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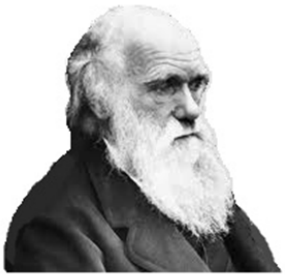

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Characterization of wheat (*Triticum aestivum*) plant infested by and identification of the African black beetle *Heteronychus arator* (Fabricius, 1775), a pest attacking wheat in Cameroon

Tange Denis Achiri[1,2,*], **Ambele Felicitas Chaba**[3], **Divine Nsobinenyui**[3], and **Njualem Dominic Khumbah**[4,5]

[1] Department of Agronomic and Applied Molecular Sciences, Faculty of Agriculture and Veterinary Medicine, University of Buea. P. O Box 63. Buea, Cameroon

[2] Department of Agronomy, School of Agricultural Science, Biaka University Institute of Buea, P. O. Box 77. Buea, SWR, Cameroon

[3] Department of Zoology, Faculty of Science, University of Bamenda, P.O. Box 39. Bambili, NWR, Cameroon

[4] Department of Crop Production Technology, College of Technology, University of Bamenda, P.O. Box 39. Bambili, NWR, Cameroon

[5] School of Tropical Agriculture and Natural Resource, Catholic University of Cameroon, P. O Box 782. Bamenda, NWR, Cameroon

*E-mail address: achiritange@gmail.com

ABSTRACT

In a study to investigate the growth and yield performance of wheat varieties, it was observed that some plants showed some leaf yellowing and overall stunted growth. Upon uprooting, some unidentified creamy white larvae were observed. A trial was later conducted to ascertain the extend of infestation by these larvae and eventually identify them using morphological measurements and pictorial comparisons. The study was conducted in the Research farm of the University of Bamenda, Cameroon in 2023. Results revealed that wheat plants infested by the weevil had many yellow leaves and dry old leaves. The roots were severely damaged and the plants did not produce spikes. The infested plants were easy to uproot. Larval and adult infestation rate were 35.0% and 12.5%, respectively. Larval and adult body length were 27.34 mm and 13.21 mm, respectively. The larva and adults were identified as the African Black Beetle

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ABB *Heteronychus arator* (Fabricius, 1775) (Coleoptera: Scarabaeidae). Thus, the ABB is reported for the first time as a damaging pest of wheat in Cameroon. Morphological and pictorial identification of the ABB are supported by established keys. The current study ignites research need into management of ABB and its ecological interactions with biotic and abiotic factors.

***Keywords*:** adult, body length, Coleoptera, larva, morphology

1. INTRODUCTION

Wheat (*Triticum aestivum*) is one of the most important cereals in the world (Behzad et al., 2021). Wheat serves as a staple for millions, meeting global food and nutrition security (Jasrotia et al., 2022). Wheat is also used as raw material for many industrial purposes (Ibukum and Moyin, 2018). The current geo-political crisis between Russia and Ukraine has interrupted about 30% of global wheat trade (Balma et al., 2022; Mottaleb et al., 2023) necessitating an upsurge in investment for domestic wheat production as the case in Cameroon (Kindzeka, 2022). Therefore, optimizing wheat production through proper pest management and monitoring is imperative.

Traditional pests of wheat include aphids (*Diuraphis noxia* and *Rhopalosiphum podi*), cereal leaf beetle (*Oulema melanopus* L.), grasshoppers (*Chrotogoma trachypterus* and *C. oxypterus*), weevil (*Tanymecus indicus* Faust), termites, armyworm (*Mythimna separata*), pod borer (*Helicoverpa armigera*), brown wheat mite (*Petrobia lateens*) (Muller), white grubs and wireworms (Farook et al., 2018). One of the less frequent pests of wheat is the African black beetle ABB (*Heteronychus arator*) with dire consequences when it occurs (Leneham, 2018; Entomologist, 2023).

The ABB also known as the black lawn beetle is soil-dwelling scarab beetle with a host range from horticultural, pasture and forestry plants (Bell et al., 20218; Lenehan, 2018). The adults are glossy black beetles, 12 – 15 mm in length. The larvae are soft and creamy in appearance with a C-shape body and a hard head capsule. Larvae can measure about 25 mm when fully grown. Eggs are white, oval and about 2mm in length. The pupae are pale yellow as they approach adulthood, they turn reddish-brown. Pupae measure about 8 mm wide and 1.5 cm long (CROPMARK, 2010; Entomologist, 2023).

In wheat trial, some plants were observed showing yellowing of leaves and upon uprooting, unidentified larvae were observed damaging the roots. Then a study was designed to (i) characterized the damage caused by these larvae to wheat plants and (ii) to identify the larvae and adult.

