Seed predation of forest species in the southern Amazon

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ABSTRACT

Seed production is an important stage in the biological cycle of plants. However, insects can interrupt this cycle, directly attacking fruits and seeds, which can influence the abundance and distribution of species. Insects are considered the main responsible for seed predation, and the main spermatophagous Orders are: Diptera, Hymenoptera, Coleoptera and Lepidoptera. In this way, the aim of this study was to identify the insects that attack the seeds sold by the Rede de Sementes do Portal da Amazônia. This analysis was carried out with seed samples sent by the seed network, and also through bibliographical research searching for predation records for species sold by the Seed Network. The groups of spermatophagous insects that were present in forest species were identified, identifying them at the level of Order, Family, Subfamily and, when possible, species. Thus, it was found that predation by these insects occurred on seeds of 15 forest species from seed houses and 12 species that are part of the list of species offered by the seed network. The main orders identified causing damage were: Coleoptera and Lepidoptera, showing a greater predominance of attack by coleoptera. Thus, there was a significant attack and record of spermatophagous insects on the seeds of native forest species in the region, mainly from the order Coleoptera.

Keywords: Spermatophagous Insects, Coleoptera, Forest Seeds.

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INTRODUCTION

The seed embryo grows and develops into an adult plant, thus making a link between past generations and a new generation of individuals, as it is the carrier of hereditary traits. The seed can be the beginning and the end of a plant's life, because in order for there to be reproduction through the seed, its life cycle begins with the germination of the seed and after its growth, it develops its biological cycles, in many cases the seed is the only means of survival of a species (MORRIS, 2009).

Plants that produce seeds appeared approximately 350 million years ago, and the seed is characterized as an organ of perpetuation and dissemination of angiosperm species (CARVALHO; NAKAGAWA, 2000). This reproductive event can often be influenced by different predators that feed on fruits and seeds (SCHUPP, 1990).

In addition to the functions mentioned for its own species, the seed has also always been and will continue to be of great importance to human beings, as it is one of the fundamental sources of nutritious substances in food, such as proteins, carbohydrates and fats. When man discovered seeds as a source of food, they began to play an important role in the development of civilization (MORRIS, 2009).

One of the main causes of seed mortality is predation by insects and vertebrates, for some species these can completely eliminate the seeds produced during the season. Thus affecting plants in their population dynamics and plant community structure. Seed consumption can occur in pre-dispersal or post-dispersal, this activity can vary according to the season of the year and the place where the seeds are stored (FRANCISCO *et al*., 2003). The intensity of pre- and post-dispersal predation and the community of predators vary from one environment to another, between species and between individuals of the same species, and may lead to a decrease in the number of seeds that will be dispersed in the environment (JANZEN, 1971).

Most of the seeds are consumed by insects or other predators, as they represent a concentrated source of proteins and minerals. Thus, the study on seed predation of species is of great importance, since it has a great influence on seed germination (MATTSON, 1980). The vast majority of sittophagous insects causing damage to fruits and seeds of forest species, both native and exotic, belong to the spermatophagous orders: Coleoptera, Hymenoptera, Diptera and Lepidoptera (CRAWLEY, 2000).

Members of the families Curculionidae, Bostrichidae, Anobiidae and Subfamily Bruchinae of the Order Coleoptera are the most found, causing some type of damage to the seeds, because their larvae feed on seeds, and as a consequence make the embryo unviable (PEREIRA; SALVADORI, 2006). The Order Lepidoptera has insects with different habits and the vast majority are associated with plants. For caterpillars, the main source of food comes from some leaf tissues, and fruits and seeds are also key parts. As a consequence of phytophagous habits, the insects of the Order

Lepidoptera have high reproduction rates with many species being considered pests. The order Hymenoptera, on the other hand, has insects with complex behavior, some of which are parasitoids, but there are also hymenoptera sitophagous, whose larvae destroy the endosperm of the seeds (GILLOT, 2005).

Seeds among plant species have a great abundance of size and shape (Leishman *et al*., 2000). Thus, the size of these influences the preference of female insects for the formation of oviposition sites. Larger seeds have a large amount of resources, increasing the chance of survival of the offspring, and the greatest damage to the seeds is mainly caused by insects in the larval stage (COPE; FOX, 2003).

Studies involving seed predation of native forest species in the Southern Amazon are still scarce, so little is known about the species, ecology, and biology of spermatophagous insect species that occur in the region. Forest seeds are an extremely important product, covering different segments in the forestry sector, and considering the growing demand for autochthonous species for the recovery of degraded areas, and reforestation programs, good quality seeds are needed, that is, not attacked by insect pests, thus demonstrating the importance of knowledge of insects associated with forest seeds in the region (OLIVEIRA; RANAL, 2014).

Thus, highlighting the lack of information on seed predation of native forest species in the Southern Amazon, and considering the importance of conducting studies on the subject, the objective of this study was to identify the insects that attack the seeds marketed by the Amazon Portal Seed Network. This analysis was carried out with seed samples sent by the seed network, and also through bibliographic research seeking predation records for the species marketed by the Seed Network.

