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ABUNDANCE AND DIVERSITY OF XYLOPHAGOUS BEETLES AS A FUNCTION OF WOOD SPECIES AND DIAMETER

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ABSTRACT
The aim of this study was to determine the influence of species on the xylophagous beetle population of the Téné classified forest in Oumé, in order to take them into account in forest management and silviculture. The method used to collect insects at the four sites was systematic excavation. These sites are primary forest, cedrela, teak and multi-species reforestation. At each site, 17 wood species and three wood diameter classes were systematically searched. A total of 201 wood-boring beetles were collected. The species most colonized by xylophagous beetles were Terminalia superba, Triplochiton scleroxylon and Tectona grandis, with 37.31%, 20.39% and 17.41% of total individuals respectively. The wood-boring beetle species most closely associated with these species are Cerambyx cerdo, Cerambyx velutinus and Spondylis buprestoides, accounting for 23.38%, 12.43% and 11.97% of total individuals respectively. The species least colonized by woodborers were Sterculia rhinopetala, Mansonia altissima, Gambeya delevoyi and Celtis mildbraedii, each with 4.14% individuals, and Cedrela odorata and Entandrophragma cylindricum, each with 2.095% individuals. Tectona grandisse and Terminalia superba are the species with the highest diversity of wood-boring beetles, and show the most damage. Sterculia rhinopetala, Mansonia altissima, Gambeya delevoyi, Celtis mildbraedii and Cedrela odorata are the least diverse in terms of wood-boring beetle species and show the least damage. In terms of wood diameter class, the greatest number of individuals were collected on large-diameter trees (175 individuals, or 58.33 ± 7.26 of the total population). Fewer individuals were collected in the small-diameter class (59 individuals or 19.66 ± 4.66 of the total population). Cerambyx velutinus, Cerambyx cerdo and Spondyles buprestoides are associated with large and medium diameters, while small diameters are characterized by the species Hylotrypes bajulus and Amphicerus cornutus. Wood-boring Coleoptera species are more diversified in the small and medium diameter class.

KEYWORDS: Abundance, wood-boring beetles, diversity, species, forest, Téné, influence, silviculture.

1. INTRODUCTION

Today, the bulk of Côte d'Ivoire's forests consists of protected areas and the rare fragments left when unprotected areas are cleared. Protected areas are therefore an essential link in the conservation of the dense rainforest and the production of timber in Côte d'Ivoire. Such is the case of the Téné classified forest in Oumé, with a surface area of 29700 ha. It is one of the largest development centers for forest plantations, a state-owned enterprise specializing in reforestation. The combination of climatic, edaphic, biotic and structural characteristics of the ecosystems in these protected areas make up a wide range of ecological niches for insect communities, which exploit this significant heterogeneity of plant hosts and the associated opportunities in terms of resources and habitats (Lucky et al. 2002, Dangles et al. 2009, Velazques 2014). Among these insects are xylophagous insects (Allaire et al., 2000), which belong to the four major groups, Coleoptera, Hymenoptera (wasps), Lepidoptera (butterfly caterpillars) and Diptera (flies), and are mainly represented by Coleoptera (AJoz. 1998), which will be the focus of this study. Xylophagous Coleoptera are organisms that feed inside trees thanks to their ability to digest and assimilate woody matter (constituting the xylem) in the first case, and products circulating in the phloem in the second, most often during their larval development (pioneer or primary xylophagous beetles) (Bouget, 2004). The group that attacks old, dead or rotting wood are saproxylophages (Brustel, 2004), playing an important ecological role in the decomposition, transformation and natural recycling of dead wood in forests. As for the pioneers, they have repercussions on the physical integrity of the wood: fresh wood / intact wood. Attacks by these species distort the quality of the wood, thus impacting on tree health, the structural condition of the wood and the wood industry (Magali et al., 2022). Worldwide, around 68 million hectares of forest are damaged by insects every year. This damage is more than double the area burnt by forest fires (FAO 2005). However, the lack of information about Wood-boring Beetles in forestry structures and protected areas is a major handicap to their management and understanding of their evolution within these agrosystems. It is therefore useful to carry out a study to shed light on the real influence of Wood-boring Beetles on the species of very important tree species.

2. MATERIALS AND METHODS

2.1. Equipment

The equipment consisted of various xylophagous beetle specimens (Fig1. A and B), a GPS device for recording geographical coordinates. Sampling of xylophagous beetle insects was carried out by systematic excavation on several tree species and on three tree diameter classes (small diameter, medium diameter and large diameter) (Fig. C). Systematic excavation was carried out on the trunk and under the bark of the various trees (Fig. D). A chainsaw and machete were used for felling, cutting and splitting the pieces of wood (Fig. E and F). The samples obtained were identified using a binocular magnifying glass. The keys to species recognition are to be found in the Catalogues of: Bense (1995), Monné (2006) and Aurivillius (1923). Insects were preserved in pillboxes containing 70% alcohol.

