MORPHOMETRIC OVERVIEW AND SEXUAL DIMORPHISM OF THE SUB-FAMILY BRUCHINAE (COLEOPTERA: CHRYSOMELIDAE) USING SAMPLES COLLECTED FROM SAMARU ZARIA, NIGERIA.

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SUMMARY

Callosobruchus maculatus, C. subinnotatus, Bruchidius. artrolineatus and Caryedon serratus **are the most common members of the subfamily Bruchinae found in Zaria. They were obtained from godowns in Samaru markets or cultured from host commodity infested with either eggs or larvae/pupae of the insects. Measurement of the major diagnostic features of the subfamily Bruchinae was illustrated and a brief description of specific observable variables and sexual dimorphism of these insects was also carried out in J.C. Deeming Insect Museum, Institute for Agricultural Research, Ahmadu Bello University Zaria. A total of twenty seven characters were used comprising of eleven measurable variables, nine explanatory variables and seven ratios. A handheld digitalized MiScope microscope (40-140x magnification) was used to capture photographs and made measurements of major measurable diagnostic traits of the subfamily Bruchinae. These insects are relatively small, variable in colouration and often alike leading to confusion in their identification. This paper elucidates the major morphological characteristics of the subfamily Bruchinae to ease their early detection, accurate identification and characterization being sine qua non for the adoption of effective management strategies. Accurate identification is also a prerequisite to World Trade Organizations (WTO) negotiations regarding the presence or absence of pests in any commodity for international transactions.**

Keywords: Godowns, Bruchinae, microscope, diagnostic and traits

The seed-beetle family (subfamily Bruchinae) has received much attention in recent times due to increasing demand for more food to meet the needs of the expanding world population. Focus has been on the need for better control of stored- product insects especially those attacking comestible leguminous seeds in ladders of developing countries and to reduce storage losses that are ruinous not only from initial damage by bruchid larvae but also from ensuing invasions of other organisms (Howe, 1973). Losses encountered by bruchids range between 80-100% and have triggered researches in many countries like Colombia, England, France, United States, Japan and Nigeria into the biology, physiology, morphology, plant-host resistance and pheromones in relation to the principal cosmopolitan species (Kingsolver, 2004).

Members of this subfamily Bruchinae are characterized by a compact body invested with short hairs and short elytra covering all but the last abdominal segment called pygidium (Lale, 2002).

Over 1200 species have been reported from different parts of the world but species of economic importance recorded in legume seeds stores in Nigeria include *Callosobruchus maculatus* (F.), *C. chinensis* (L.), *C. subinnotaus* (Pic) and *Caryedon serratus* (Olivier).

The recognition and identification of Bruchinae is often tedious and difficult because many species are small in size (average length 1.0-6.0 mm) and sympatric in nature (closely related and look alike). A large gap exists in our ability to accurately identify and name these pests by mere observation of their diagnostic features being essential for the adoption of effective management strategies. In the light of the aforementioned, this paper intends to highlight the major specific measurable diagnostic features, their mode of measurement as well as some specific observable features that will aid in the identification of these pests species in Nigeria.

MATERIALS AND METHODS

The biological materials used to depict the major diagnostic characteristics of the sub-family Bruchinae were; *Callosobruchus maculatus, C. subinnotatus, Bruchidius. artrolineatus and Caryedon serratus* collected from godowns in Samaru Zaria markets or cultured from host commodity infested with either eggs or larvae/pupae of the insect. They were identified and sexed in J.C. Deeming Insect Museum, Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria.

Raising of insect culture

Cultures of adult insects used were raised in 1- litre capacity, clear plastic containers (9 cm diameter, 16 cm high) with 8 cm diameter screw- type lids. Each container contained about 200 g seeds of a susceptible bruchinae host-legume seeds; cowpea (*Vigna unguiculata*); Bambara groundnut (*V. subterranea* (L.) Verdcourt; shelled and unshelled groundnut as well as tamarind fruits enough for producing bruchids in 3- 4 weeks (Bandara and Saxena, 1995). The lid of each container had a central circular perforation (3 cm diameter) covered with fine muslin cloth for aeration. These were kept under laboratory conditions at 28±2 ºC and 70±5% Relative humidity (RH) and observed daily until adult emergence. The lid and side walls of the container with active species (*C. maculatus*, *C. subinnotatus*, *B. artrolineatus*) were tapped repeatedly so that the adults gathering around the lid or the side walls dropped back unto the seeds and were chilled by refrigeration before collection.