MATERIALS AND METHODS

This study was carried out in partnership with the Amazon Portal Seeds Network, located in the municipality of Alta Floresta-MT in 2020. The seeds used were from seven seed houses in the municipalities of: Nova Canaã do Norte, Alta Floresta, Apiacás, Colíder, and Terra Nova do Norte.

Seed samples were sent from each seed house, identified by the collectors. The samples were analyzed separately in order to verify if there were signs of predation, such as insect emergence holes and damaged seed parts. This analysis was carried out during six months where the samples were analyzed periodically, seeking to find signs of predation, and at the end of this period the percentage of predation for each species was obtained. The identification of the insects was carried out based on identification keys at the order level.

In addition, a bibliographic research was carried out looking for records of insect attacks on the seeds of native forest species that are commercialized by the Seed Network of the Amazon Portal.

The bibliographic research was carried out through bibliographic surveys in scientific journals, in the Portuguese and English languages. We searched online databases of Google Scholar and Scielo for scientific articles with information on predation records. Performing an exploratory, selective and analytical reading. The keywords used were: predation of forest seeds in the Amazon, predation of seeds of forest species in the Amazon, evaluation of damage caused by insects in forest seeds and the scientific name of the species marketed by the seed network (Table 1).

The Amazon Portal Seed Network sells approximately 70 species, which are fruit trees and also forest species. Of these, 38 forest species have their seeds offered for commercialization in the region, as shown in Table 1. Thus, direct predation analysis and literature research were carried out with these species.

Table 1 – Forest species marketed by the seed network of the Amazon portal.

Forest Species		
Cochlospermum orinocense (Kunth) Steud.	*Tabebuia roseoalba* (Ridl.) Sandwith.	*Ceba speciosa* (est.-hil.) Ravenna.
Chloroleucon acacioides (Ducke) Barneby & J.W.Grimes.	*Mezilaurus itauba* (Meisn.) Head. Ex Mez.	*Bauhinia ungulata* L.
Parkia pendula (Willd.) Benth. ex Walp.	*Machaerium hirtum* (Vell.) Stellfeld.	*Apeiba tibourbou* Aubl.
Anadentara Peregrina (L.) Speg.	*Hymenea Korbar* L.	*Caryocar brasiliense* Cambess.
Samson Tubulosa (Benth.) Barneby & J.W.Grimes.	*Leucaena leucocephala* (Lam.) de Wit.	*Micranta tremor* (L.) Blume.
Cedrela fissilis Vell.	*Solanum crinitum* Lam.	*Schizolobium parahyba* var. *amazonicum* (Huber ex Ducke) Barneby.
Physocalymma scaberrimum Pohl.	*Diospyros inconstans* Jacq.	*Colubrina glandulose* Perkins.
Dipteryx odorata (Aubl.) Forsyth f.	*Senegalia polyphylla* (DC.) Britton & Rose.	*Seiba Bendant* (L.) Gerdn.
Copaifera sp L.	*Beech avia tomentosa* Eichler.	*Tamarindus indica* L.
Apuleia leiocarpa (Vogel) J.F.Macbr.	*Swietenia macrophylla* King.	*Videka Polikama* Sam.
Handroanthus serratifolius (Vahl) S.Grose.	*Guazuma Ulmifolia* Lam.	*Enterolobium timbouva* Mart.

Vitex excelsa Moldenke.	*Enterolobium schomburgkii* (Benth.) Benth.	*Parkia multijuga Benth.*
Bixa orellana L.	*How does Huber arbore* ?	

RESULTS AND DISCUSSION

Of the 38 forest species commercialized by the Amazon Portal Seed Network, it was observed that 15 of them (39.5%) had some type of seed predation, as shown in Table 2.

Species	Groups of Sittophagous Insects
Simarouba versicolor A.St.-Hil. (Deadness)	Lepidoptera: Pyralidae
- *Bixa orellana (*Urucun)	Coleoptera: Chrysomelidae
Enterolobium timbouva (Timburi)	Coleoptera: Chrysomelidae: Bru humble
*Buchenavia tomentosa (*Mirindiba)	Coleoptera: Chrysomelidae: Bruchinae
Spondias mombin L. (Cajazinho)	Coleoptera: Chrysomelidae
*Samanea tubulosa (*Old Man's Staff)	Coleoptera: Chrysomelidae
Handroanthus serratifolius (Yellow Ipê)	Coleoptera: Chrysomelidae
*Dipteryx odorata (*Champanhe)	Coleoptera: Chrysomelidae
Senegalia polyphylla (Mijoleiro)	Coleoptera: Chrysomelidae
Dialium guianense (Aubl.) Sandwith. (Roxinho)	Coleoptera: Chrysomelidae
Bauhinia ungulata (pata de vaca)	Coleoptera: Chrysomelidae
Sterculia striata A.St.-Hil. & Naudin. (Xixá)	Coleoptera: Chrysomelidae
Tamarindus indica (Tamarind)	Coleoptera: Curculionidae: *Sitophilus linearis* (Herbst, 1797)
Vitex excelsa (Tarumã)	Coleoptera: Chrysomelidae
Chloroleucon acacioides (Yellow)	Coleoptera: Chrysomelidae

According to the data in Table 2, it is noted that of the 38 species submitted to analysis for the identification of predatory insects, 39.5% of these forest species had their seeds preyed upon by sittophagous insects. However, of this total, 34.2% of the forest species were being preyed upon by insects of the family Chrysomelidae and 2.65% of the species had insects of the family Curculionidae preying on their seeds, both families belonging to the Order Coleoptera.

