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Bioecologia de *Oncideres cervina* Thomson (Coleoptera: Cerambycidae) em *Persea americana* Mill. (Lauraceae)

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Abstract

Cerambycidae beetles limit production and establishment of forest and fruit trees. *Oncideres cervina* Thomson, 1868 (Coleoptera: Cerambycidae) is one of the most important species. The objective was to record *O. cervina* girdling branches of *Persea americana* Mill. (Lauraceae) for the first time, check the number of oviposition incisions (Noi) as a function of the diameter of branch sections, period of emergence, and describe the larval-pupal chamber. Individuals of *O. cervina* were observed, for the first time, in *P. americana* orchards in Santa Maria, Rio Grande do Sul, Brazil. The middle section of branches (40-60 cm interval) had higher number of incisions. Girdled branches with a diameter of 40-50 mm had higher number of them. Adults emerged from November through January. Larval-pupal boreholes had diameters between 9 and 11 mm, and average tunnel length was 28 mm, with a mean volume of consumed wood of 4.3 mL. This information is useful for establishing integrated pest management practices against *O. cervina* in *P. americana* since this crop has a high added value and can be significantly compromised by attack by Cerambycidae beetles.

Keywords: twig girdlers, avocado, ethology, integrated pest management.

Resumo

Os besouros da família Cerambycidae limitam a produção e o estabelecimento de essências florestais e frutíferas. *Oncideres cervina* Thomson, 1868 (Coleoptera: Cerambycidae) é uma das espécies mais importantes. O objetivo foi registrar *O. cervina* danificando ramos de *Persea americana* Mill. (Lauraceae) pela primeira vez, verificar o número de incisões de postura em relação ao diâmetro das secções dos ramos, período de emergência e descrever a galeria larval-pupal. Indivíduos de *O. cervina* foram observados pela primeira vez em pomares de *P. americana* em Santa Maria, Rio Grande do Sul, Brasil. A secção média dos ramos (intervalo de 40-60 cm) apresentou maior número de incisões. Ramos danificados com diâmetro de 40-50 mm tiveram maior número delas. Adultos emergiram de novembro a janeiro. Os orifícios larvais-pupais tinham diâmetros entre 9 e 11 mm, e o comprimento médio da galeria era de 28 mm, com um volume médio de madeira consumida de 4,3 mL. Essas informações são úteis para estabelecer práticas integradas de manejo de pragas contra *O. cervina* em *P. americana*, já que essa cultura tem alto valor agregado e pode ser significativamente comprometida pelo ataque de besouros da família Cerambycidae.

Palavras-chave: besouro-serra-pau, abacate, etologia, manejo integrado de pragas.

1. Introduction

Lauraceae plants are good for reforestation projects, production of fruits, oils, and spices (Marques, 2001). The production of avocado (*Persea americana* Mill. (Lauraceae) in Brazil is around 15.8 tons.ha^{-1}, generating, on average, R$ 15,862.00.ha^{-1} on revenue (IBGE, 2019). The avocados are used mainly for the production of candies, cosmetics, oil from pulp, and *in natura* consumption (Salgado et al., 2008).

One of the main limiting factors for avocado production is the occurrence of twig girdlers beetles (Coleoptera: Cerambycidae) (Mankin et al., 2018). Twig girdlers may damage and cause economic impact in a wide range of host plants, specially, when they are cultivated in monocultures (Bernardi et al., 2011; Lemes et al., 2011; Ono, 2015).

Oncideres Serville, 1835, with more than 100 species and 100 associated host plants, is the most important genus of

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twig girdlers in the Americas (Vulcano and Pereira, 1978; Paro et al., 2011). The *Oncideres* females girdle fresh and healthy branches of trees where they lay their eggs. This occurs due to the need for larvae to feed on branches that are in the beginning of the decomposition process (with high humidity and still soft tissues), to complete their development cycle (Baucke, 1962; Coppedge, 2011; Witeck Neto et al., 2015).