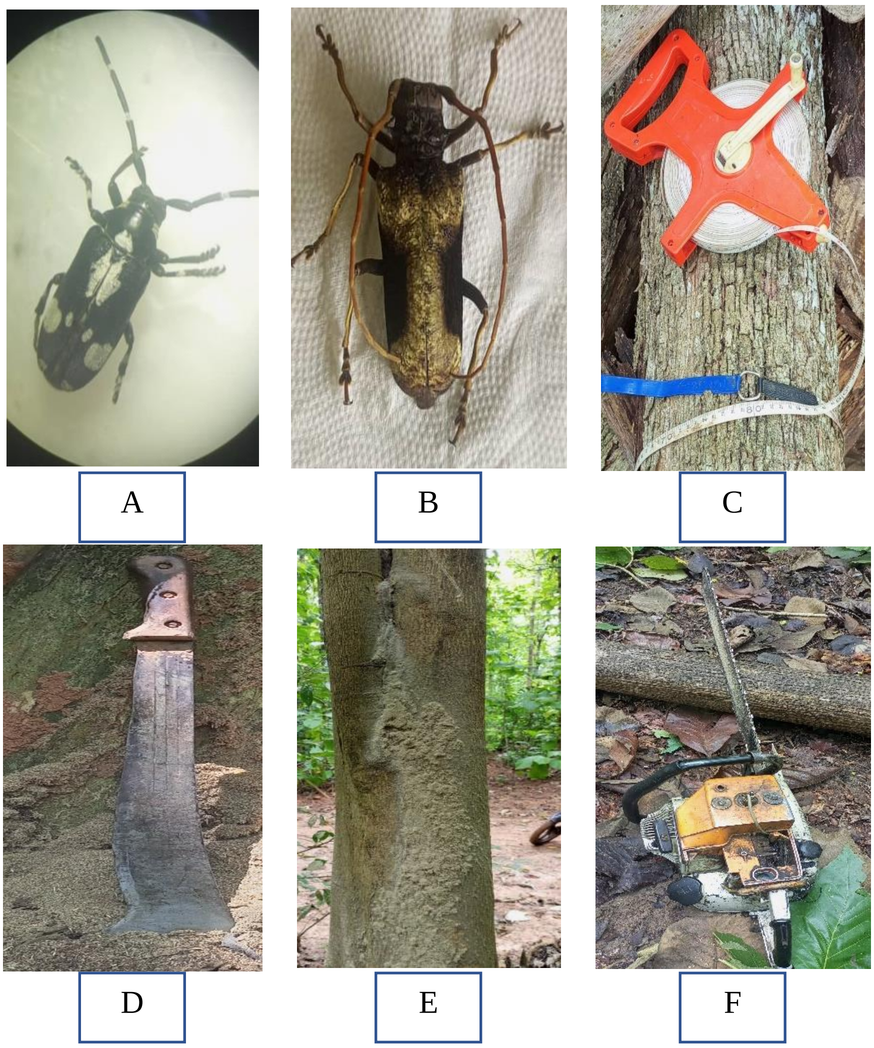


Fig. 1: Equipment, A and B: wood-boring insects; C: decameter; D: tree trunk; E: chainsaw; F: walker.

2.2 Methods

The sampling system covered an area of 10,000 m² at four sites. Within this area, 80 living trees, each marked with a red ribbon, were randomly selected. Around these trees, excavations were carried out on the trunk, under the bark and in the buttresses. As for the deadwood, 90 trees were selected (30 dry deadwood, 30 fresh deadwood and 30 decaying deadwood). Trees with a circumference of between 0.5 and 1.2 m were cut with a chainsaw. They were then cut into smaller pieces for excavation. For larger circumferences, however, the dead trees were excavated without being cut up. During excavation, insects captured under bark, in buttresses and in galleries made by insects were put directly into pillboxes containing 70% diluted alcohol. The pillboxes were labelled according to site, wood type, circumference, species (for live wood and fresh dead wood) and month the month of sampling.

2.2.2. Study site

The study took place in central-western Côte d'Ivoire (the Gôh region) in the department of Oumé, more precisely in the Téné classified forest. This forest covers a total area of 29700 ha (Fig. 2). The average annual rainfall recorded in 2021 and 2022 is 1007.2 mm and 1499 mm respectively, divided into four seasons (the long rainy season, the short rainy season, the long dry season and the short dry season). The sampling months for these four seasons are May, September, February and August respectively. The mean annual temperature in 2021 and 2022 is 26.61°C and 26.44°C respectively, with a minimum of 24.9°C in July, 24.8°C in August and a maximum of 27.9°C and 28.4°C in February. The department of Oumé belongs to the mesophilic sector of the Guinean domain. This zone marks the transition between forest and savannah, where formations are represented by forest patches or islands with a floristic composition of Celtis spp and Triplochiton scleroxylon, characterized by semi-deciduous forests and reforestation plantations. Four sites - the cedrela site, the teak site, the multi-species site and the primary forest - were chosen on the basis of nature, the intensification of human activity and, above all, the diversity of forestry practices. The geographical locations of these sites are: the cedrela site (6°30'08.500''N and 5°22'53.620''W), the teak site (6°29'15.220''N and 5°23'05.842''W), the multi-species site (6°29'06.425''N and 5°21'16.024''W) and the primary forest (6°29'46.500''N and 5°24'52.240''W).

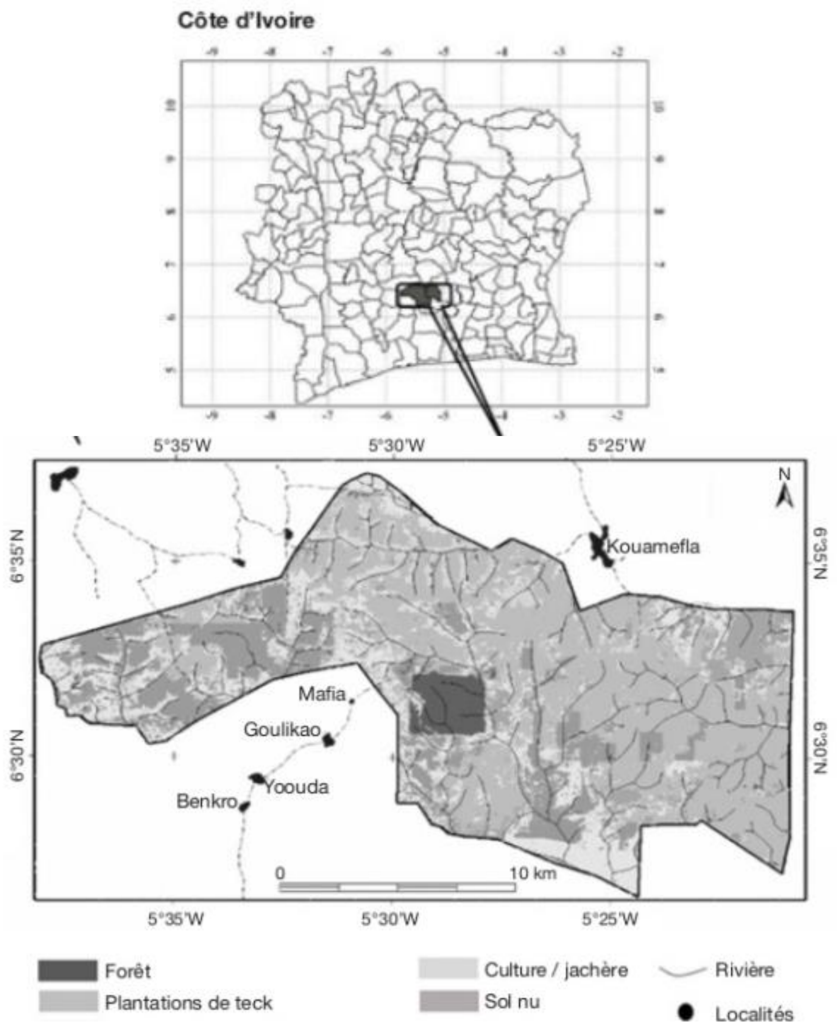


Fig. 2: Location map of the Téné classified forest (BIOPAMA, 2022).