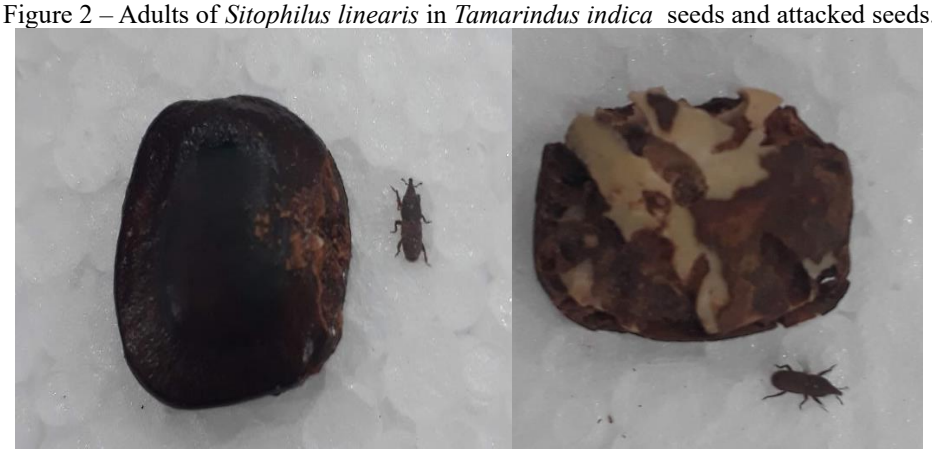
Insects of the family Pyralidae of the Order Lepidoptera were identified preying on 2.65% of the forest species. For the forest species presented, in only two it was possible to identify individuals belonging to the subfamily Bruchinae with their predatory activities on the seed, namely: *Buchenavia tomentosa* and *Enterolobium timbouva*.

Figures 1, 2 and 3 show examples of seed predation observed in the predation analyses performed in this study.

Figure 1- Larvae of *Sitophilus linearis* in seeds of *Tamarindus indica.*

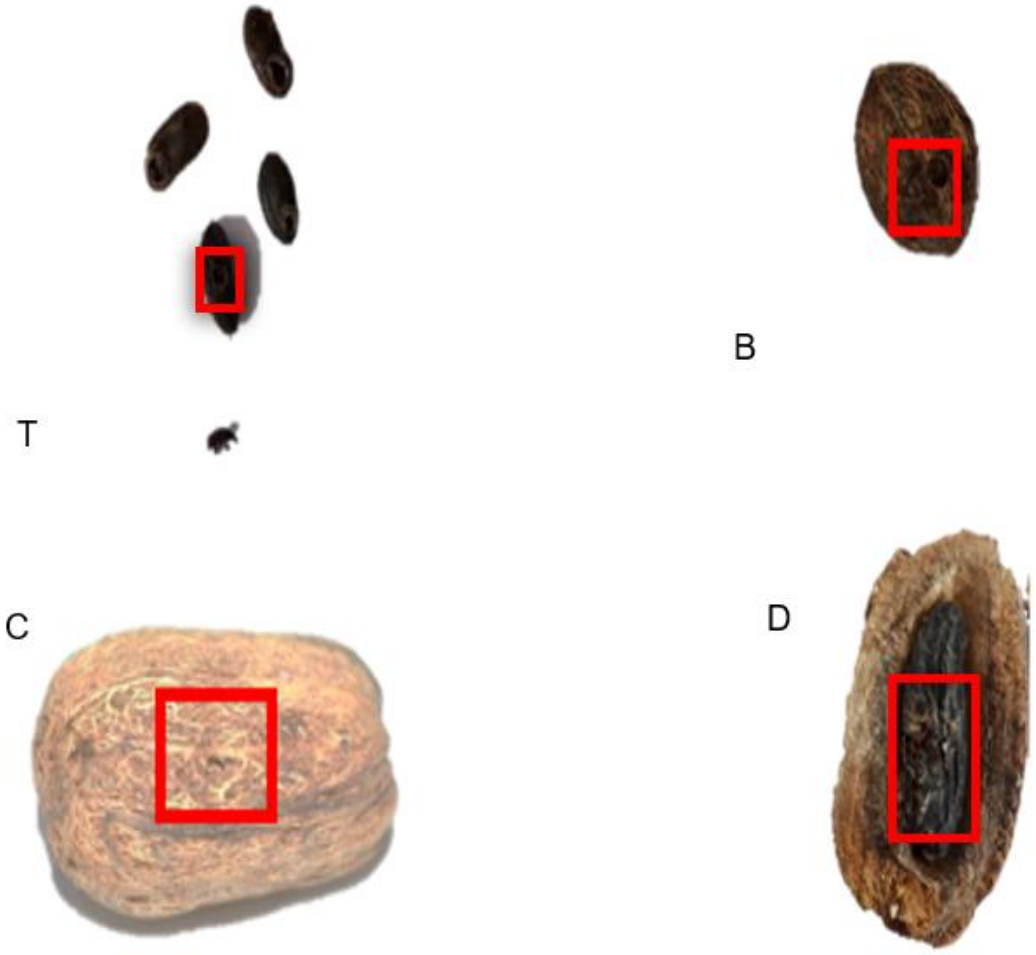
Source: The Authors

Figure 2 – Adults of *Sitophilus linearis* in *Tamarindus indica* seeds and attacked seeds.



