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SURVEY OF THE LONGHORNED BEETLE SPECIES (COLEOPTERA: CERAMBYCIDAE) ON *ACACIA SENEGAL* L. (WILD) IN KORDOFAN REGION, SUDAN

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Abstract

Acacia senegal, the gum Arabic producing tree, is of great economic importance in Sudan. Serious biotic and abiotic factors are threatening its growth and production. Among these, the long-horned beetles (Coleoptera: Cerambycidae) are the most deleterious insect pests resulting in complete death of *Acacia* trees. This study was conducted in northern Kordofan state Sudan season 2007/2008 with aims to identify spectrum, relative abundance and phenology of long-horned beetle species acting as pests of *A. senegal* tree. Moreover, the study focuses on the assessment of tree characteristics triggering the infestation. The species spectrum and their relative abundance were determined by catch results of flight interception traps, microclimatic conditions were assessed using data loggers, tree characteristics were done by direct measurements in addition, and a questionnaire was designed to assess farmers' knowledge on long-horned beetles. The results indicated that seven species of the long-horned beetles were recorded from the flight interception traps on the study sites. The recorded species were *Anthracocentrus arabicus* (Thomson 1877), *Crossotus subocellatus subocellatus* (Fairmaire 1886) (Eisa et al. 2008), *Crossotus strgifrons* (Fairmaire 1886) *Doesus telephoroides* (Pascoe, 1862), *Titoceres Jaspideus* (Serville 1835) (Eisa et al. 2008), *Tithoes* sp. and *Gasponia gaurani* (Fairmaire 1892). The highest percentage of infestation (100%) was recorded in El Demokeya site with an average tree age of 43 years, followed by on Acacia agricultural project site (23.5%) with an average tree age of 10 years and on Elhemaira site (20%).

Key words: *Acacia senegal*, Gum Arabic, Long-horned beetles.

Introduction

The gum Arabic belt in Sudan where *A. senegal* grows naturally lies between latitudes 10º and 14º N. The two most conspicuous gum Arabic-producing areas outside these limits are in the northeast (Faw, Gedaref and Kassala areas), and in

the southeast along the Blue Nile/Upper Nile states border (El Amin and Olavi 2006). A. senegal is a multifunctional tree in Sudan producing gum Arabic which is the major and most important non-wood forest product in the country. Gum Arabic is an export commodity and hard currency earner. It plays an important role as a major source of foreign exchange. Furthermore, the tree is reported to be utilized for fuel wood, forage, and medicine. It contributes to environmental protection, improvement of soil fertility, delivers shade and shelter in agro-forestry system, as well as amenity. In Sudan the main zone of gum Arabic production is the western part of the country. A. senegal is attacked by numerous insects pests, among these pests the long-horned beetles are the most serious. Long-horned beetles (Cerambycidae) are one of the largest groups of Coleoptera. Most of the species can be found in tropical and subtropical regions. These beetles are called longhorns because of their often long antennae, especially in males. Cerambycidae mostly have elongate and almost cylindrical bodies. They vary greatly in length (Evans et al. 2004). Cerambycidae family comprising about 40,000 described species worldwide (Cocquempot and Lindelöw 2010).

Study Area and Methodology

This study was conducted in North Kordofan State, Sudan. North Kordofan state is located in the dry semi-arid region between latitudes 11.15°–16.45° N and longitudes 27.5°–32.15° E. The field work had been conducted between May 2007 and October 2008. Three study sites grown by *A. senegal* were selected for the study. These sites are El Demokeya reserve forest, Elhemaira forest and Acacia agricultural project (Table 1). These sites meet the criteria of different pattern of management; a traditional system (Elhemaira), researcher managed (El Demokeya) and the mechanized system (Acacia agricultural project). Temporary sample plots technique (El Tayeb et al. 2006) was conducted in all of the study sites in this study to investigate the effects of long-horned beetles on *Acacia* tree species. A number of five circular sample plots (SPs) (each with a radius of 17.8 m and 0.1 ha in size) were taken. The SPs were located at a distance of 1 km. In each SP, observation, measurement and counting were conducted.

Flight interception traps

Nine flight interception traps were located in two of the study sites at Acacia agriculture project (AAP) and El Demokeya reserve forest with the objective to detect the presence of the longhorned beetles in addition, to verify the species spectrum of the long-horned beetles. The traps were distributed E, N, S and W directions of the forest. Traps were monitored bi-monthly and trapped insects were collected from the killing jar and conserved in 75% alcohol. The specimens collected were identified by Gianfranco Sama (Vi Raffaello Sanzio, 84, I 47521, CESENA – ITALY) in 2008.

Percentage of infestation rates

The percentage of infestation was calculated based on the ratio of the number of infested trees, as identified through

inspections, and the total of trees per plot, together with the tree age.