The girdling damage limits the establishment of monoculture plantations of forest and fruit tree species, like *Acacia mearnsii* De Wild, *Ocotea puberula* (Rich.) Nees and *Pyrus pyrifolia* (Burm F.) Nakai. (Witeck Neto and Link, 1997; Cordeiro et al., 2010; Lemes et al., 2011; Magistrali et al., 2013; Witeck Neto et al., 2013). These insects may also cause indirect damage due to morphological alterations of their hosts, such as creation of forks in the trunk and an accumulation of nitrogen in branches. These damage may result in depreciation of the commercial value of wood and reduce fruit productivity (Calderón-Cortés et al., 2011; Witeck Neto et al., 2013; Coppedge, 2014).

The characterization of the larval-pupal galleries left by the larvae of Cerambycidae after adult emergence is an important tool to evaluate questions related to adaptation cost, feeding behavior, and morphometric aspects of the emerged adults (Link et al., 1994; Witeck Neto et al., 2015; Corrêa et al., 2024). With respect to wood consumption by the larvae, the length and volume of the galleries were measured, and these parameters are related to host adaptability.

Oncideres cervina Thomson, 1868 (Coleoptera: Cerambycidae) is an insect pest capable of causing damage to species from different families (i.e. Lauraceae and Thymelaeaceae) (Paro et al., 2011; Witeck Neto et al., 2015). However, their records in host plants are still scarce, a factor that can complicate their management.

Describe the occurrence and bioecology of twig girdlers in new hosts is important to verify population density, damage prediction, and elaborate integrated pest management strategies (Witeck Neto et al., 2015; Corrêa et al., 2022). The objective of this study was to record the occurrence of *O. cervina* on branches of *P. americana,* for the first time, and to investigate biological parameters in this host.

2. Material and Methods

2.1. Study area

Branches girdled by twig girdlers were collected from a 40 ha *P. americana* orchard in Santa Maria, Rio Grande do Sul, Brazil, from November 2011 to January 2012. This area is part of the Central Depression physiographic region (29°41'24"S, 53°48'42"W), and its climate is humid subtropical without a dry season (Cfa), according to the Köppen climate (Valério et al., 2018). The collected branches were stored in plastic boxes covered with voile cloth to determine adult emergence.

2.2. Branch diameter and number of oviposition incisions (Noi)

The branches were split into five sections, each measuring 20 cm long, making a total branch length of 100 cm. Each section represents a specific position on the branch, starting from the base where it attaches to the trunk (0-20 cm) and ending at the top (80-100 cm). The number of oviposition incisions (Noi – a opening made by a female to deposit her eggs in the branches) were counted for each section, and branch diameter was measured, at 1 cm from the girdling, with a caliper. Branch length was measured using a soft tape measure.

2.3. Period of emergence and larval-pupal chamber

We observed the branches stored in the laboratory every two weeks to determine adult specimens of *O. cervina*. After emergence of the adults, the length and diameter of the larval-pupal galleries were measured using a caliper. The galleries were filled with fine sand to determine the volume of wood consumed by measuring the sand volume in a graduated volumetric cylinder.

2.4. Statistical analysis

Descriptive statistics were done for data for Noi and branch diameter including means, minimum, maximum, standard error and deviation, sample variance, and coefficient of variation.

Diameter x Branch sections. The interaction between branch section and diameter was tested using a completely random design (CRD) with 5 treatments with 37 repetitions (branches). The treatments were the classes of branch length: T1: 0-20; T2: 20-40; T3:40-60 and T4: 80-100 cm. To evaluate the effect of branch section and diameter, the data were analyzed using a linear model. The quality of the model fit was graphically evaluated using a half-normal-plot with simulation envelopes at a level of 95%, using the '*hnp()*' function from the '*hnp*' package in the R software (Moral et al., 2017). Subsequently, the model was submitted to an analysis of variance (ANOVA), and the means comparison between branch sections was conducted using a Tukey post hoc test.