Source: The Authors

Figure 3 - Insect exit hole in the seeds of (A) *Parkia pendula*da, (B) *Buchenavia tomentosa,* (C) *Spondias mombin* and (D) *Dipteryx odorata.*



Source: The Authors

Of the 38 native forest species most commercialized by the seed network of the Amazon portal submitted to bibliographic research, in 12 of them (Table 2) it was possible to find records of predation by insects, mainly of the orders Coleoptera, Lepidoptera and Hymenoptera.

Table 2 – Forest species commercialized by the Portal da Amazônia Seed Network with predation records observed in bibliographic research.

Species	Set of Sittophagous Insect	Source
Modeloa orellana	Coleoptera: Dasytidae: *Astylus* sp	(ROCHA; POLATTO, 2017)
Parkia pendula	Coleoptera: Brussiane: *Acanthoscelides imitator* (Kingsolver, 1985)	(BARRETO *et al*., 2017)
Copaifera sp	Coleoptera: Curculionidae e Brentidae: *Rhinochenus brevicollis* (Chevrolat, 1871)	(SANTOS *et al*., 2015)

	Hymenoptera: Braconidae and Eurytomidae	
	Lepidoptera	
Hymenea Korbaril	Coleoptera: Curculionidae e Anobiidae: *Rhinochenus stigma* (Linnaeus, 1758)	(CRUZ *et al*., 2013; RODRIGUES, 2013)
	Lepidoptera	(RODRIGUES, 2013)
Leucaena leucocephala	Coleoptera: Chrysomelidae e Anthribidae	(RODRIGUES, 2013)
Senegalia polyphylla	Coleoptera: Chrysomelidae: Bruchinae: *Stator* sp	(FONSECA *et al*., 2020)
Buchenavia tomentosa	Coleoptera: Bruchinae: *Amblycerus insuturatus* (Pic, 1902)	(ZARDO, 2008)
Swietenia macrophylla	Lepidoptera: Crambidae, Pyralidae e Tortricidae	(CASTRO; MONTALVÃO; MONNERAT, 2018)
Guazuma Ulmifolia	Coleoptera: Bruchinae: *Amblycerus Cistelinus* (Gyllenhal, 1833)	(JANZEN, 1975)
Caryocar brasiliense	Lepidoptera: *Carmenta* and *Synanthedon* still	(FARIAS, 2010)
Schizolobium parahyba var. *amazonicum*	Coleoptera: Anobiidae and Cerambycidae	(RODRIGUES, 2013)
Multi-play parkia	Coleoptera: Brussiane	(ALVES, 2019)

During the bibliographic research, it was found that 31.6% of the forest species made available for sale have a record of predation, with a predominance of attacks by individuals belonging to the order Coleoptera, totaling 83.33% of incidence on the species offered. The incidence of lepidoptera was in the proportion of 33.33%, whereas individuals of the order Hymenoptera were found only in *Copaifera* sp.

Analyzing the data observed in this study, both in the direct analysis and in the literature search, it was noted a predominance of the incidence of sitophagous insects of the Order Coleoptera causing damage to different forest species. The seeds can be consumed by only one or several

individuals, causing numerous losses to the plant, reducing the number of viable seeds per fruit (SANTOS *et al*., 2001). In addition, they can cause damage caused by the perforation of the larvae in the seed coat, and also cause damage to the embryo that is still forming, resulting in the abortion of the seed by the plant (NASCIMENTO, 2009). According to Spironello *et al*. (2004), fruit abortion is a strategy that the tree develops to avoid energy expenditure with damaged fruits in development.

This predominance of beetles can be explained by the fact that the Order Coleoptera is the most diverse of the Class Insecta, with approximately 370,000 species already described, presenting different shapes and sizes. Most beetles are phytophagous, some of them became known due to their larvae feeding on seeds, consuming all available material, making the embryo unviable (CROWSON, 1981; PEREIRA, SALVADORI, 2006), negatively affecting the reproduction of new individuals of forest species. The hatching of the adults leaves a perforation with significant size in the seed. The most common seed predators of the order Coleoptera belong to the families Chrysomelidae and Curculionidae, which have more than 135,000 described species (PEREIRA; SALVADORI 2006).

According to Figueiredo *et al*. (2008) Nesting by the larvae of coleoptera occurs in immature seeds, a period that precedes dehydration, these larvae develop during the final stage of seed maturation and consume the reserves in the cotyledons and the embryo itself, so the predation that occurs in the pre-dispersal makes the seeds unviable, presenting low germination rates.