The newly emerged species of *C. maculatus, C. subinnotatus* and *B. artrolineatus* were sieved out from the cowpea seeds while *C. serratus* were picked with forceps into vials (7.5 cm high and 2.5 cm diameter) containing 100% ethanol until use. The preserved samples were identified using keys on adult morphological characters by Southgate (1957) and Haines (1991), as well as, comparison with preserved specimens in the reference collections of the J.C. Deeming Insect Museum of Crop Protection Department, Faculty of Agriculture, Ahmadu Bello University Zaria. Preserved samples were washed using distilled water, transferred onto clean cardboard papers, whole/parts removed were allowed to dry and a handheld digitalized MiScope microscope (40-140x magnification) was used to illustrate photographs and of measurements of diagnostic features.

A total of twenty seven characters were illustrated comprising of eleven measurable variables, nine explanatory variables and seven ratios. *C. maculatus* and *C. subinnotatus* samples were used to depict mode of measurement of the measurable variables.

RESULTS

C. maculatus, B. artrolineatus, C. subinnotatus and *C. serratus* were the most common members of the sub-family Bruchinae found in comestible legumes in Samaru, Zaria. *C. maculatus* and *B. artrolineatus* were found on *Vigna unguiculata*, *C. subinnotus* on *Vigna subterranean* and *C. serratus* on tamarind fruits culture as shelled and unshelled groundnut seed cultures had no emergence.

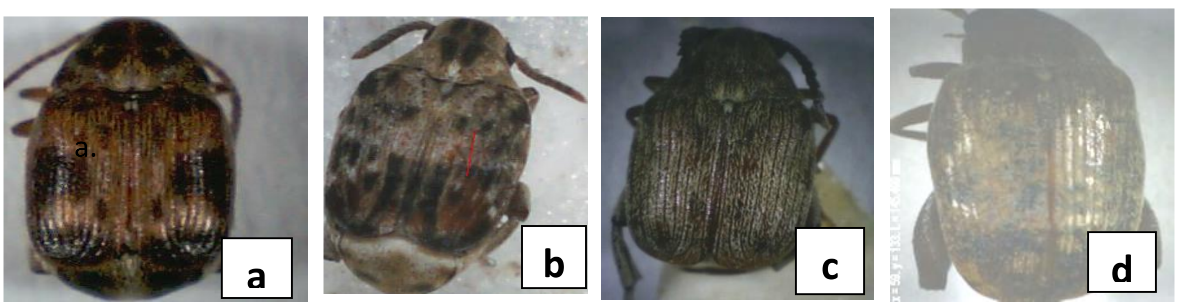


Plate 1 a, b, c and d: Dorsal Habitus of *C. maculatus, B. artrolineatus, C. subinnotatus* and *Caryedon serratus* respectively.

