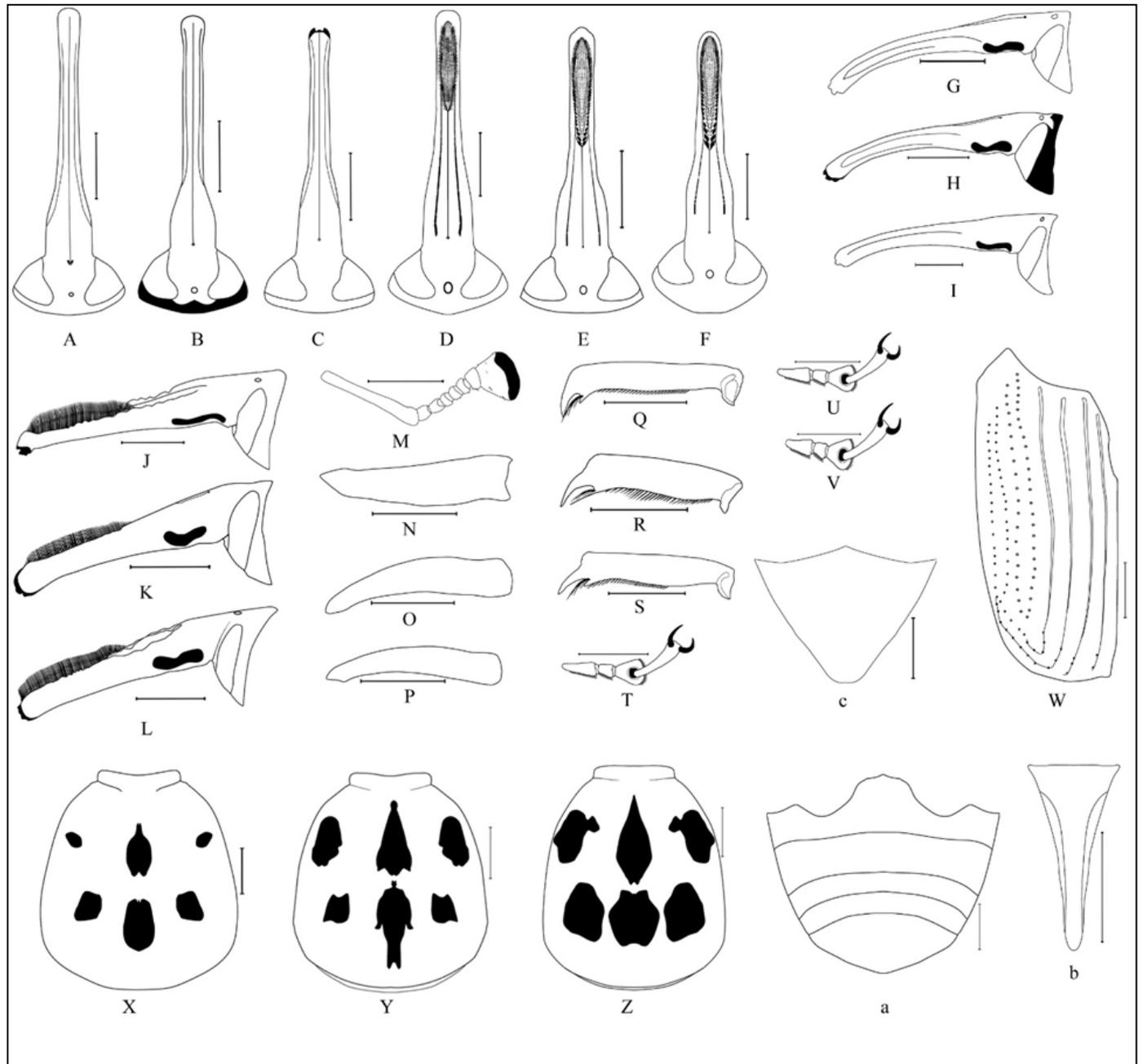


Plate 1: *Rhynchophorus ferrugineus*: (A)-(F) rostrum, dorsal view; (A) ♀ of Group A; (B) ♀ of Group B; (C) ♀ of Group C; (D) ♂ of Group A; (E) ♂ of Group B; (F) ♂ of Group C; (G)-(L) rostrum, lateral view; (G) ♀ of Group A; (H) ♀ of Group B; (I) ♀ of Group C; (J) ♂ of Group A; (K) ♂ of Group B; (L) ♂ of Group C; : (M) Antenna; (N) Profemur; (O) Mesofemur; (P) Metafemur; (Q) Protibia; (R) Mesotibia; (S) Metatibia; (T) Protarsus; (U) Mesotarsus; (V) Metatarsus (W) Elytron, dorsal view; (X)-(Z) Pronotum, dorsal view; (X) Group A; (Y) Group B; (Z) Group C. (a) Venter; (c) Pygidium; (b) Scutellum. Scale=2mm.