Analyzing the results, it was observed the presence of individuals belonging to the subfamily Bruchinae both in the seeds analyzed and in the bibliographic research carried out, a result that was also observed by Rodrigues (2013) where the author verified that 2008 bruchines emerged from the seeds in the species *Senna hirsuta* (L.) H.S.Irwin & Barneby and only two insects in the species *Schizolobium parahyba* var. *amazonicum*. Insects belonging to the subfamily Bruchinae are important seed predators, and have a strong association with plants mainly of the Fabaceae family (SOUTHGATE, 1979).

Fonseca *et al*. (2020) also found that bruchineous attack reduced germination of *Senegalia polyphylla* seeds and also quantified and proved that this species had the worst germination performance when compared to the germination of normal species (without insect attack). According to Farias (2010), larvae of *Amblycerus insuturatus* (Coleoptera: Crysomelidae: Bruchinae) were found in fruits collected directly from the canopy of *Buchenavia tomentosa* trees, which indicates pre-dispersal predation. Masetto *et al*. (2007) also recorded the presence of Bruchinae, and stated that the presence of the larvae of these insects results in a reduction in the vigor of the seeds of *Eugenia pleurantha* O. Berg.

Donato *et al*. (2010) found that the vigor of the seeds of *Enterolobium contortisiliquum* (Vell.) Morong. It is totally influenced by the attack of insects of the genus *Caryedes* sp (Coleoptera:

Crysomelidae: Bruchinae), significantly reducing the physiological quality of the seeds, by the consumption of their nutrient reserves.

As well as obtaining results of the presence of Crysomelidae, it was also found that individuals of the Curculionidae family caused damage to the seeds that were submitted to analysis as in the bibliographic research. Rodrigues (2013) found that curculionids caused different and important damages to the collected seeds of *Albizia niopoides* (Spruce ex Benth.) Burkart., *Bauhinia forficata* Link., *Camptosema scarlatinum (Mart. ex Benth.) Burkart.*, *Dalbergia brasiliensis* Vogel., *Hymenaea courbaril, Luehea divaricata Mart*., *Machaerium nyctitans* (Vell.) Benth., *Machaerium villosum* Vogel., *Senna pendula* (Humb.& Bonpl.ex Willd.) H.S. Irwin & Barneby and *Terminalia argentea* Mart. & Zucc., due to the direct consumption of the embryo by its larvae during its development. According to the author, this large family of the Order Coleoptera can cause damage to different species of plants and can also vary the degree of intensity of attack on forest species.

In addition to insects of the order Coleoptera that were present in the study, the presence of lepidoptera was also recorded. The insects belonging to the Order Lepidoptera, feed on plants and reproductive organs in the larval stage, causing direct and indirect losses to productivity, therefore, if they cannot be controlled satisfactorily, they can cause enormous damage to crops (BUSOLI *et al*., 2014).

Individuals belonging to the Pyralidae Family were found in different seed houses addressed in this study, but the only record of insects belonging to the order Lepidoptera was in relation to the species *Simarouba versicolor,* popularly known as Morcegueira. The insect spends its entire larval period inside the seed, feeding on the resources it makes available, and thus develops until it reaches the stage where it pierces the seed, making an exit hole to complete its life cycle outside the seed. According to Rodrigues (2013), for the order of lepidoptera, the hardness of the seeds explains the variation in the body size of these insects, showing that the greater the hardness of the seeds, the greater the body size, he also stated that the emergence of lepidoptera is influenced by the size and quality of the seed, presenting greater emergence in larger seeds.

The caterpillars seek their food source in seeds, part of fruits and also in leaves, the constant attack of these insects on native forest species make them pest insects of great importance in the forestry sector The consumption of seeds by caterpillars causes the seeds to reduce their germination potential, due to the fact that they directly reach the embryo. The life cycle of these individuals varies between species and metabolic rates, as well as the interaction with the host plant (COELHO, 2008).

Pereira and Silva (2013) observed in their study, for example, that the amount of seeds of *Erythrina falcata* Benth, which are preyed upon by lepidoptera, may be related to their nutritional quality. Ferro *et al*. (2006) reported that plants with low nutrient seeds have a higher rate of predation

by insects, as this factor prolongs the development time of their larvae and directly affects the number of surviving seeds.

Pereira and Silva (2013) observed that *Erythrina falcata* they also have a predation index by three species of Crambidae: *Liopasia ochracealis* (Walker, 1866), *Agathodes designalis* (Guenée, 1854) and *Terastia meticulosalis* (Guenée, 1854), and this predation has a considerable result in decreasing the amount of viable seeds produced by the plant.

As well as the presence of Pyralidae, Pinto (2007) obtained results indicating that *Hypsipyla ferrealis* (Hampson, 1929) and *Hypsipyla grandella* (Zeller, 1848) (Lepidoptera: Piralidae) are the main species of insects associated with predation on seeds of *Carapa* guianensis Aubl. and *Carapa p*rocera DC., with average predation rates of 61.96% to 39%, respectively, however, this predation reduced the germination process, which in non-preyed seeds ranged from 47.77% to 90% to 8.88% to 17.77% in preyed seeds, consequently reducing the amount of seeds available for regeneration.