3. RESULTS AND DISCUSSION

3.1 Wood diameter classes considered

In this study, three diameter classes of the wood species on which beetles were collected are considered. These are the small-diameter class (diameter less than or equal to 0.3 meters or PD ≤ 0.3 m), the medium-diameter class (diameter between 0.3 meters and 0.9 meters or 0.3 m ≤ DM ≤ 0.9 m) and the large-diameter class (diameter greater than or equal to 0.9 meters or GD ≥ 0.9 m)

3.1.1. Beetles associated with small diameters (PD ≤ 0.3 m)

A total of 59 individuals were collected in this diameter class. Ten species and one genus were identified, divided between seven beetle families. Spondylis buprestoides, Cerambyx cerdo and Arhopolus rusticus with respective means of 33, 33 ± 0.88; 2.66 ± 0.88 and 2.66 ± 0.66 individuals per site were the most numerous on this wood diameter class. Statistical analyses showed a significant difference between the means of the different species on this wood diameter. Beetle abundance therefore varied from one site to another according to diameter (p <0.05) (**Table 1**).

Table 1: Average abundance of wood-boring beetle species associated with small wood diameters.

Families	Species	Average	
Anobiidae	*Xestobium rufovillosum*	0,66 ± 0,33	b
Bostrichidae	*Amphicerus cornutus*	1± 0,57	ab
Cerambycidae	*Aegosoma scabricorne*	0,66 ± 0,33	b
	Arhopalus rusticus	2,66 ± 0,66	a
	Cerambyx cerdo	2,66 ± 0,88	a
	Cerambyx velutinus	1,66 ± 0,66	ab
	Chloropholus sp	0,33 ± 0,33	b
	Derobrachus germinatus	0,33 ± 0,33	b
	Evodinus clathratus	1,66 ± 0,33	ab
	Hylotrupes bajulus	0,66 ± 0, 33	b
	Spondylis buprestoides	3,33 ± 0,88	a
	Diastocera trifasciata	1 ± 0,57	ab
Curculionidae	*Catapionus quadrilineatus*	0,33 ± 0, 33	b
	Melanotus villosus	0,33 ± 0,33	b
Lucanidae	*Ceruchus chrysomelinus*	0,33 ± 0,33	b
Nitidulidae	*Epuraea ocularis*	0,66 ± 0,33	b
Trogossitidae	*Tenebroides mauritanicus*	0,66 ± 0,33	b
	Lophocateres pusillus	0,66 ± 0,33	b

Mean values ± standard error with similar letters are not significantly different at the 5% level.

3.1.2. Beetles associated with average diameters (0.3 m ≤ DM ≤ 0.9 m)

A total of 76 individuals were collected. Their identification yielded 18 species and one genus divided into eight families. On this diameter, Cerambyx cerdo, Cerambyx velutinus and Spondylis buprestoides were the most numerous, with averages of 7 ± 0.57, 3.66 ± 0.33 and 3.33 ± 0.88 individuals per site respectively. Statistical analysis using a one-factor Anova test revealed a highly significant difference (p = 0.0052) between means (**Table 2**). Beetle abundance therefore varied from site to site as a function of diameter.

Table 2: Average abundance of wood-boring beetle species associated with average wood diameters.

Families	Species	Average	
Anobiidae	*Xestobium rufovillosum*	0,66 ± 0,33	b
Bostrichidae	*Amphicerus cornutus*	0,33 ± 0,33	b
Cerambycidae	*Aegosoma scabricorne*	1,33 ± 0,33	b
	Arhopalus rusticus	0,33 ± 0,33	b
	Cerambyx cerdo	7 ± 0,57	a
	Cerambyx velutinus	3,66 ± 0,33	ab
	Chloropholus sp	0,33 ± 0,33	b
	Evodinus clathratus	0,66 ± 0,66	b
	Hylotrupes bajulus	1 ± 0, 57	b
	Mionochroma elegans	1,33 ± 0,33	b
	Petrognatha gigas	0,66 ± 0,33	b
	Spondylis buprestoides	3,33 ± 0,88	ab
Curculionidae	*Catapionus quadrilineatus*	0,33 ± 0, 33	b
Elateridae	*Podeonius acuticornis*	1 ± 0,57	b
	Melanotus villosus	0,66 ± 0,66	b
Lucanidae	*Ceruchus chrysomelinus*	0,66 ± 0,33	b
Nitidulidae	*Epuraea ocularis*	0,33 ± 0,33	b
Trogossitidae	*Tenebroides mauritanicus*	0.66 ± 0,33	b

	Lophocateres pusillus	1± 0,57	b

Mean values ± standard error with similar letters are not significantly different at the 5% level.

3.1.3. Beetles associated with large diameters (GD ≥ 0.9 m)

The number of individuals collected in this diameter class was 175. Identification yielded 19 species and one genus, all distributed among eight beetle families. Cerambyx cerdo and Cerambyx velutinus were the most widely collected species, with respective averages of 10 ± 1.15 and 5.66 ± 1.15 individuals per site. Statistical analysis using the one-factor Anova test revealed a significant difference ($p = 0.016$) between the means of the individuals identified (**Table 3**).

Table 3: Average abundance of wood-boring beetle species associated with large wood diameters.

Families	Spècies	Average	
Anobiidae	*Xestobium rufovillosum*	3,33 ± 1,45	b
Bostrichidae	*Amphicerus cornutus*	3 ± 1,15	b
Cerambycidae	*Aegosoma scabricorne*	2,66 ± 0,88	b
	Arhopalus rusticus	3,33 ± 1,85	b
	Cerambyx cerdo	10 ± 1,15	a
	Cerambyx velutinus	5,66 ± 1,20	bc
	Chloropholus sp	1 ± 0,57	b
	Derobrachus germinatus	1,66 ± 0,33	b
	Evodinus clathratus	2 ± 0,57	b
	Hylotrupes bajulus	3,66 ± 1, 76	b
	Mionochroma elegans	1,66 ± 0,88	b
	Petrognatha gigas	1 ± 0,57	b
	Spondylis buprestoides	5 ± 1	bc
Curculionidae	*Catapionus quadrilineatus*	1,66 ± 0, 33	b
Elateridae	*Podeonius acuticornis*	2,33 ± 0,33	b
	Melanotus villosus	2,66 ± 1,20	b
Lucanidae	*Ceruchus chrysomelinus*	1,66 ± 0,66	b
Nitidulidae	*Epuraea ocularis*	3 ± 1,15	b
Trogossitidae	*Tenebroides mauritanicus*	2 ± 0,57	b
	Lophocateres pusillus	1± 0,57	b

Mean values ± standard error with similar letters are not significantly different at the 5% level.

3.1.4. Comparison of beetle abundances between the three diameter classes

The highest number of individuals was collected in the large-diameter class (175 individuals, i.e. an average of 58.33 ± 7.26 individuals sampled per site), while the lowest number of individuals was collected in the small-diameter class (59 individuals, i.e. an average of 19.66 ± 4.66 individuals per site). Comparison of mean beetle abundance between diameter classes using a one-factor analysis of variance produced a significant difference ($p = 0.0072$). Beetle distribution varied according to wood diameter class (**Fig 3**).