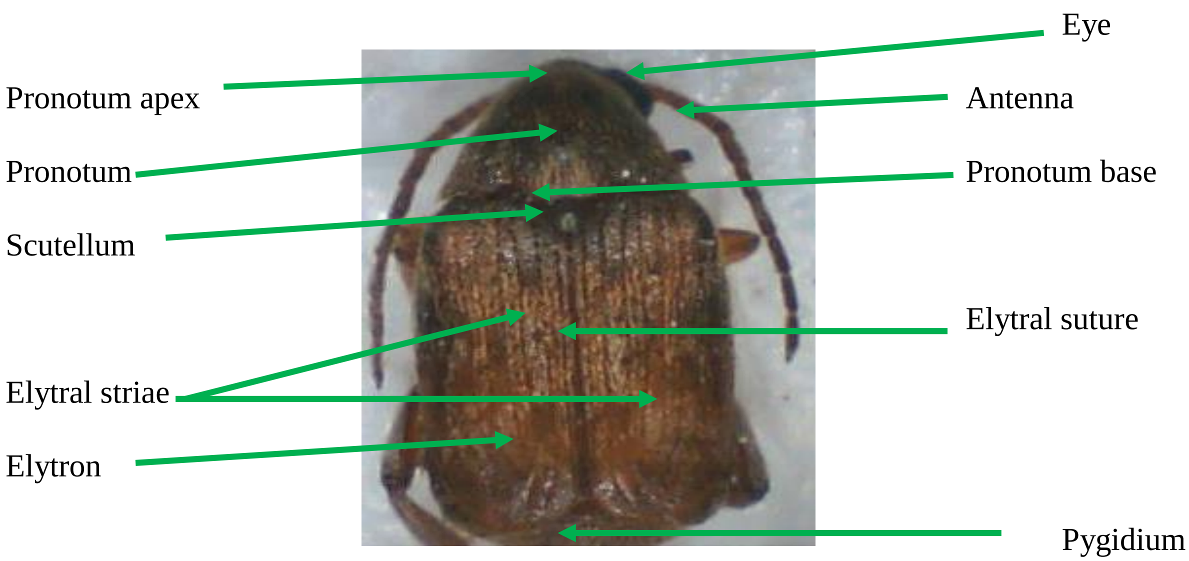


Plate: Dorsal view of a typical Bruchinae

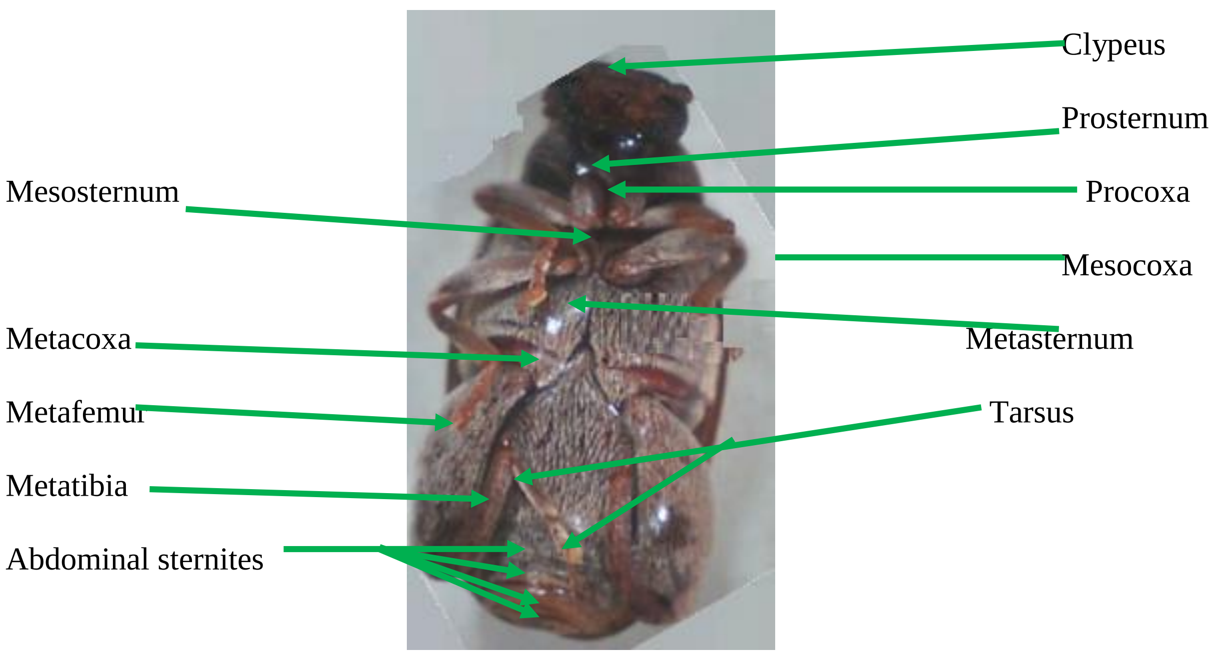


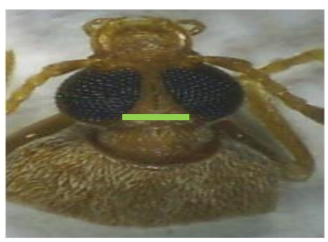
Plate III: Ventral view of a typical Bruchinae

MEASURABLE VARIABLES

Features hitherto used by Southgate *et al.* (1957), Haines (1989), Bandara and Saxena (1995) as well as Kingsolver (2004) were adopted.

i. **narrowest width between eyes (nwe);** measured on a horizontal plane across the narrowest distance between eyes

ii. **greatest width across eyes (gwe);** measured on a horizontal plane across the greatest distance between eyes



iii. **Eye width (ew)** : measured as greatest width across eye from inner edges to side edges

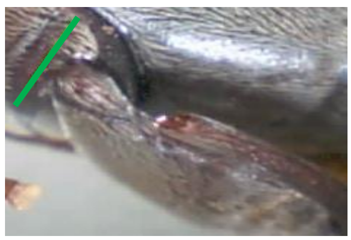
iv. **body length (bl);** measured centrally from anterior margin of head to tip of abdomen (bl).