Statistical analysis methods

The data collected during field survey on *Acacia* species were coded, computerized and analyzed using the Microsoft Excel programme and the SPSS for windows; version 15 for statistical analysis, computations and functions.

Table 1. Study sites.

Site name	Elevation, m	Plot, No	Number of surveyed trees
Acacia agricultural project	569	1	26
Acacia agricultural project		2	17
Acacia agricultural project		3	22
Acacia agricultural project		4	25
Acacia agricultural project		5	23
Elhemaira forest	543	1	21
Elhemaira forest		2	10
Elhemaira forest		3	17
Elhemaira forest		4	10
Elhemaira forest		5	15
El Demokeya reserve forest	543	1	5
El Demokeya reserve forest		2	5
El Demokeya reserve forest		3	7
El Demokeya reserve forest		4	2
El Demokeya reserve forest		5	5

Results

Seven species of longhorned beetles were recorded on the study plots of El Demokeya site (Table 2).

Distribution of the recorded species:

1. Anthracocentrus arabicus **(Thomson 1877)**

Saharan and Sahelian countries from southern Morocco and Mauritania to Central Eastern Africa (Sudan, Somalia, Eritrea); also known from the Arava Valley in southern Jordan and Israel, the Sinai Peninsula and the whole Arabian peninsula from the United Emirates to Yemen (Sama and Rapuzzi 2006).

2. *Crossotus strigifrons* **(Fairmaire 1886)**

Described from "Soudan", widespread in Saharan and Sahelian countries from Mauritania and Southern Morocco to Upper Egypt and Sinai Peninsula, as well as in desert areas of southern Israel and Jordan; also known in Somalia, Eritrea, Ethiopia and Arabian Peninsula (Breuning 1942, Holzschuh and Téocchi 1991, Sudre et al. 2007).

3. *Doesus telephoroides* **(Pascoe 1862)**

India: Central provinces: Jabalpur (Gahan 1906); from Senegal au Laos; Sénégal, Bénoué (Cameroun), Bahr-Sara (Congo Français) (Lepesme 1948); Nigeria, French Equatorial Africa, (Ubangui-Chari), Western French Africa (French Sudan, currently Mali), Senegal, Cameroon (Ferreira and da Veiga Ferreira 1959); Uganda, Sudan (Darfur), Chad (G. Sama personal collection).

Table 2. Long-horned beetle catches at flight interception traps on the El Demokeya site (*Acacia senegal*).

Species of longhorned beetles	**Host plants** according to literature (Sama, in preparation, personal communication)	**Synonyms**	**Date of recording**	**Length**
Anthracocentrus arabicus (Thomson 1877)	*Tamarix articulata*, *A. raddiana* and *A. scorpioides*	Unknown	April/2008	Length: 45–81 mm
Crossotus strgifrons (Fairmaire 1886)	*Acacia raddiana*; *A. ehrenbergiana*, and *A. seyal*.	*Crossotus albicans* (Breuning 1942) *Dichostethes nebulosus* (Fairmaire 1892) *Dichostates strigifrons* (Fairmaire 1886)	April/2008	Length: 12–18 mm
Doesus telephoroides (Pascoe 1862)	Unknown	*Doesus telephoroides* (Breuning and Villiers 1972) *Doesus telephoroides* (Lepesme 1948) *Doesus telephoroides* (Lepesme 1952)	November/2008	Length: 16–20 mm
Tithoes sp.		Unknown	August/2008	Length: 30–70 mm
Gasponia gaurani (Fairmaire 1892)	*Acacia nilotica*	Unknown	June/2008	Length: 9–12 mm

4. *Tithoes* sp.

The distribution area of this species covers the whole Tropical Africa (probably except rain forest areas) from Mali to South Africa (Gilmour 1956); it is also known from the Arabian Peninsula (Fuchs 1969, Holzschuh 1993) and Upper Egypt (Sama in print).

5. *Gasponia gaurani* (Fairmaire 1892)

The genus includes three species: *G. fascicularis* (Fairmaire 1887) from Tanzania; *G. gaurani*, described from Obock (Djibouti) and recorded from several countries in Sub-Saharan

Africa (such as Somalia and Kenya) and from the Arabian Peninsula (Yemen); *G. penicillata* (Gahan 1906), sometimes regarded as a synonym (Breuning 1942, 1962) or a subspecies of *G. gaurani* (Téocchi 1998), but, very likely, a distinct species (Adlbauer 2001) widespread in south African countries from Malawi to South Africa.

Table 3. Infestation percentages for long-horned beetles at the Acacia Agricultural Project site.