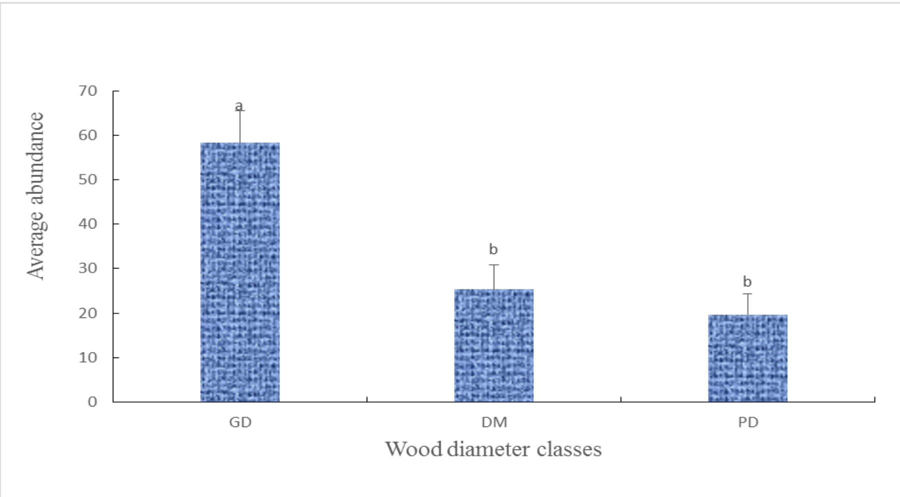
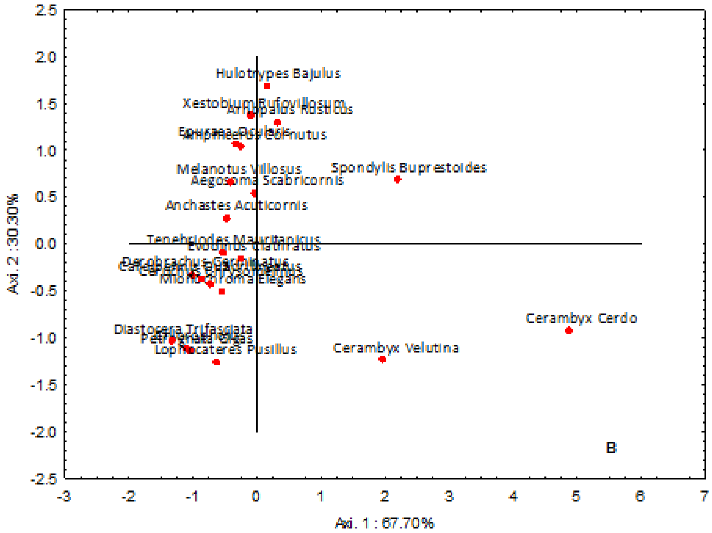


Fig. 3: Abundance of wood-boring beetles associated with wood diameter classes.

Mean values ± standard error with similar letters are not significantly different at the 5% threshold. PD : small diameter; DM : medium diameter; GD : large diameter

3.1.5. Affinity between wood boring beetle species and wood diameter class

Analysis of the correlation circle shows that the large wood diameter class with r = 0.97 and the medium wood diameter class with r = 0.95 correlate significantly with axis 1, while axis 2 is correlated significantly by the small diameter class with r = 0.92 (**Figure 4 A**). Both axes contribute 98% to total inertia (67.70% for axis 1 and 30.30% for axis 2). Projection onto the factorial plane reveals that the variables correlating with axis 1 are the species Cerambyx velutinus, Cerambyx cerdo and Spondylis buprestoides (**Fig 4 B**), while axis 2 is characterized by the species Hylotrupes bajulus and Amphicerus cornutus.



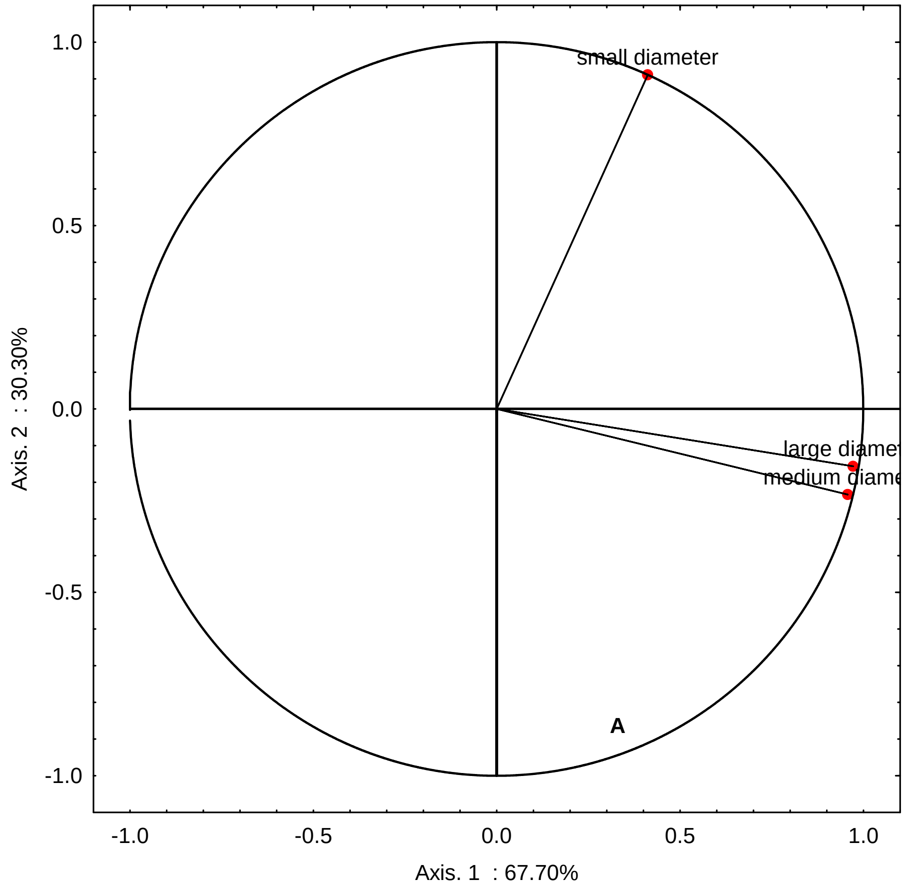


Fig. 4: Affinity between wood boring beetle species and wood diameter classes, A: Correlation circle ; B: Star projection in the factorial plane.

3.1.6: Diversity of wood-boring beetles associated with different wood diameters

The Shannon diversity index is relatively high for small-diameter wood (H = 2.96) and relatively low for large-diameter wood (H = 2.17). Statistical analysis showed no significant difference (p = 0.18) between the values of this diversity index at diameter class level. Eighteen (18) beetle species were identified on small-diameter wood and twenty (20) species on medium- and large-diameter wood. Furthermore, the high equitability indices obtained indicate a good equi-repartition of species between diameter classes (**Table 4**).