2. MATERIALS AND METHOD

2. 1. Location of the experimental site.

This research was carried out in The University of Bamenda research farm located in the North West Region of Cameroon (Western Highlands agro-ecological zone III of Cameroon) in the University of Bamenda campus. It has geographical coordinates of 5°59’0” North, 10°15’0” East, with an altitude of 1558m above sea level. This area has temperature ranging from 18 - 30 °C, characterized by annual rainfall of 2230 mm and average humidity of 70%

and 52% in the rainy season and dry season respectively (Tatah et al., 2021). The soil type is Ferralitic with sandy loam soil which can promote wheat/soybeans cultivation. The topography of this location is hilly but with gentle slopes and deep valleys filled with alluvial soils. The weather parameters during the study period (March – August, 2023) is reported in Table 1, obtained from Institute of Agricultural Research for Development (IRAD), Bambili, Cameroon.

Table 1. Weather parameters of study site

Months	Temperature (°C)	RH (%)	Rainfall (mm)
March	26.87	69.6	133
April	22.75	74.15	143
May	21.19	83.90	216
June	20.02	88.22	254
July	19.08	90.99	367
August	18.61	87.75	382

RH – Relative humidity

2. 2. Field preparation and Layout

The field or experimental universe was cleared with a machete and later ploughed with a handheld hold. Four blocks were mapped out and each block received poultry manure (80 kg ha^{-1}). The wheat variety Boyo was planted in four blocks each measuring 6 m × 1 m. Each block was separated from the other by a distance of 1m. A block was a raised bed of height 15cm. Wheat was planted in rows that ran perpendicular to the blocks. Four wheat seeds were planted 3 cm deep into the sow. Inter raw spacing was 30 cm and intra raw spacing was 10 cm. The wheat was planted in April of 2023 and relied extensively on rainfed irrigation.

2. 3. Monitoring

Wheat plants that showed some forms of yellowing were marked and carefully examined at 7 weeks after planting. Ten plants per block were carefully uprooted by slowly removing the earth around the root area of the plants. Monitoring took place in the month of June. Larvae collected were taken to the Plant Protection Laboratory in Institute of Agricultural Research for Development (IRAD), Bambili. Each larva was kept in a plastic jar (10 cm × 6 cm). The jar was filled with loose soil collected around the wheat plant and the larvae were gently immersed 2 cm into the soil. The jar was covered by a white mesh material and fastened by a rubber band, and kept under laboratory conditions. One month later, the soil in the jar was inspected for adults. The number of plants infested with the larvae and adults was expressed as a percentage to give the larval infestation rate (Equation 1) and adult infestation rate (Equation 2). The adult emergence rate was also estimated as a percentage (Equation 3).

$$Larval\ infestation\ rate\ (\%) = \frac{Number\ of\ plants\ infested\ with\ larvae}{Number\ of\ plants\ examined}\ x\ 100 \ldots\ldots\ldots\ldots \text{Eq. 1}$$

$$Adult\ infestation\ rate\ (\%) = \frac{Number\ of\ plants\ infested\ with\ adults}{Number\ of\ plants\ examined}\ x\ 100 \ldots\ldots\ldots\ldots\ldots \text{Eq. 2}$$

$$Adult\ emergence\ rate\ (\%) = \frac{Number\ of\ adults\ that\ emerged\ in\ the\ laboratory}{Number\ of\ larvae\ that\ was\ stored\ in\ the\ laboratory}\ x\ 100 \ldots \text{Eq. 3}$$

2. 4. Identification of larvae and adults of the African black beetle

Some physical parameters of the larvae and adult collected were measured with help of vernier caliper and meter rule. These prominent morphological features were compared to archives of *Heteronychus arator*. Results are also supported by a photo gallery. Comparisons were made with the keys of Venter and Louw, 1978; King et al., 1981; CROPMARK, 2010 and McDonald, 2016.