v. **body width (bw)**; measured as greatest width across elytra

vi. **antennal length(al);** measured when antenna is fully extended with head in hypognathous position and covered the distance from the socket at base of antennal scape to apex of last antennal segment

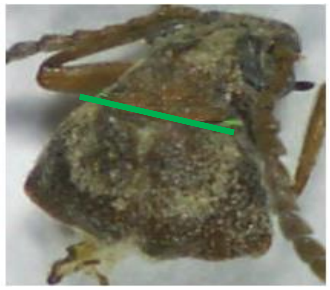
vii. **hind femoral width (hfw);** measured across greatest width of hind femur

viii. **Width of coxa (wc);** measured across the greatest distance of metacoxa



ix. **length of pronotum (lp)**; measured centrally on the dorsum from anterior margin to the posterior margin of the pronotum

x. **width of pronotum apex (wpa)**; measured across the narrowest width of pronotum from the anterior margin



xi. **width of pronotum base (wpb)**; measured across the greatest width of pronotum at the basal region

Plate IV i – xi: Mode of measurement of measurable variables

RATIOS USED IN BRUCHINAE MORPHOMETRICS

The most commonly used body parts ratio used in the morphometric studies of the members of the subfamily Bruchinae are listed and defined below:

i. Occular index (o:i); obtained by dividing the greatest width across eyes by the narrowest width between eyes.

ii. Eye width to greatest distance between eyes (ew:gbe); determine by diving eye width with greatest distance across eyes.

iii. Body length to body width (bl:bw) : calculated by diving body length with body width of the insect

iv. Elytral length to elytral width (el:ew); compared by dividing the length of elytra with width of elytra.

v. Elytral length to length of thorax (el:lt) ; obtained by dividing the length of elytra with the length of thorax.

vi. Hind femoral width to with of coxa (hfw:wc); can be obtained by dividing the hind femoral width of meta thoracic leg by the width of meta coxa.

vii. Width of pronotum base to width of pronotum anterior (wpb:wpa): can be calculated by dividing the width of pronotum base by width of pronotum apex.

EXPLANATORY VARIABLES

Emphasis here was largely on visible body parts devoid of dissection or dismemberment and these include; colour characteristic on elytra, number of elytra striae intervals, pronotal shape, antennal structure or shape, type of hind femoral tubercle, shape of tibia, tarsal segments, shape of pygidium and an ecological factor which is mode of pupation.

BRIEF DESCRIPTION AND SEXUAL DIMORPHISM OF SPECIES

C. maculatus: Elytral colour of adult male *C maculatus* collected in Zaria and environs were generally brownish in colour and without markings on the elytra unlike the females which had strong markings on the elytra consisting of two large lateral dark patches mid-way along the elytra and smaller patches at the anterior and posterior ends, leaving a pale –brown cross-shaped area covering the rest of the body. In addition, males usually have shorter abdomen and dorsal side of terminal segments curved sharply downwards in contrast to the females which have omparatively longer abdomen and the dorsal side of terminal segments only slightly bent downwards

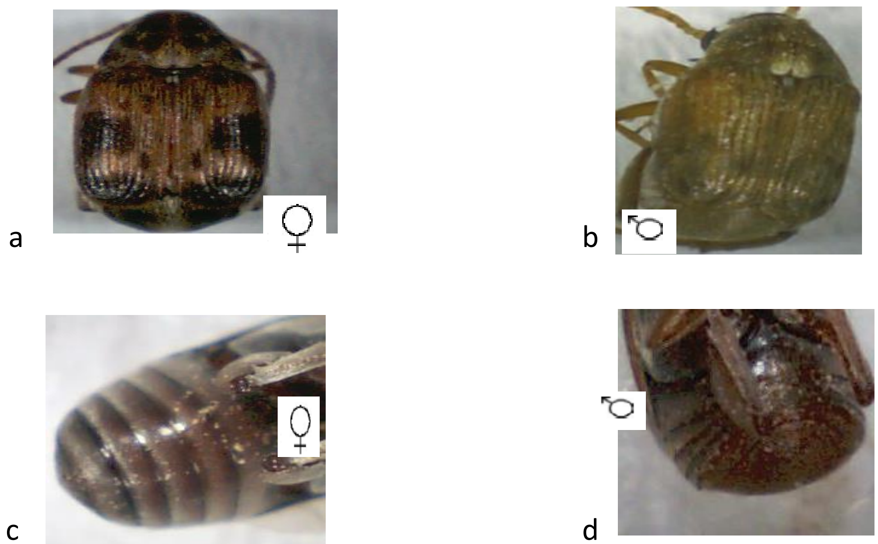


Plate V: Diagnostic view of female (a. and c.) and male (b. and d.) *C. maculatus.*