Table 4: Beetle species diversity indices by diameter class.

	Diameter class	Probability		
Indices	GD	DM	PD	P
H	2,17	2,45	2,96	0,18
E	0,76	0,83	0,97	
S	20	20	18	

PD: Small diameter; DM: Medium diameter; GD: Large diameter; H: Shannon diversity index; E: Equitability; S: Species richness.

3.1.7 Hierarchical ascending classification of wood diameter classes

The diameter classes were grouped using Hierarchical Ascending Classification based on Sorensen's similarity index according to their beetle species composition. The resulting dendrogram shows two clusters (Fig 5). A grouping between the large-diameter class and the medium-diameter class. This reflects a similarity in their species composition of wood-boring Coleoptera.

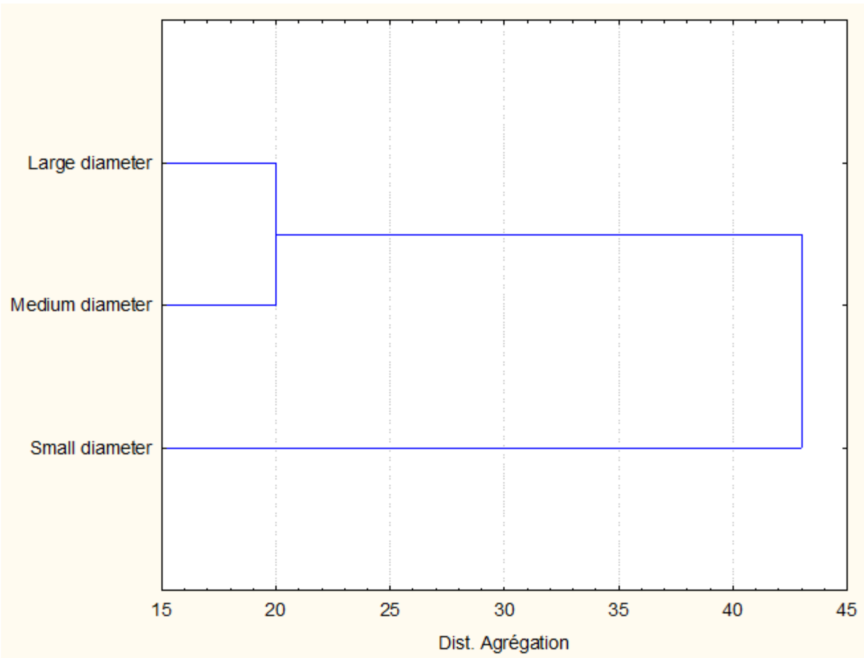


Fig. 5: Diameter classes grouped according to beetle species composition.

3.2 Wood species used for the systematic search

The systematic search for specific species of wood-boring beetles was carried out on 17 species of wood divided into 11 families. A single species was identified for most families, with the exception of the Malvaceae family with four species and the Sapotaceae with two species (Table 5).

Table 5: Families and species of wood species.

Families	**Species**
Apocynaceae	*Funtumia latifolia*
Cannabaceae	*Celtis mildbraedii*
Combretaceae	*Terminalia superba*
Fabaceae	*Guibourtia ehie*
Lamiaceae	*Tectona grandis*
Malvaceae	*Ceiba pentandra*
	Sterculia rhinopetala

	Triplochiton scleroxylon
	Nesogordonia papaverifera
Meliaceae	*Entandrophragma cylindricum*
	Guarea cedreta
	Cedrela odorata
Moraceae	*Morus mesozygia*
Sapotaceae	*Gambeya africana*
	Aningeria robusta
Sterculiaceae	*Mansonia altissima*
Verbenaceae	*Gmelina arborea*

3.2.1. Abundance of wood-boring beetle species according to wood species

201 wood-boring beetle individuals were collected from the various wood species. Of all the wood-boring beetles collected, the species on which the most wood-boring beetle species were found were Terminalia superba, Triplochiton scleroxylon and Tectona grandis, with 75, 41 and 35 wood-boring beetle individuals respectively. Cerambyx cerdo was most abundant on all three species, and particularly on Terminalia superba with 23 individuals (Appendix).

3.2.2. Comparison of wood-boring beetle species abundance by species

Terminalia superba was the species with the highest number of wood-boring Coleoptera species collected, with 75 individuals, i.e. an average of 3.80 ± 1.52 of the total. Comparison of species abundance of wood-boring Coleoptera using the one-factor Anova test showed a highly significant difference ($P < 0.05$). Beetle abundance varied significantly from one species to another (Fig 6).

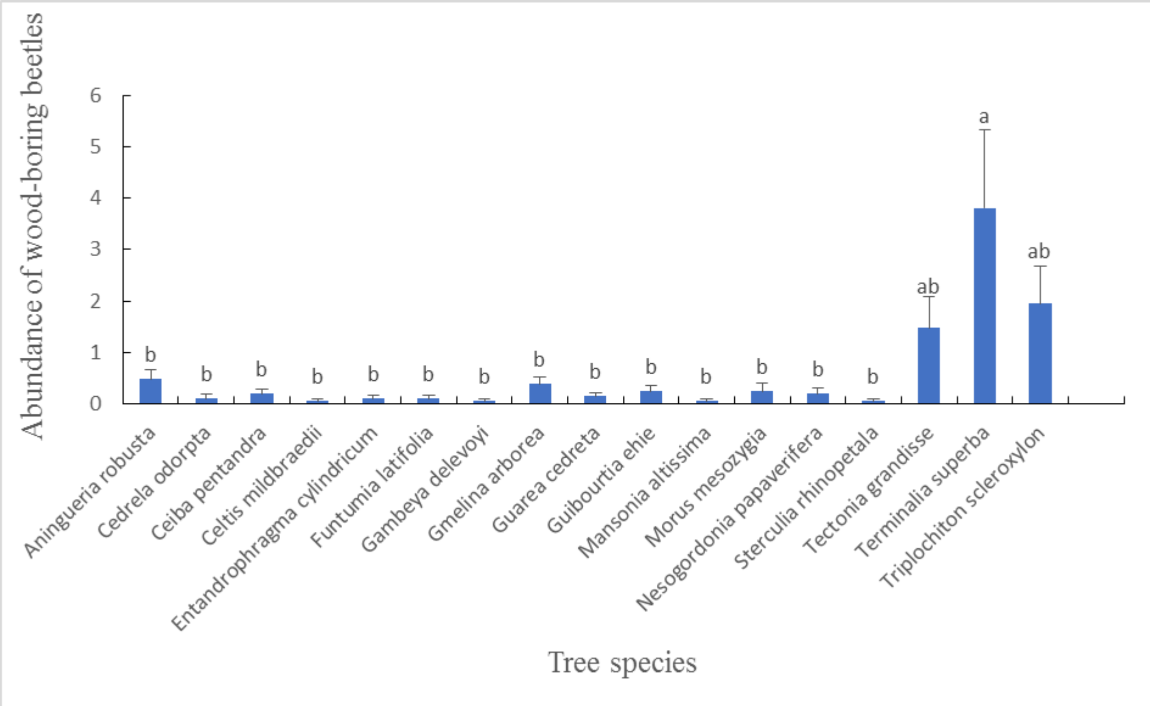


Fig 6. Average abundance of wood-boring beetle species by species.