3. RESULTS

3. 1. Wheat plant showing characteristics of African black beetle (*Heteronychus arator*) attack

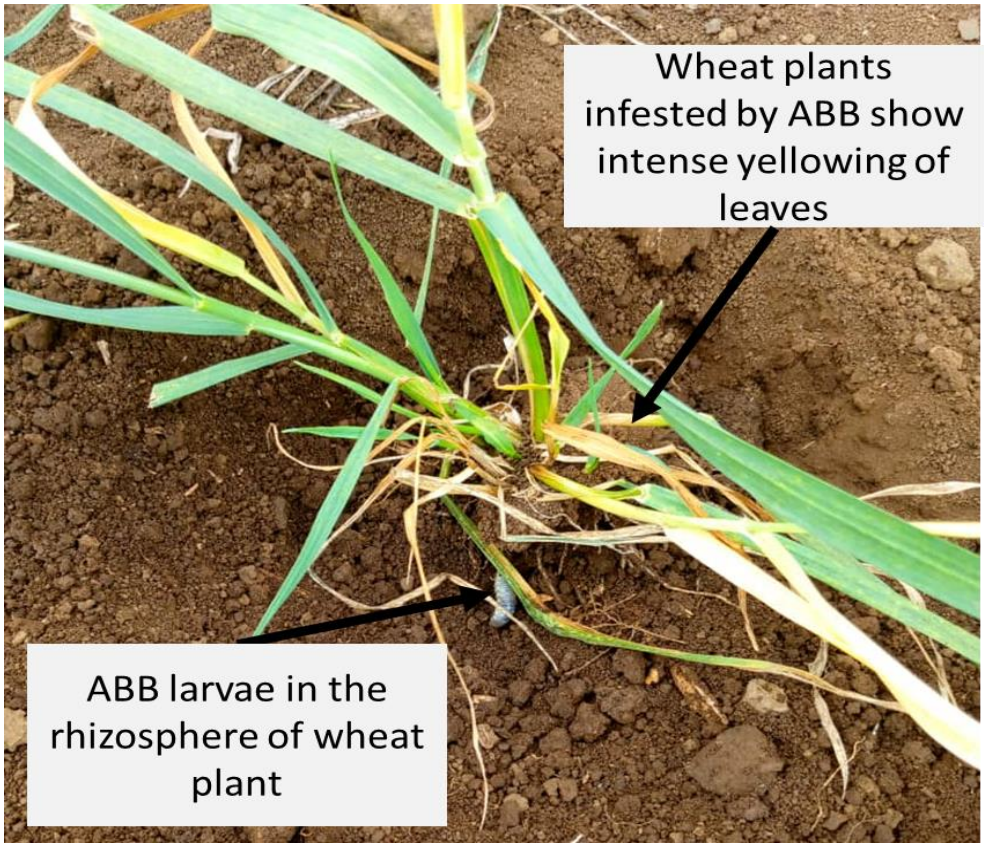

Figure 1. Wheat plants infested by African black beetle show intense yellowing of leaves. (Source Achiri DT, 2023)

Wheat plants that were attacked by the larvae of the ABB showed characteristic yellowing of some whole leaves (Fig. 1). Some leaves showed complete yellowing while others, especially older leaves were completely dried. Some younger leaves were still fresh and green (Fig. 1).

Upon uprooting the wheat plant, the roots of ABB infested plants were severely damaged (Fig. 2). The roots were shortened, even though not rot. Uprooting was effortless.

Figure 2. Root infrastructure of wheat plants infested by the African black beetle severely damaged. (Source: Achiri DT, 2023).

3. 2. Number of larvae collected

A total of 14 larvae were collected from 40 sampled plants giving an infestation rate of 35.0% (Fig. 3). Only one larva was recorded per plant.

3. 3. Number of adults

Two numbers of adult are reported: (i) number of adults collected from digging the soil beneath the suspected wheat was 5. This gave a total adult infestation rate of 12.5% (Figure 4). Also, only one adult was found per plant. (ii) the number of adults that emerged from the larvae kept in the laboratory was 8, given an adult emergence of 57.1% (Fig. 4)