Striae are of irregular sizes, slightly punctured and consist of ten intervals on each elytra while the pronotum is dark- red to black in colour usually with a pattern of paler hairs forming two white oval spots closed together at the middle of the base. Scutellum triangular and covered with white scale-like pubescence. Antennal structure in both sexes of *C. maculatus* (Fabricius) are slightly serrate withoutmarked dimorphism between sexes. They are segmented and inserted at the mouth of eye emargination (Southgate, 1958)

Bruchidius artrolineatus: Also called the African cowpea bruchid, is *a species that* predominates in the fields and cannot breed in stores. It is sympatric in distribution and superficially similar to *C. maculatus* in shape but differ in the absence of one tooth on the ventral side of the hind femur.

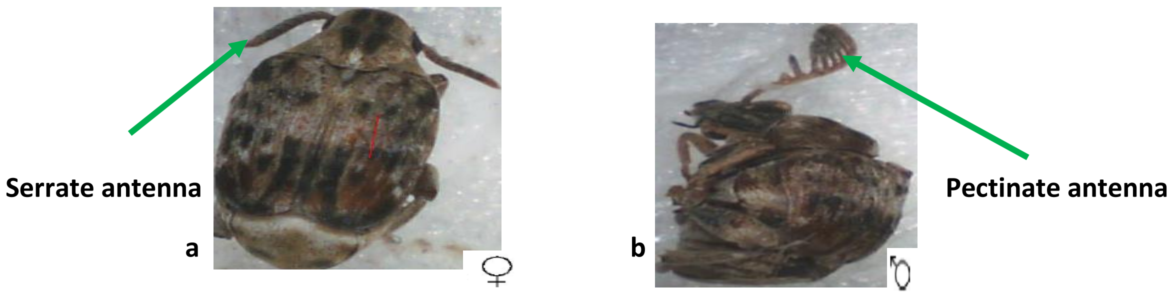


Plate VI: Female (a) and male (b) of *Bruchidius artrolineatus*

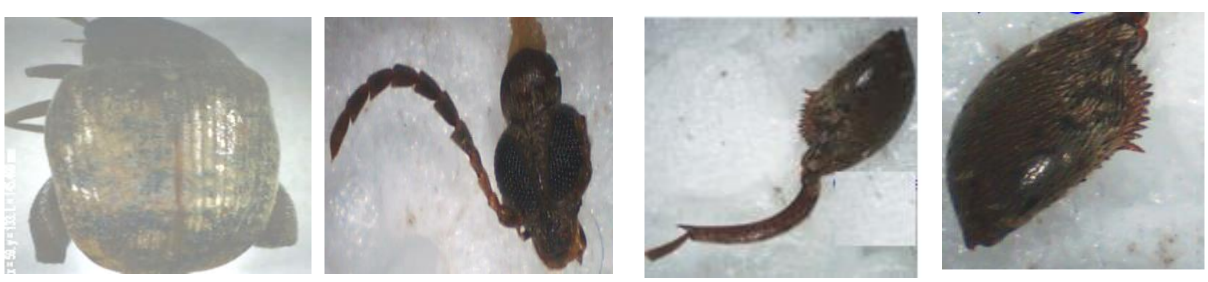
Furthermore, male *B. artrolineatus* possess an unusual profound pectinate antennal shape which is subserrated in the female.

Callosobruchus subinnotatus: Body colour is uniformly dark brown to black with pale setae. It closely resembles *C. maculatus* though larger in size. Dimorphism between sexes is not well pronounced however females in contrast to males have dark fuscous to black derm with whitish setae forming a pattern on the elytra and antenna less serrated in females compared to the males.

Plate VII: Dorsal habitus of *Callosobruchus subinnotatus*

Males possess head with large bulbous eyes that are prominent, coarsely faceted and deeply emarginated. Pronotum conical and evenly convex with lateral margins slightly sinuate. Scutellum pubescent with white scale-like setae. Pygidium nearly vertical with sides arcuate and clothed with golden setae. Legs reddish testaceous, hind femur bicarinate on ventral margin with inner tooth acutely triangular and slightly longer than the outer one with straight tibia just as in *C. maculatus*.