Mean values ± standard error with similar letters are not significantly different at the 5% threshold.

3.2.3. Diversity of wood-boring beetles by wood species

The Shannon diversity index is higher on Tectona grandis and Terminalia superba, with H = 2.18 and H = 2.16 respectively, compared with other species. Statistical analysis using the values of this diversity index showed a significant difference between these values ($p = 0.007$). Diversity varies from one species to another. The equitability index is high (0.75 to 1) on 12 species, and its value is zero (0) on five species (Table 6). High values of this index indicate a good even distribution of species among species. On the other hand, values equal to zero indicate a poor distribution of these beetle species between wood species. The highest number of species was obtained on Terminalia superba with 18 species, while only one species was identified on the wood species Sterculia rhinopetala, Mansonia altissima, Gambeya delevoyi, Celtis mildbraedii and Cedrela odorata. Species richness varied significantly ($p = 0.007$) from one species to another.

Table 6: Diversity index of wood boring beetle species on wood species.

Tree species	S	H	E
Aningeria robusta	7	1,83	0,94
Cedrela odorata	1	0	0
Ceiba pentandra	4	1,38	1
Celtis mildbraedii	1	0	0
Entandrophragma cylindricum	2	0,69	1
Funtumia latifolia	3	1,09	1
Gambeya africana	1	0	0
Gmelina arborea	6	1,73	0,96
Guarea cedreta	3	1,09	1
Guibourtia ehie	4	1,33	0,96
Mansonia altissima	1	0	0
Morus mesozygia	3	0,95	0,86
Nesogordonia papaverifera	3	1,04	0,94
Sterculia rhinopetala	1	0	0
Tectona grandis	14	2,18	0,82
Terminalia superba	18	2,18	0,74
Triplochiton scleroxylon	9	1,91	0,87

3.2.4. Attack level of wood species according to observed damage

Damage is assessed on the basis of the galleries dug by the insects on the trunk and the amount of worm damage on the tree.

- Species with more damage caused by wood-boring beetle species

Species with more damage account for 75.11% of the total number of species. Terminalia superba, Triplochiton scleroxylon and Tectona grandis were the wood species most damaged by xylophagous beetles, with 37.31%, 20.39% and 17.41% of total individuals respectively (Fig 7).

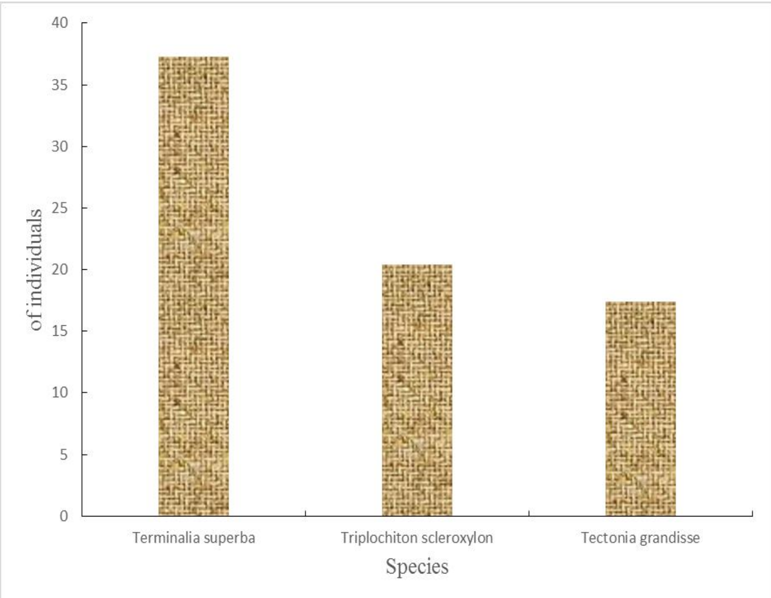


Fig. 7: Proportion of species showing more damage from wood-boring beetles.

- Species with less damage caused by wood-boring beetle species

Sterculia rhinopetala, Mansonia altissima, Gambeya africana and Celtis mildbraedii with 4.14% each, and Cedrela odorata and Entandrophragma cylindricum with 2.095% each (Table 7).

Table 7: Proportion of wood species least attacked by beetles.

Species	Percentages
Sterculia rhinopetala	4,14 %
Mansonia altissima	4,14 %
Gambeya africana	4,14 %
Celtis mildbraedii	4,14 %
Cedrela odorata	2,095 %
Entandrophragma cylindricum	2,095%

3.2.5. Bottom-up classification of tree species according to their specific composition of wood-boring Coleoptera

Species were grouped using a hierarchical ascending classification based on Sorensen's similarity index, according to their xylophagous Coleoptera species composition (proportion of shared species). The resulting dendrogram shows three clusters. A cluster between Aningeria robusta, Cedrela odorata, Ceiba pentandra, Celtis mildbraedii, Gambeya africana, Sterculia rhinopetala, Mansonia altissima, Entandrophragma cylindricum, Nesogordonia papaverifera, Funtumia latifolia, Guarea cedreta, Guibourtia ehie, Morus mesozygia and Gmelina arborea. A second group is formed by Tectona grandis and Triplochiton scleroxylon. The third group is made up of the single species Terminalia superba (Fig 8). These groupings reflect the similarity between the species in terms of their specific composition of wood-boring beetles.