Noi x branch section. To test for the effect of branch section on Noi, a CRD with 5 treatments with 37 repetitions. The treatments were the classes of branch length: T1: 0-20; T2: 20-40; T3:40-60 and T4: 80-100 cm. To evaluate the effect of branch section (treatment) on the concentration of Noi, a general linear model was used (GLM), with a negative binomial error distribution using the function 'glm.nb()' from the '*MASS*' package (Venables and Ripley, 2002). The fit of the model was graphically evaluated using a half-normal-plot with simulation envelopes at a level of 95%, using the '*hnp()*' function from the '*hnp*' package (Moral et al., 2017). Subsequently, the model was submitted to an analysis of variance (ANOVA), and the means comparison between branch sections was conducted using a Tukey post hoc test.

Noi x branch diameter. The relationship between Noi and branch diameter was analyzed using a quadratic GLM with a negative binomial error distribution. In this test, Noi was set as a response variable as a function of branch diameter. The quality of the model fit was graphically evaluated using a half-normal-plot with simulation envelopes at a level of 95%, using the 'hnp()' function from the '*hnp*' package (Moral et al., 2017). The model was

subsequently submitted to deviance analysis to verify the significance of the observed tendencies.

All statistical analyses were done using the *software* R v. 4.0.2 (https://cran.r-project.org/bin/windows/) with a probability level $\alpha = 0.05$.

3. Results

3.1. Descriptive statistics

The mean number of oviposition incisions was 3.13. branch^{-1}, with a coefficient of variation of 119%, and amplitude from 0 to 24. Mean branch diameter was 44.4 mm, with a coefficient of variation of 30.6%, and amplitude from 15 to 80 mm.

3.2. Period of emergence and larval-pupal chambers

The greatest number of *O. cervina* adults emerged during the second half of November, reducing at the start of December, and ceased by the second half of January (Figure 1).

The boreholes were between 9.53 to 11.02 mm, with the largest axis having an amplitude between 6.7 and 15.3 mm, and the smallest between 5.0 and 12.7 mm. The mean length was 28.07 mm, and the volume was 4.31 mL. The coefficient of variation for the volume was large, indicating a high proportion of variation in the values of wood consumption between larval-pupal galleries in relation to the mean value (Table 1).

3.3. Effect of branch section on Noi

The initial section of branches, T1: 0-20 cm, had less Noi (1.65 oviposition incisions.branch^{-1}) than the middle section of the branches (T2: 40-60 cm) (4.00 oviposition incisions.branch^{-1}) (Figure 2).

3.4. Effect of branch diameter on Noi

The analysis of deviance for the GLM indicated significant effects for the linear ($\beta 1x$) and quadratic ($\beta 2x^2$) components of branch diameter on mean Noi ($\beta 1x$: $x^2 = 11.70$; df = 1; $p < 0.001$; $\beta 1x^2$: $x^2 = 11.66$; df = 1; $p < 0.001$). The GLM indicated a rate increase (log) of 0.097 for mean Noi as a function of branch diameter up to approximately 45 mm. For branches larger than 45 mm, the GLM estimated a rate decrease (log) of -0.001 for Noi (Figure 3).

4. Discussion

4.1. Period of emergence and characterization of larval-pupal galleries

The season of adult emergence is of great importance to predictive models based on time series, which are useful for implementation of strategies for Integrated Pest Management (IPM). Predicting periods of greater occurrence of this pest helps to intensify monitoring and decision-making for control. Adults emerged during November through January, with the largest emergence during the second half of November. In southern Brazil, twig girdlers beetles of the *Oncideres* genus emerge between October and May, a period corresponding to that observed in the present study (Witeck Neto and Link, 1997; Witeck Neto et al., 2013; Witeck Neto et al., 2015).

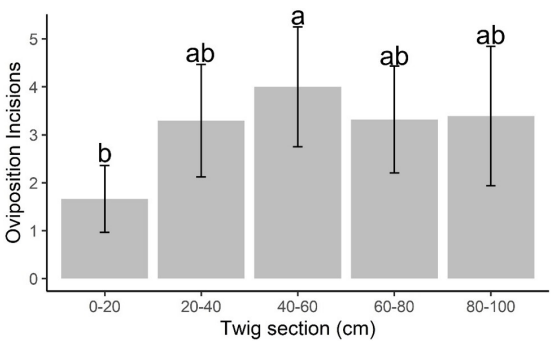

Figure 2. Mean number of oviposition incisions by *Oncideres cervina* Thomson, 1868 (Coleoptera: Cerambycidae) in *Persea americana* Mill. (Laurales: Lauraceae), measured on different branch sections. Bars are standard error. Identical letters are not statistically different by the Tukey test at $\alpha < 0.05$. Santa Maria, RS, Brazil.