***Caryedon serratus*:** A large robust Bruchinae with reddish brown colour and clothed with grey brown setae. The elytron is strongly convex with sub-parallel striae intervals. Antenna elongate and coarsely serrate and reaching metacoxa in the males while in females, it reaches the middle of episternum. Pronotum trapezoidal with lateral margins rounded anteriorly while scutellum is rectangular and flat. The pygidium narrow, apically rounded and densely setosed. Each hind femur swollen dorsoventrally flattened and bears a conspicuous ventral comb (one large spine and 8-12 smaller ones) with a curved tibia unlike other Bruchinae.



a b c d

Plate VIII a, b, c and d: Dorsal habitus, coarsely serrate antenna, curved tibia and dosoventrally flattened hind femur of *C. serratus* respectively.

DISCUSSION

The knowledge of the morphometric variability that exists among members of the subfamily Bruchinae would ease species identification, sex differentiation and may lead to ecotype or biotype discovery. Sexual dimorphism is generally common among insects with females being bigger than the males (Teder and Tammaru, 2005).

The significance of linear measurable traits, body parts ratio and explanatory variables in the morphometric studies of the subfamily Bruchinae cannot be over emphasized. Parameters like body length (bl), body width (bw), elytral length (el) and antennal length (al) could have specific ranges peculiar to some species which could aid in their identification. For instance, Magaji *et al*. (2013) reported that the bl, bw and al of *B. artrolineatus* collected from different ecological zones of Northwestern Nigeria, ranged between (1.6 – 2.9 mm), (1.1 – 1.7 mm and (1.5 – 1.6 mm) respectively. Similarly, Lale (2002) reported *C. maculatus* body length to range between 2.5 – 3.5 mm, antennae twice as long as thorax and that *C. subinnotaus* was at least twice as large as *C. maculatus* with body length ranging between 4.5-5.5 mm and the elytral 1.2 times as long as broad. Howe (1973) reported the body length of *Caryedo serratus* collected from different regions of the United States and Canada to range between 3.5 to 6.8 mm and the width 1.8- 3.0 mm and that, the elytral length was 1.5 times as long as wide. Ocular index and antennal structures are dimorphic in some species and aid in sex differentiation. This is in agreement with the report of Magaji *et al*. (2013) who showed the ocular index of *Caryedon serratus* to be 6.75:1 in males and 6.2:1 in females while antennal structures were reported to be serrate to coarsely serrate in both male and female *C. maculatus, C. subinnotatus* and *caryedon serratus* but pectinate in the males of *B. artrolineatus*.

Pronotal ratios, presence or absence of metathoracic hind femoral pectin as well as hind femoral to coxal ratios, are essential in the morphometrics of the subfamily Bruchinae. Width of pronotum at base was three times the anterior width in male and female *C. serratus* but approximately twice the anterior width in *B. atrolineatus, C. maculatus* and *C. subinnotatus* (Magaji *et al*., 2013).

Some explanatory variables such as elytral colour, striae intervals, pronotal shape, hind femoral tubercle, shape of tibia, tarsal segments, and shape of pygidium and mode of pupation are of taxonomic importance and could be used to identify a species or discriminate among individuals of different populations while some have constant values and are not discriminatory in nature but rather are characters specific to the species. Delobel and Tran (1995) supported this idea when he established the number of teeth as a non-discriminating parameter in *C. maculatus*.

Colour characteristics could be used to identify *C. subinnotatus* and, *Caryedon Serratus* but not *C. maculatus* because the later are variable in colours leading to confusion in their identification with others members of the genus (Southgate *et al*., 1957).

Unlike other members of the subfamily Bruchinae which have straight metathoracic tibia, the hind femoral leg of *Caryedon serratus* is dorso-ventrally swollen bearing a row of denticles, possesses straight tibia and the only Bruchinae that pupates externally.

CONCLUSION

Illustrations on the major morphological characteristics of some members of the subfamily Bruchinae found in Zaria will help in the detection and accurate identification of these species. Effective management strategies including biological control are only possible if the accurate identities of both the pests and their parasites or parasitoids are known to enable successful introduction of biocontrol agents. Mistakes in species concepts or identifications as well as the use of inappropriate biocontrol agents often accounts for most failures in biocontrol measures and could sometimes cause great impact on non-target species.

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