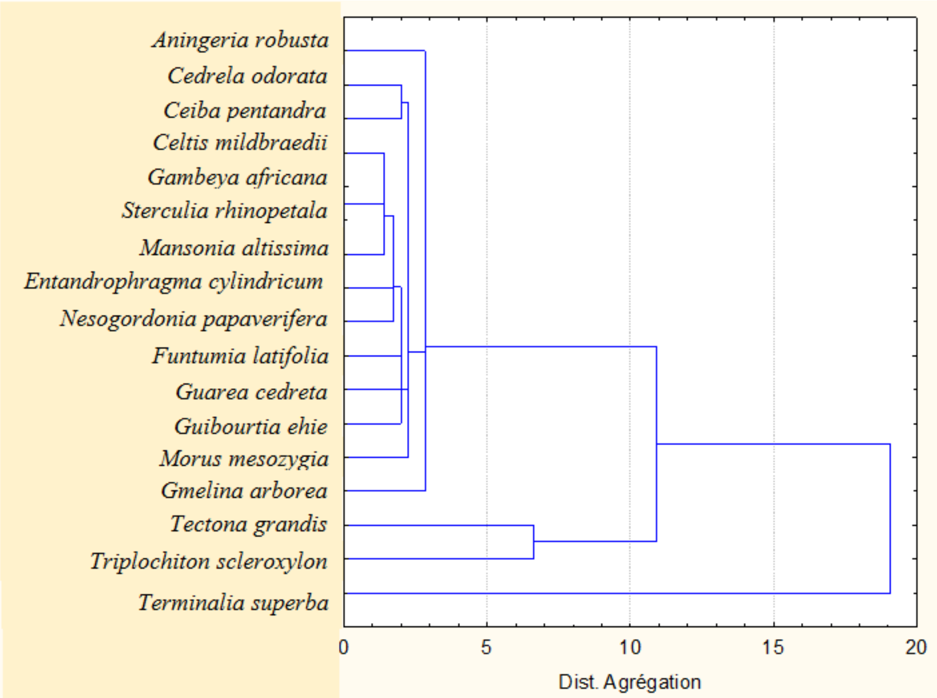


Fig. 8: Wood species grouped according to beetle composition.

3.2.6. DISCUSSION

Abundance and diversity at diameter class level

In this section, the abundance, affinity and diversity of wood-boring Coleoptera associated with different wood diameter classes were studied. The results show that many individuals were collected on large-diameter wood and fewer on small-diameter wood. Larger-diameter trees are thought to attract more insects due to their greater availability of woody material and thicker bark, which offer better protection for the insects' life cycle and more food resources. According to Kland and Bakke (1998), and Bouget and Duelli (2004), large-diameter trees are more likely to support a higher diversity and density of wood-boring beetles after disturbances such as windfall, due to the mass of wood available and the structural complexity of larger trees. Furthermore, Saint Germain et al (2007) showed that large-diameter trees in burnt forests were particularly attractive to wood-boring beetles. The opposite was true of small-diameter wood, on which fewer wood-boring beetles were found. This could be explained by the lack of woody material, which favours competition between different wood-boring species and therefore limits the number of insects. Large and medium-diameter trees are also characterized by the species Cerambyx velutinus, Cerambyx cerdo and Spondylis buprestoides. The dependence of these species could be due to specific ecological needs linked to tree size and age, as a larger diameter is likely to offer more space for oviposition and larval development. This could also be due to the need for abundant wood, more developed bark, stable microclimatic conditions and trophic resources adapted to a prolonged larval cycle. Dubois et al (2009) observed that Cerambyx cerdo shows a strong preference for large-diameter oaks, which offer thick bark and a large amount of dead wood necessary for larval development. According to Buse and Ranius (2007), Cerambyx velutinus mainly colonizes large-diameter trees, where it finds microclimates suited to its development. Large trees are essential for maintaining optimal humidity and temperature conditions inside trunk cavities. Horak et al (2012) have also shown that large-diameter trees in forests disturbed by natural events such as storms continue to provide valuable habitat for wood-boring Coleoptera such as Cerambyx cerdo and Spondylis buprestoides. The species Hylotrupes bajulus and Amphicerus cornutus, meanwhile, characterize small-diameter wood. These results could be due to the fact that these two species take advantage of the structure, chemistry and microclimate specific to small-diameter wood to optimize their oviposition, larval feeding and life cycle duration. According to Rotheray et al (2012), small-diameter wood is particularly critical for certain specialized species such as Hylotrupes bajulus and Amphicerus cornutus, which do not colonize large trunks, finding small branches a less competitive and easier-to-access resource. For example, Amphicerus cornutus, is a species that mainly colonizes small-diameter branches and young dead or stressed trees according to Schwert et al. (2015) and kassab et al. (2018). This is also the case for Hylotrupes bajulus, which prefers small-diameter wood such as wooden construction beams and young branches. The grouping of the large and medium-diameter classes reflects their similarity in wood-boring beetle species composition. Indeed, large and medium-diameter wood offer very similar ecological conditions (substrate volume, hygrometric and thermal stability). Wood-boring beetles from large-diameter trees can also colonize medium-diameter trees, thanks to their ability to exploit large volumes of wood (Mûller et al., 2010).

Abundance and diversity on wood species

Terminalia superba is the species on which there were the most species of wood-boring Coleoptera collected, dominated by Cerambyx cerdo. More damage was also observed on Terminalia superba. The high numbers of beetles and their damage on this species of wood could be explained by the wood's characteristics. Terminalia superba is relatively soft and nutrient-rich, and also water-demanding. It therefore tolerates periods of severe drought with difficulty. Although rainfall in the year under study was slightly higher than in previous years, the drop in precipitation from one year to the next could have created a stress that favoured insect attacks. Its moisture content and low level of defensive substances make it a magnet for insects. With this in mind, Dale et al. (2017) argued that Terminalia superba is heavily attacked by wood-boring beetles, particularly species of the Cerambycidae family such as Anoplophora glabripennis and Monochamus sp. According to these authors, its soft wood and rapid growth (Terminalia superba) create favorable conditions for egg-laying, and the moisture contained in freshly felled wood is ideal for larval development. As for the high diversity of beetles on Tectona grandis, this could be explained by its widespread use in the study area and also by its wide distribution. Indeed, teak occupies more space than any other species in the study area and is often faced with a management problem. According to Beeson (2019), poor maintenance of teak plantations can increase vulnerability to attack by specific species such as Xylotrechus quadripes, while Terminalia superba attracts a greater diversity of species due to its less resistant wood and distribution in less managed forests. Kouadio and Yapi (2021), comparing the diversity of wood-boring beetles in teak and fraké plantations in Côte d'Ivoire, found that fraké plantations were home to a greater diversity of beetles, with species mainly from the Cerambycidae, Scolytidae and Bostrichidae families. On the other hand, the wood species Sterculia rhinopetala, Mansonia altissima, Gambeya delevoyi, Celtis mildbraedii, Cedrela odorata and Entandrophragma cylindricum are less damaged by wood-boring beetles. This could be due to their chemical composition, which makes their wood unattractive, or the presence of toxic compounds that repel or kill these wood-boring insects. According to Vega et al (2018), Cedrela odorata is naturally resistant to several species of wood-boring beetles due to the presence of chemical compounds (cedrol and limonoids) that repel or kill the insects. Adjakpa and Doucoure (2019) have also observed that Mansonia altissima is resistant to attack by these insects, and infestations are often limited to very low levels due to the presence of lactones, toxic compounds that repel the insects. Sterculia rhinopetala is also rarely attacked by wood-boring beetles, thanks to the presence of phenolic acids and tannins in its wood, making it difficult for larvae to survive (Nguepjop and Mbolo, 2020).