In the bibliographic research, in addition to the Coleoptera and Lepidoptera orders found causing damage to the seeds of native forest species, the attack of Hymenoptera was also observed in a genus that is commercialized by the seed network of the Amazon portal, *Copaifera* sp.

The action of predatory insects in the pre-dispersal and post-dispersal phases has a great impact on the host plants, that is, it influences and modifies the distribution and also the density of the seeds, reducing the germination and survival of the species, causing losses to the total production of seeds, interfering with the final development and establishment of the seedlings (TOMAZ *et al*., 2007).

The activities of these predators can vary according to the place where these seeds are deposited and also vary throughout the seasons, because according to Bartimachi *et al*. (2008) concluded in their study the variation in predation on seeds of *Anadenanthera falcata* Benth. Throughout the fruiting season is directly related to the activity of the predators because they obtained the result that the number of seeds preyed on at the beginning of the season was lower than at the peak and at the end, this can be explained by the fact that the predators are not in full activity at the beginning of the fruiting season, where the number of seeds is reduced. It is not found in abundance, which makes it difficult to find them, so the predation rate increases according to the location of the source by the predator and as the resource increases.

According to Garcia and Colpas (2004), seed production and dissemination is an important process of plant population dynamics, mainly because they never achieve perfect results, because not all habits favor the establishment of new individuals, and not all seeds can survive. Among its causes of seed mortality, attack by parasites and predation by insects stand out.

Reis (2004) points out that probably the biggest predators of seeds are insects, whose damage is caused mainly in the larval stage. Damage can occur: by consuming parts of the flower or

inflorescence; by the plundering of pollen by adult insects; by the predation of the still immature seed, consuming the seed reserve material and often the damage still occurs in the storage phase of the seeds, due to the various failures in their treatment. The author also emphasizes that the control of this group is mainly the harvesting of seeds at the ideal time, which prevents the seeds from remaining in the field, subjecting themselves to attack by predators.

In forests, the host specificity of seed predators in the pre-dispersal phase is particularly unknown, in fact, the existing literature on seed predation in most systems largely ignores predation of pre-dispersal seeds, this is a good reason to explain that it often makes it difficult to study seeds in the field (OWEN; GRIPENBERG, 2008).

Costa and Paula (2012) point out that research carried out in the entomological area relating seed predation by sitophagous insects is becoming increasingly important, as it makes the results of research viable for seed storage and seedling production. However, it is necessary to identify these organisms and quantify their damage to native species of economic importance and important for reforestation.

According to Habib (1984), one of the basic prerequisites for the management of seed-predatory insects would be to better understand the insect and its behavior in relation to the environment and other information. This management means, then, to reduce the population of a pest insect below the economic level of damage, using ecological and economic methods that are compatible with the conditions for each region, which shows us that the population dynamics of a phytophagous insect provides us with the first resources for its management. And this will determine which are the factors in the environment, biotic and abiotic, that have been responsible for the oscillations in the population of the pest, as well as the relationship between the insects and their habitat, as well as the information about their reproductive capacity, will allow us to evaluate and predict the number of the population and its distribution over time.

CONCLUSION

In this study, it was found the significant attack of sitophagous insects of the order Coleoptera on the seeds of native forest species commercialized by the Portal Seed Network of the Amazon, namely: *Bixa orellana, Enterolobium timbouva, Buchenavia tomentosa, Spondias mombin, Samanea tubulosa, Handroanthus serratifolius, Dipteryx odorata, Senegalia polyphylla, Dialium guianense, Bauhinia ungulata, Sterculia striata, Tamarindus indica, Vitex excelsa* and *Chloroleucon acacioides.* Regarding the order Lepidoptera, the presence of insects in the species *Simarouba versicolor was observed*.

In the bibliographic search, the records found of coleoptera preying on seeds were in the following species: *Bixa orellana, Parkia pendula, Copaifera* sp, *Hymenaea courbaril, Leucaena*

leucocephala, Senegalia polyphylla, Buchenavia tomentosa, Guazuma ulmifolia, Caryocar brasiliense, Schizolobium parahyba var. *amazonicum* and Parkia *multijuga.* Lepidopterans were recorded in: *Copaifera* sp, *Hymenaea courbaril*, *Swietenia macrophylla* and *Caryocar brasiliens*.

REFERENCES

1. ALVES, M. M. Parkia multijuga (Fabaceae): interação multo-espécies e estratégias que maximizam a sobrevivência nos estágios iniciais de sua história de vida. 2019. 92 f. Dissertação (Mestrado em Ciências Biológica) - Instituto Nacional de Pesquisas da Amazônia, Manaus, 2019.

2. BARRETO, M. R. et al. Predação de sementes de Parkia pendula (Willd.) Benth. Ex Wlp. (Fabaceae) por Acanthoscelides imitator Kingsolver, 1985 (Coleoptera: Chrysomelidae: Bruchinae). Boletín de la Sociedad Entomológica Aragonesa, v.1, n. 61, p. 169-174, 2017.

3. BARTIMACHI, A. et al. Predação pós-dispersão de sementes do angico Anadenanthera falcata (Benth.) Speg. (Leguminosae-Mimosoideae) em mata de galeria em Barra do Garças, MT. Revista Brasil, v. 31, n. 2, p. 215-225, 2008.