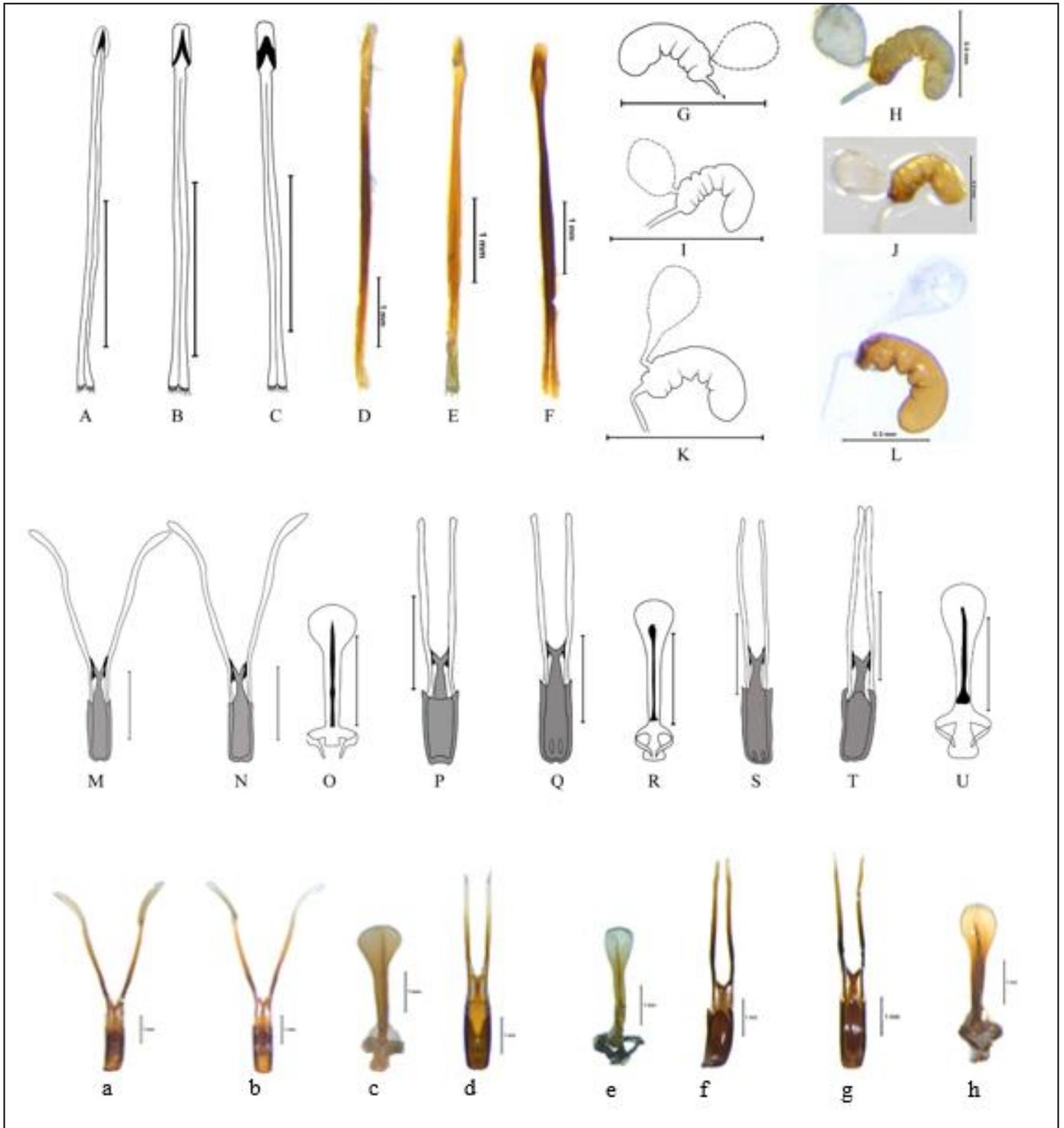


Plate 2: *Rhynchophorus ferrugineus*: (A)-(F) Spiculum ventrale; (A), (D) Group A; (B), (E) Group B; (C), (F) Group C. (G)-(L) Spermatheca; (G)-(H) Group A; (I)-(J) Group B; (K)-(L) Group C; (M)-(U) male genitalia, aedeagus dorsal, aedeagus ventral and tegmen; (M)-(O) Group A; (P)-(R) Group B; (S)-(U) Group C; (a)-(h) male genitalia, aedeagus dorsal, aedeagus ventral and tegmen; (a)-(c) Group A; (d)-(e) Group B; (f)-(h) Group C, Scale= 2 mm, Spermatheca scale= 1mm.

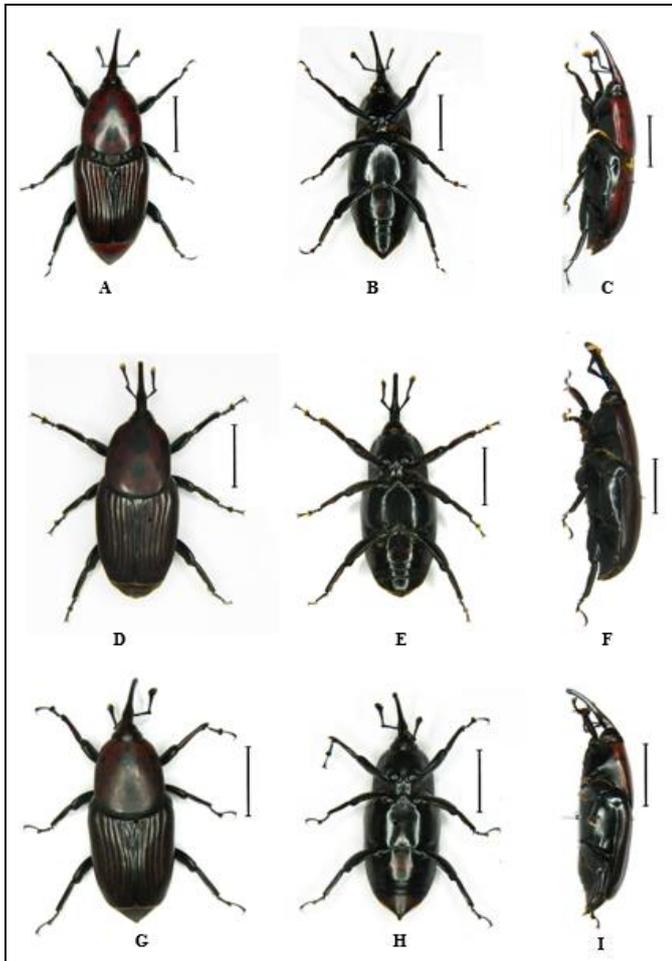


Plate 3: *Rhynchophorus ferrugineus*: Habitus, dorsal view, ventral view and lateral view; (A)-(C) Group A, (D)-(F) Group B, (G)-(I) Group C; Scale= 1 cm.

Conclusion

R. ferrugineus shows higher level of morphological variations, due to which many authors have described the same as separate species, thus causing confusion in identification. Wattanapongsiri (1966) [18] redescribed the species and gave a detailed description of all the life stages of species along with key, he also reported the morphological variations of *R. ferrugineus* and *R. vulneratus* and reported them as separate species from Oriental region. Hallet *et al.* (2003) [7] synonymised *R. vulneratus* with *R. ferrugineus*. The present study corroborate with study of Wattanapongsiri (1966) [18]. The Present study includes the detailed morphometric observations along with the genitalia description using the standard taxonomic terms.

Various colour morph was available within species but among all group no difference were observed in genitalia characters. These particular coloured morphological variations may be recorded due to differential feeding or available food material (host plants). Variations may be due to the environmental variations in different zones of collection and the microclimatic conditions. The variations found among the different groups are compared in Table 1.

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