The dendrogram was used to obtain habitat groupings based on their composition in terms of wood-boring beetle species. These groupings reflect the similarity between species in terms of wood-boring beetle species composition. Thus, by constructing a dendrogram based on the association of wood-boring beetles on different tropical tree species, Nair and Mathew (2021) found that beetles from the Cerambycidae and Buprestidae families frequently attack species such as Tectona grandis, Shorea robusta and Dipterocarpus alatus, while species from the Scolytidae family prefer softer species such as Terminalia superba. They demonstrated that there is a strong correlation between the chemical characteristics of wood and the groups of beetles that attack it, resulting in distinct groupings in the dendrogram.

3.3 Partial conclusion

Wood-boring beetles show a clear preference for large-diameter trees. Cerambyx velutinus, Cerambyx cerdo and Spondylis buprestoides are associated with large and medium diameters. Hylotrupes bajulus and Amphicerus cornutus show a preference for small-diameter wood. Large- and medium-diameter woodborers share many similarities in terms of habitat selection. More insects and damage were observed on the Terminalia superba wood species. On the other hand, the diversity of wood-boring beetles is high on Tectona grandis and Terminalia superba. Wood species on which fewer insects were collected included Sterculia rhinopetala, Mansonia altissima, Gambeya delevoyi Celtis mildbraedii, Cedrela odorata and Entandrophragma cylindricum.

BIBLIOGRAPHY

1. **Adjakpa, J. B et Doucoure, T. O.,** Impact of insect pests on *Mansonia altissima* in tropical plantations: Observations from West Africa. Journal of Tropical Wood Protection, **2019;** 8(3): 197-205.

2. **Ajoz, R.,** Les insectes et la forêt. Lavoisier, Tec & Doc, **1998;** 594.
3. **Allaire, G., Sylvander, B., Mollard, A., Pecqueur, B., Perrier-Cornet, P et Touzard, J.M.,** Qualité, secteurs et territoires, Symposium : Recherches pour et sur le développement territorial, Montpellier, 2000/01/11; 2000/01/12 - INRA, DADP. Délégation à l'Agriculture, au Développement et à la Prospective, Paris. - 2000/01, **2000;** 9.
4. **Beeson, C. F. C.,** The Ecology and Control of Forest Insects in Tropical Plantations. *Journal of Forest Ecology*, **2019;** 45(4): 327-345.
5. **Bouget, C., & Duelli, P.,** The effects of windthrow on forset insect communities : A literature review. *Biological Conservation*, **2004;** 1183): 281-299.
6. **Brustel. H.,** Coléoptères saproxyliques et valeur biologique des forêts françaises: Perspectives pour la conservation du patrimoine naturel. *Les dossiers forestiers*, n°13. Paris: Office National des Forêts, **2004;** 297.
7. **Buse, J & Ranius, T.,** Ffavourable microclimatic conditions in tree hollows for the saproxylic beetle Cermbyx velutinus (Coleoptera :Cerambycidae). Biodiversity and conservation, **2007;** 16(15): 4421-4435.
8. **Dangles, O., A. Barragan, R.E. Cardenas, G. Onore and C. Keil.,** Entomology in Ecuador: Recent developments and future chanlleges. *Ann. Soc. Entomol*. Fr., **2009;** 45: 424-436.
9. **Dubois,G., Brustel, H., & Vgnon, V.,** Habitat selection and population size of Cerambycidae in an ancient oak forest in southwestern France. *Journal of Insect Conservation*, **2009;** 13(5): 553-564.
10. **Horrak, J., Vodka, S., Kout, J & Donato, D.C.,** Dead wood dependent organisms in one of the oldest protected forests of Europe: investigating the effects of a major windstorm disturbance. Forest Ecology and Management, **2012;** 279: 52-58.
11. **Kouadio, A. S et Yapi, E.,** Comparative analysis of xylophagous beetle diversity in teak and fraké plantations in West Africa. *African Journal of Forest Entomology*, **2021;** 13(1): 66-82.
12. **Kassab, Z., Gaudillat, G & Dumoulin, Y.,** Biologie et écologie du capricone des maisons Hylotrupes bajulus (Coleoptera: Cerambycidae): Implications pour le controle des infestations dans les structures en bois. Annales des Sciences Forestières, **2018;** 75(1): 95-108.
13. **Kland, B & Bakke, A.,** The influence of tree size and condition on the population dynamics of bark beetles in Norway spruce (Picea abies). Forest Ecology and Management, **1998;** 106(2-3): 189-198.
14. **Lucky, A., Erwin T. L and Witman J. D.,** Temporal and spatial diversity and distribution of arboreal carabidae (Coleoptera) in a western Amazonian Rain Forest. *Biotropica*, **2002;** 34: 376-386.
15. **Magali, T., Aline, D et Fabien, F.,** Xylophages, les nouvelles de l'archéologie, **2022;** 167: 31-36.
16. **Müller, J., & Bütler, R.,** A review wood : a baseline for management recommendations in European forests. European Journal of Forest Research, **2010;** 129(6): 981-1992.
17. **Nair, K. S. S.,** Insect pests and management in tropical forestry plantations : Focus on steak (Tectonia grandis). *Forest Pest Management and Control Journal*, **2018;** 22(2): 198-211.
18. **Nguepjop, J. R. et Mbolo, P. M.,** Chemical defenses of tropical hardwoods against xylophagous insects : Case of *Sterculia rhinopetala. African Journal of Forest Entomology*, **2020;** 12(1): 58-69.
19. **Pousset, A et Bouju, A.,** Xylophagous insect assemblages on Terminalia superba in African tropical forests. Forest Entomology and Management Journal, **2020;** 17(2): 99-115.
20. **Rotheray, G. E., & Blacfburn, T. M.,** The role of small-diameter dead wood in sustainig saproxylic insects : Evidence from a meta-analysis. Forest Ecology and Management, **2012;** 266: 28-34.
21. **Saint-Germain, M., Drapeau, P & Hébért, C.,** Comparaison of Coleoptera assemblages from a recently burned and unburned black spruce forests of northeastern North Americz. Biological Conservation, **2007;** 136(2): 158-172.
22. **Schwert, D., & Iller, R. L.,** Amphicerus cornutus : Ecology and habitat preterences in North American deciduous forests. Environnemental Entomology, **2015;** 44(3): 587-594.
23. **Vega, F. Eet Schroeder, W.,** Resistance of *Cedrela odorata* to insect pests in tropical regions. Tropical Forest Insect Journal, **2018;** 14(4): 220-234.
24. **Velazques, E.B., 2014.** La biodiversida en el Ecuador. https://dspace.ups.edu.ec/bitstream/123456789/6788/1/La%20Biodiversidad.pdf