4. BUSOLI, A. C. et al. Manejo Integrado de Pragas: Pesquisas, avanços e desafios. In: BUSOLI, A.C. et al. (eds). Tópicos em Entomologia Agrícola VII. 8. ed. Jaboticabal, SP: Maria de Lourdes Brandel, 2014. p. 309-329.

5. CARVALHO, N. M.; NAKAGAWA, J. (eds). Sementes: ciência, tecnologia e produção. 4. ed. Jaboticabal: FUNEP, 2000. 588 p.

6. CASTRO, M. T. et al. Damange in fruits of mahogany caused by Hypsipyla grandella (Zeller) (Lepdoptera: Pyralidae) in Brasiília, Brazil. Revista EntomoBrasilis, v. 11, n. 1, p. 09-12, 2018.

7. COELHO, R. R. O papel da planta hospedeira na história de vida do percevejo predador Brontocoris tabidus (Signoret) (Hemiptera: Pentatomidae). 2008. 61 f. Dissertação (Mestrado em Entomologia Agrícola) - Universidade Federal Rural de Pernambuco, Recife, 2008.

8. COPE, J. M.; FOX, C. W. Oviposition decisions in the seed beetle, Callosobruchus maculatus (Coleoptera: Bruchidae): effects of seed size on superparasitism. Journal of Stored Products Research, v. 39, edição especial, p. 355–365, 2003.

9. COSTA, E. M.; PAULA, R.de C. A.L.de. Levantamento Preliminar dos Insetos Associados às Sementes de Albizia polycephala Benth em Vitória da Conquista– BA. Scientia Plena, v. 8, n. 4, p. 1-5, 2012.

10. CRAWLEY M. J. Seed predators and plant population dynamics. In: FENNER, M. Seeds: the ecology of regeneration in plant communities. 2. ed. Wallingford: CAB International Publishing, 2000. p. 167-182.

11. CROWSON, R. A. The Biology of the Coleoptera. 1. ed. Londres: Academic Press, 1981. 802p.

12. CRUZ, O. M. et al. Biometria de frutos, germinação e predação de sementes de jatobá (Hymenaea courbaril L.). In: Congresso Nacional De Botânica, LXIV, 2013, Belo Horizonte. Botânica Sempre Viva... Belo Horizonte: UEAP, 2013. p. 10-15.

13. DONATO, D.B. et al. Dano de Caryedes sp. (Coleoptera:Bruchidae) e seus Reflexos na Propagação de Enterolobium contortisiliquum (Leguminosae). Revista Floresta e Ambiente, v. 17, n. 2, p. 118-123, 2010.

14. FARIAS, J. de. Dispersão e predação de sementes de mirindiba (Buchenavia tomentosa Eichler - Combretaceae) em Cerrado sentido restrito, Barra do Garças, MT. 2010. 47 f. Dissertação

(Mestrado em Ecologia e Conservação) - Universidade do Estado de Mato Grosso, Nova Xavantina, 2010.

15. FERRO, V. G. et al. Why do larvae of Utetheisa ornatrix penetrate and feed in pods of Crotalaria species? Larval performance vs. chemical and physical constraints. Entomologia Experimentalis et Applicata, v. 121, n, 1, p. 23-29, 2006.

16. FIGUEIREDO, P. S.de. et al. Predação e parasitismo em sementes de duas populações de Parkia platycephala Benth., em áreas de cerrado no nordeste do Brasil. Revista Brasil, v. 31, n. 2, p. 245-251, 2008.

17. FONSECA, A.G. et al. Sementes de Senegalia polyphylla (Fabaceae) atacadas por bruquíneos podem ser viáveis? Pesquisa Florestal Brasileira, v. 40, edição especial, p. 1-5, 2020.

18. FRANCISCO, M. R. et al. Massive seed predation of Pseudobombax grandiflorum (Bombacaceae) by parakeets Brotogeris versicolurus (Psittacidae) in a forest fragment in Brazil. Biotropica, v. 34, n. 4, p. 613-615, 2003.

19. GARCIA, E.; COLPAS, F. T. Efeitos da predação de sementes no recrutamento de espécies vegetais. 2004. Disponível em:< http://www.ib.unicamp.br/profs/fsantos/nt238/2004/Monografias/Monografia-Emilio-Flavia.pdf>. Acesso em: 12 de - ago. 2020.

20. GILLOTT C. Entomology. 3 ed. Saskatoon: Springer, 2005. 831p.

21. HABIB, M. E. M. Manejo Integrado de Pragas Florestais. Sociedade Brasileira de Silvicultura, v. 10, n. 39, p. 19-20, 1984.

22. JANZEN, D.H. Intra- and Interhabitat in Guazuma ulmifolia (Sterculiaceae) Seed Predation by Amblycerus Cistelinus (Bruchidae) in Costa Rica. Revista Ecology, v. 56, n. 4, p. 1009-1013, 1975.