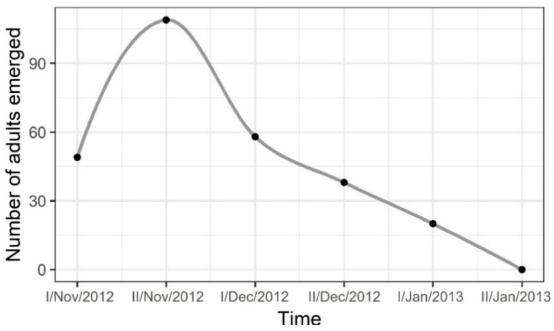

Figure 1. Period of emergence of adults *Oncideres cervina* Thomson, 1868 (Coleoptera: Cerambycidae) on *Persea americana* Mill. (Laurales: Lauraceae) evaluated every two weeks between November 2012 and January 2013. Santa Maria, RS, Brazil.

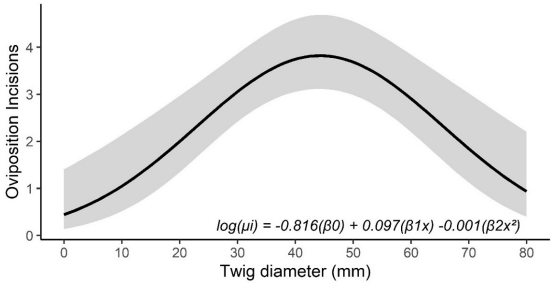

Figure 3. Mean number of oviposition incisions by *Oncideres cervina* Thomson, 1868 (Coleoptera: Cerambycidae) on *Persea americana* Mill. (Laurales: Lauraceae) as a function of branch diameter (mm). The shadowed area represents the 95% confidence level. Caption: $\log(\mu i)$ = mean Noi; $\beta 0$ = intercept; $\beta 1x$ = linear component of branch diameter; $\beta 2x^2$ = quadratic component of branch diameter. Santa Maria, RS, Brazil.

Table 1. Characterization of the larval-pupal galleries of *Oncideres cervina* Thomson, 1868 (Coleoptera: Cerambycidae) in branches of *Persea americana* Mill. (Laurales: Lauraceae). Santa Maria, RS, Brazil.

Galleries (N =42)	Ø (mm)		Length (mm)	Volume (ml)
	>	<		
Mean	11.02	9.53	28.07	40.31
Amplitude	6.72-15.31	5.00-12.70	14.00-60.50	11.40-64.52
Standard error	1.59	1.42	14.36	17.34
Coefficient of variation	14.39%	14.86%	51.16%	54.95%

Ø: diameter of borehole; >: larger axis; <: smaller axis.

For larval-pupal galleries length, the results from this study (28 mm) were inferior to those for *O. cervina* on of *O. puberula* (53.7 mm) (Witeck Neto et al., 2015), indicating a lower rate of consumption on *P. americana*. This result could be related to the physical structure of the branches and wood density, factors than can influence the rate of larval wood consumption (Coppedge, 2011; Brown et al., 2016).

The volume of wood consumed indicates the nutritional adaptability of the host (Forcella, 1984; Costa and Marques, 1988; Witeck Neto et al., 2015). In this case, *O. cervina* that occur on *P. americana* tend to have a lower rate of assimilation, and consequently a greater necessity to consume wood to support their development, compared to other species of Lauraceae, such as *O. puberula* as related by Witeck Neto et al. (2015).

The dimensions reported for *O. cervina* on *O. puberula* (Witeck Neto et al., 2015), show that, in the current study, the boreholes made in *P. americana* were larger and had a lower coefficient of variation, suggesting emergence of larger adults and with lower variability between individuals. This variation indicates and effect of the botanical species not only on aspects related to oviposition behavior, wood consumption, and larval viability, but also on the final size of the emerged adults.