Plot, No	Number of observed trees	Number of infested trees	Average of age	Infested trees, %
1	26	4	10	15.38
2	17	4	10	23.53
3	22	1	10	4.55
4	25	0	10	0.00
5	23	1	10	4.35

Infestation rates of the long-horned beetles on study sites of *A. senegal*

Acacia agricultural project site

At the Acacia agricultural project study site 5 study plots with a total of 113 Acacia trees were under investigation. All trees of the five plots observed for the infestation of *A. senegal* with the longhorned beetles, had an average age of 10 (S.D. ± 0.0). Infestation rates of trees varied between no infestation (0.00%) and 23.53%, Table 3.

Elhemaira study site

At the Elhemaira study site 5 study plots with a total of 73 Acacia trees were under investigation. Trees of the five plots observed for the infestation of *A. senegal* with the longhorned beetles, had an average age range between 10 and 17. Infestation rates of trees varied between no infestation (0.00%) and 20%, Table 4.

The results of the first plot with a total number of 21 trees, and with no infested trees, showed zero percentage of infestation, (0.00%) and corresponded to an average age of 10 (S.D. ± 4.9). In the second plot with a total number of 10 trees, and with no infested trees, the percentage of infestation was 0.00% and corresponded to an average age of 17 (S.D. ± 3.86), whereas the results of the third plot

Table 4. Infestation percentages for long-horned beetles at the Elhemaira forest site.

Plot, No	Observed trees, number	Infested trees, number	Tree age, years Mean ± S.D.	Infested trees, %
1	21	0	10 (S.D ± 4.9)	0.00
2	10	0	17 (S.D ± 3.86)	0.00
3	17	1	13 (S.D ± 5.75)	5.88
4	10	2	12 (S.D ± 6.81)	20.00
5	15	0	15 (S.D ± 0.0)	0.00

with a total number of 17 trees, and with one infested tree, the percentage of infestation was 5.88% and the average age was 13 (S.D. ± 5.75). The results of the fourth plot with a total number of 10 trees, and with 2 infested trees, showed a percentage of infestation that reached 20% with an average age of 12 (S.D. ± 6.81). The fifth plot with a total number 15 trees showed no infested trees, the percentage of infestation was zero (0.00%) with an average age of 15 (S.D. ± 0.00).

El Demokeya study site

At El Demokeya study site 5 study plots with a total number of 24 Acacia trees were under investigation. All trees of the five plots observed for the infestation of *A. senegal* with the longhorned beetles, had an average age of 43 (S.D. ± 0.00). Infestation rates of trees varied between no infestation (0.00%) and 100%, Table 5.

The results of the first plot with a total number of 5 trees, and with no infested trees, showed zero percentage of infestation, (0.00%) and corresponded to an average age of 23 (S.D. ±0.00), while on the second plot with a total number of 5 trees, and with 4 infested trees, the percentage of infestation was 80% and corresponded to an average age of 43 (S.D. ± 0.00). On the third plot with a total number of 7 trees, and with 4 infested trees, the percentage of infestation was 57.14% and the average age was 43 (S.D. ± 0.00). The results of the fourth plot with a total number of 2 trees infested, showed a percentage of infestation reaching 100% with an average age of 43 (S.D. ± 0.00).

Table 5. Infestation percentages for long-horned beetles at the El Demokeya site.

Plot, No	Number of observed trees	Number of infested trees	Average Age, years	Infested trees, %
1	5	0	43	0.00
2	5	4	43	80.00
3	7	4	43	57.14
4	2	2	43	100.00
5	5	3	43	60.00

Discussions

At the study sites, seven long-horned beetle species were captured using flight interception traps. According to the literature, most of the species have a more or less extended distribution range. *Anthracocentrus arabicus* (Thomson 1877) occurs in Saharan and Sahelian countries, from southern Morocco and Mauritania to Central Eastern Africa (Sudan, Somalia, Eritrea). It also occurs in the Arava Valley in southern Jordan and Israel, the Sinai Peninsula and the whole Arabian Peninsula from the United Emirates to Yemen (Sama and Rapuzzi 2006). *Crossotus strigifrons* (Fairmaire 1886) is also widespread in Saharan and Sahelian countries, from Mauritania and Southern Morocco to Upper Egypt and the Sinai Peninsula. It is also spread across the desert areas of southern Israel and Jordan and in Somalia, Eritrea, Ethiopia and the Arabian Peninsula (Breuning 1942, Holzschuh and Téocchi 1991, Sudre et al. 2007). Individuals of *Crossotus subocellatus* Fairmaire (*Crossotus subocellatus subocellatus* (Fairmaire