23. JANZEN, D. H. Seed predation by animals. Anual Review of Ecology and Systematics, v. 2, n. 1, p. 465-492, 1971.

24. LEISHMAN, M.R. et al. The evolutionary ecology of seed size. In: FENNER M. Seeds: the ecology of regeneration in plant communities. 2. ed. New South Wales: CAB Internacional, 2000. p.31-58.

25. MASETTO, T. E. et al. Avaliação da qualidade de sementes de Eugenia pleurantha (Myrtaceae) pelo teste de raios x1. Revista Brasileira de Sementes, v. 29, n. 3, p. 170-174, 2007.

26. MATTSON, W. J. Herbivory in relation to plant nitrogen content. Annual Review of Ecology and Systematics, v. 11, n.1, p. 119-161, 1980.

27. MORRIS, R.J. Interactions between plants and herbivores. In: LEVIN, S. A. (ed). The Princeton guide to ecology. 1. ed. New Jersey: Princeton University Press, 2009. p.227-232.

28. NASCIMENTO, L. S. Ecologia de Bruchidae na predação pré-dispersão de sementes de Albizzia lebbeck (Benth.) em arborização. 2009. 73 f. Dissertação (Mestrado em Ciências Ambientais e Florestais) – Universidade Federal Rural do Rio de Janeiro, Seropédica, 2009.

29. OLIVEIRA, J. P. R.; RANAL, M. A. Sementes florestais brasileiras: início precário, presente inebriante e o futuro, promissor? Ciência Florestal, v. 24, n. 3, p. 771-784, 2014.

30. OWEN, T. L.; GRIPENBERG, S. Insect seed predators and environmental change. Jornal of Applied Ecology, v. 45, n. 6, p. 1593-1599, 2008.

31. PEREIRA, C.M.; SILVA, P.R. da. Capacidade de predação de sementes de Erythrina falcate Benth. (Fabaceae, Faboideae) por larvas de três espécies de Lepidoptera – Crambidae e o efeito de parasitoides sobre a interação. Revista Biotemas, v. 26, n. 4, p. 69-74, 2013.

32. PEREIRA, P. R. V. S.; SALVADORI, J. R. Identificação dos principais Coleoptera (Insecta) associados a produtos armazenados. Embrapa Trigo, 2006. (Documentos Online, 75). Disponível em:<http:www.cnpt.embrapa.br/biblio/do/p_do75.htm>. Acesso em: 12 agt. 2023.

33. PINTO, A.A. Avaliação de danos causados por insetos em sementes de Andiroba [(Carapa guianensis Aubl.) e Andirobinha (C. procera DC.) (Meçliaceae)] na Reserva Florestal Adolpho Duck em Manaus, AM, Brasil. 2007. 60f. Dissertação (Mestrado em Biologia Tropical e Recursos Naturais) - Instituto Nacional de Pesquisas da Amazônia, Manaus, 2007.

34. REIS, E. R. dos. Colheita de sementes florestais. In: HOLPE, J.M. et al. (eds). Produção de sementes e mudas florestais. 2. ed. Santa Maria: Universidade Federal de Santa Maria, 2004. 388p.

35. ROCHA, A. N.; POLATTO, L. P. Bixa Orellana L. (Bixaceae): dependência de polinizadores e estratégias de forrageio dos visitantes florais. Biota Amazônia, v. 7, n. 3, p. 1-7, 2017.

36. RODRIGUES, L. M. S. Insetos predadores de sementes e suas relações com a qualidade e a morfologia de frutos e sementes. 2013. 110 p. Tese (Doutorado em Ciências Biológicas) - Universidade Estadual Paulista, Botucatu, 2013.

37. SANTOS, I. M. et al. Predação de sementes por insetos em três espécies simpátricas de Copaifera L. (Fabaceae). Revista Biotemas, v. 28, n. 2, p. 87-95, 2015.

38. SANTOS, G. P. et al. Danos causados por Rhyssomatus sp. (Coleoptera: Curculionidae), Triaspis sp. (Hymenoptera: Braconidae) e Lepidoptera (Pyralidae) em sementes de Angico-Vermelho. Revista Ceres, v. 48, n. 280, p. 539-549, 2001.

39. SCHUPP, E. W. Annual variation in seedfall, postdispersal predation, and recruitment of a neotropical tree. Revista Ecology, v. 71, n. 2, p. 504–515, 1990.

40. SOUTHGATE, B. J. Biology of the Bruchidae. Annual Review of Entomology, v. 24, edição especial, p. 449-473, 1979.

41. SPIRONELLO, W. R. et al. Produção e predação de frutos em Aniba rosaeodora Ducke var. amazonica Ducke (Lauraceae) em sistema de plantio sob floresta de terra firme na Amazônia Central. Acta Botanica Brasílica, v. 18, n. 4, p. 801-807, 2004.

42. TOMAZ, C. A. et al. Effects of the seed predator Acanthoscelides schrankiae on viability of its host plant Mimosa bimucronata. Biological Research, v. 40, n. 3, p. 281-290, 2007.

43. ZARDO, R. N. Efeito do impacto da extração de frutos na demografia do pequi (Caryocar brasiliens) no Cerrado do Brasil central. 2008. 50 f. Dissertação (Mestrado em Ecologia) - Universidade de Brasília, Brasília, 2008.