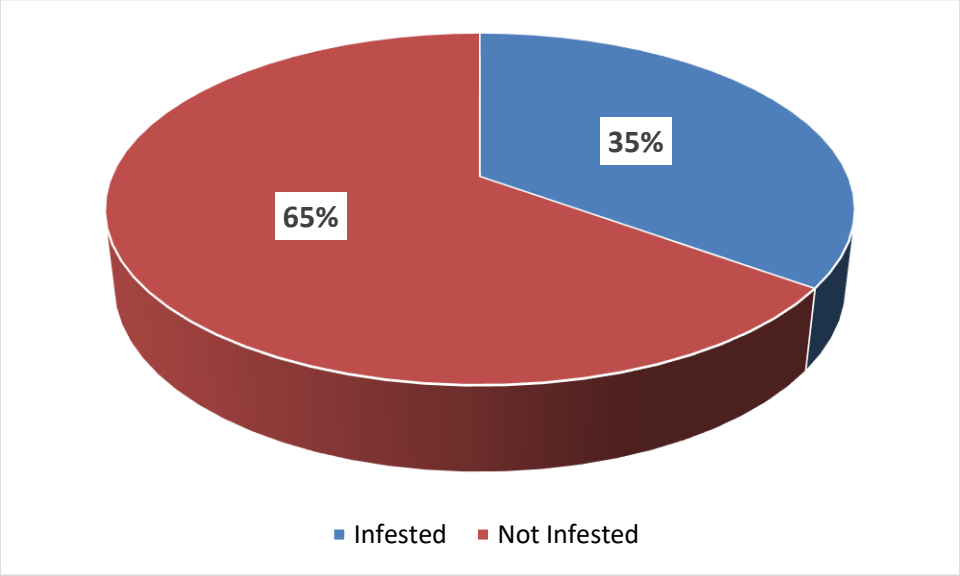

Figure 3. Wheat plants (%) infested by larvae of *Heteronychus arator*

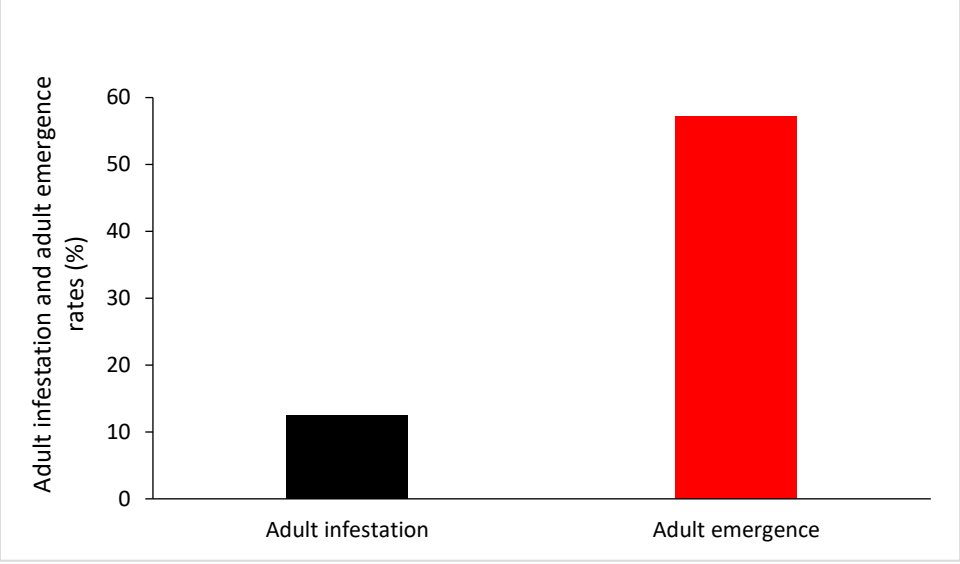

Figure 4. Adult infestation and adult emergence rate of the African black beetle in wheat.

3. 4. Identification of larva and adult

The larvae of collected beetles were identified as African Black Beetle (ABB) using morphological measurements and picture comparisons. The body of the larvae was creamy white with a yellow-brown head. The terminal abdominal portion was dark and the larvae took a characteristics "C" – shape when disturbed (Fig. 5). The larvae were mobile with the help of 3 pairs of legs. The average body length and diameter was 27.34 mm and 7.71 mm, respectively (Fig. 5).

The adult of the ABB was identified using morphological measurements and picture. The average body length was 13.21 mm. Adults have club antenna fixed on a hypognathous head. The hindlegs and are demonstrably larger than the middle and the fore legs. The entire body is shiny black (Fig. 6).