1886) are found in the southern part of the Arabian Peninsula, Sudan, Somalia, Ethiopia, Eritrea, and Kenya. In Northern Africa, the species is only found in Egypt (common in South-Eastern Desert and Sinai), Libyia, Senegal, Saudia Arabia, Morroco, Chad, Mauritania, and Niger. Sama (personal communication) argues that *Doesus telephoroides* (Pascoe 1862[1]) was recorded for the first time in Sudan. It is widely distributed throughout central provinces of India and Jabalpur (Gahan 1906). In Africa, it can be found in Senegal, Cameroon (Ferreira and da Veiga Ferreira 1959), Bahr-Sara (Congo Français) (Lepesme 1948), Nigeria, French Equatorial Africa (Ubangui-Chari), Western French Africa (French Sudan, currently Mali), Uganda, Sudan (Darfur), and Chad (G. Sama personal collection). *Titoceres jaspideus* (Audinet Serville 1835) is a common species throughout Africa, extending from South Africa northward. The *Tithoes* sp., very likely *T. confinis* (Castelnau 1840), has a distribution area that covers the entire tropical African region (probably except rain forest areas) from Mali to South Africa (Gilmour 1956). It has also been found on the Arabian Peninsula (Fuchs 1969, Holzschuh 1993) and Upper Egypt (Sama in print). Jamal (1994) recorded the presence of this species, using the synonym *Acanthophorus confinis* Cast (Cerambycidae, Prioninae). This pest exerted several attacks on the branches of *Acacia* trees. *Gasponia gaurani* (Fairmaire 1892) was first recorded in Sudan. In the present study *A. senegal* trees differ in their infestation rates with the long-horned beetles in different sites (Table 1, 2 and 3). These results could be demonstrated, as site conditions or factors in relation to pest infestation were discussed by many investigators. Coulson and Witter (1984) mentioned that site condition is an important consideration because the site contains the host material (tree species in various stages of growth) that pest species utilize for food and habitat. The availability of suitable preferred and alternate hosts is a primary requisite for development of insect populations. Different sites vary in plant species composition, density, and age classes. Therefore, the opportunity for insect populations to grow in size varies on different sites. Site condition, in combination with weather, determines the rate of growth and general vigor of the host trees present, moreover Speight and Wylie (2001) mentioned that feeding of the larvae of *Celosterna scabrator*, the babul borer (Cerambycidae) causes cessation of growth and sometimes death of the plant above ground. Incidence of attack of up to 80% has been recorded for trees growing on unsuitable sites and they also mentioned that *Strongylurus decoratus* (McKeown) (Cerambycidae) has affected trees ranging in age from 4 years to more than 30 years and in height from 3 to 31 m. This description was agreed with the findings of infestation rates of *Acacia* trees with longhorned beetles in different sites with different age range, where highest infestation coincided with the highest average of tree age for Acacia company project site and El Himaira forest site respectively. El Demokeya reserve forest site indicated the highest percentage of infestation with the minimum average of tree age (Table 1, 2 and 3 for *A. senegal*);

[1] First record from Sudan

moreover the height of *A. senegal* ranged from 1 to 9 m. The positive correlation of tree age and tree infestation was mentioned for other long-horned beetle species. Investigation on other long-horned beetles also demonstrate for the obtained results about *Acacia* species infestation. The locust borer *Megacyllene robiniae* (Forst.) (Cerambycidae) a wood – boring beetle attacks the host when stems are 3 to 5 years old with sufficient diameter to support the extensive wood mining done by the larvae (Thatcher 1961). The greatest damage by the locust borer *Megacyllene robiniae* (Forst.) (Cerambycidae) is coincident with drought conditions since drought enables a larger number of larvae to survive. The attacks are most serious on trees under 6 inch in diameter since breakage due to structural weakening of narrow stems is proportionally greater but dry periods may allow the larvae to successfully and severely attack larger trunks (Thatcher 1961). Moreover, Dajoz (1992) stated that temperature under bark is a function of the exposure of the tree to sunlight, and the structure of the bark. At sunny sites, daily variation in temperature is much bigger than those recorded at sheltered trees. Under bark sheltered from sunlight fluctuations of temperature are slighter than those of the ambient air. The same applies to the temperature inside the trunk. Thus, temperature plays an important part in the localization of insects that live in tree trunks. As an example, the life cycle of the Cerambycid *Monochamus scutellatus* lasts one year in trunks exposed to sunlight, and three years in shaded trunks. In this study, the least number of infestation holes of *A. senegal* was located on the south direction, which has the lowest sun exposition during the course of a day.

Conclusions

More than one species of the long-horned beetles had been identified from *Acacia* species as the species *Acacia* reported as an important from ecological perspectives for family Cerambycidae. Further research is needed to verify other host tree species and to study about larval behavior due to lack of ecological data of these species in the savanna low rainfall zone in the study area.

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