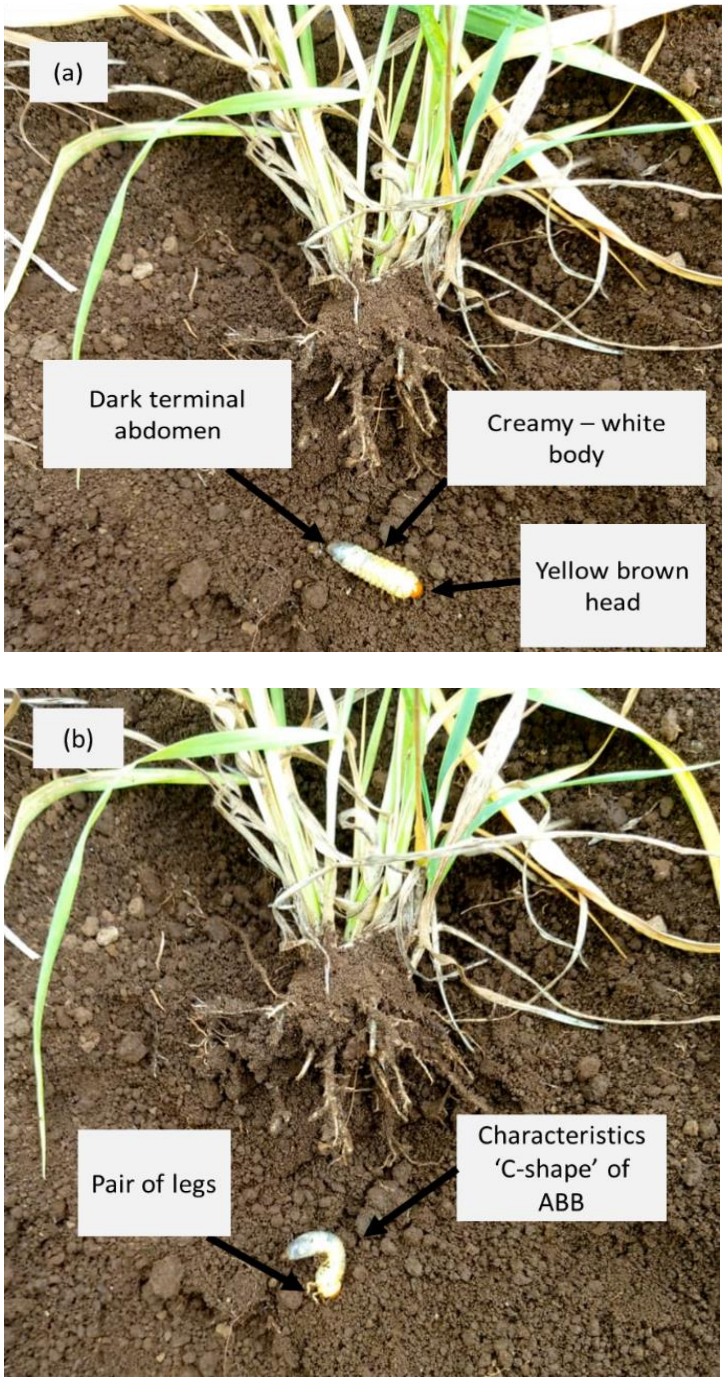

Figure 5(a,b). Larvae of the African black beetle with characteristic features. **(a)** Yellow to brown head, creamy white body and dark abdominal termina, **(b)** characteristic 'C-shape' especially when disturbed. (Source: Achiri DT 2023).

Figure 6. Adult of the African black beetle showing characteristic features - *Heteronychus arator* (Fabricius, 1775).
(Source: Achiri DT, 2023).

4. DISCUSSION

Wheat plants severely attacked by the ABB larvae and adults were similar to diseased plant, showing general yellowing of leaves. The severe root damage is characteristic of ABB damage (Ahad and Bhagat, 2012). The finding of the current study is inline with the report of CropMark (2010), that ABB larvae and adult damage to root of grasses such as maize and wheat are similar to those of grass grub. Such degree of damage from the ABB has the potential to result into low yield or total crop failure in severe infestation (Drinkwater, 1987). Severe wheat damage, resulting to low yield was reported from another ground-dwelling coleopteran pest *Tanymecus indicus* Faust (Coleoptera: Curculionidae) similar to the ABB by Pajn, (1989).

The current study was conducted between March and August, a period described as rainy season, even though it is reported that ABB population is high during the hot seasons (CropMark, 2010).

The identification of the ABB at larval and adult stages are in line with many other reports (CropMask, 2010; Ahab and Bhagat, 2012; Abdallah et al., 2016). The subterranean behaviour of all stages of ABB is well documented with the adults having the ability to fly (King et al., 1981). With origin in South Africa (Venter and Louw, 1978), *Heteronychus arator* has been reported in Eastern and Southern countries such Tanzania, Democratic Republic of Congo, Bostwana, Malawi, Mozambique, Zambia and Namibia (Ahad and Bhagat, 2012). The present study present for the first time a record of *Heteronychus arator* on wheat in Cameroon. Therefore, it opens new research avenues in areas such as management of ABB, and ecological interactions with biotic and abiotic factors.

5. CONCLUSION

The African black beetle *Heteronychus arator* has been reported for the first time as a damaging pest of wheat in Cameroon. Morphological and pictorial identification of the ABB are supported by established keys. The current study ignites research need into management of ABB and its ecological interactions.

Authors contribution

TDA: Conceptualization, Methodology, Data curation, Formal analysis, Funding acquisition, Writing draft, Editing and Review.
AFC: Methodology, Literature search, Writing draft, Editing and Review.
DN: Methodology, Literature search, Writing draft, Editing and Review
NDK: Supervision, Visualization, Validation, Editing and Review

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