4.2. Effect of branch section and diameter on Noi

Our results suggest a preferential zone for oviposition by *O.* cervina in the middle section (40-60 cm). Similarly, the GLM model estimated greater Noi between diameters of 40 and 50 mm, with a peak around 45 mm (Figure 2), corroborating the data on the preferential zone for oviposition. Witeck Neto et al. (2015) also reported a larger value for Noi by *O. cervina* in the middle section of branches (80-100 cm) of *Ocotea puberula* (Rich.) Nees, in Santa Maria, Rio Grande do Sul, Brazil. The mean Noi found in branches of *O. puberula* (13.10) by Witeck Neto et al. (2015) was greater than that for the current study of *P. americana* (4.00), indicating a possible effect of species-specific characteristics (i.e., wood chemical composition, density, and nutrient availability).

The preference for a specific section of a branch for oviposition may be related to the wood density and availability of nutrients (Rice, 1989). In the current study, the mean diameter of the basal section of branches (0-20 cm) was greater than the mean diameter of the final section of the branch (80-100 cm).

Besides these factors, another aspect that may contribute to a preference for the middles section of branches for oviposition by *O. cervina*, is the rate at which the branch dries out. At the base and apical sections, the rate of drying is greater than the other sections, which makes larval development difficult (Diodato et al., 1997). Therefore, these two extremities do not have favorable conditions for oviposition, and they are avoided in favor of the middle section of the branch. This result agrees with that from Lemes et al. (2014), where there was greater Noi in branches with diameters that were between the thinner and thicker sections of the branch, which could be related to the combination of girdling ability of females and the necessity to provide resources to the larvae.

5. Conclusions

The current study reports the first occurrence of *O. cervina* on branches of the *P. americana*. The results presented and discussed in this research are of great importance for the organization of monitoring plans for insect pests and creation of strategies for integrated pest management for *P. americana*, which now should consider *O. cervina*.

The emergence of adults of *O. cervina* on *P. americana* occurred between November and January, with a peak of emergence during the second half of November.

Parameters related to the dimensions of larval-pupal galleries suggest a necessity for a greater consumption of *P. americana* wood compared to other species of Lauraceae. The dimensions of the boreholes indicate a larger size of adults emerging from *P. americana*, while the length of larval-pupal galleries in *P. americana* was smaller than other Lauraceae species.

Branches of *P. americana* with a diameter of approximately 45 mm (middle section of a 1m branch) represent the preferential zone for oviposition by *O. cervina*.

References

BAUCKE, O., 1962. *A inseto fauna da acácia-negra no Rio Grande do Sul: biologia e controle às pragas mais importantes*. Porto Alegre: Secretaria de Agricultura Indústria e Comércio, 32 p.

BERNARDI, O., GARCIA, M.S., ELY E SILVA, E.J., ZAZYCKI, L.C.F., BERNARDI, D., MIORELLI, D. and FINKENAUER, É., 2011. Besouros cerambycidae associados a *Eucalyptus* spp. no município de

Pinheiro Machado, RS. *Ciência Florestal*, vol. 21, no. 1, pp. 23-30. http://dx.doi.org/10.5902/198050982744.

BROWN, W.P., ZUEFLE, M.E. and DOMBROSKIE, J.J., 2016. The effect of twig diameter on emergence rates of the oak twig pruner (Coleoptera: cerambycidae). *Canadian Entomologist*, vol. 148, no. 6, pp. 693-697. http://dx.doi.org/10.4039/tce.2016.25.

CALDERÓN-CORTÉS, N., QUESADA, M. and ESCALERA-VÁZQUEZ, L.H., 2011. Insects as stem engineers: interactions mediated by the twig-girdler oncideres albomarginata chamela enhance arthropod diversity. *PLoS One*, vol. 6, no. 4, p. e19083. http://dx.doi.org/10.1371/journal.pone.0019083. PMid:21526161.

COPPEDGE, B.R., 2011. Twig morphology and host effects on reproductive success of the twig girdler Oncideres cingulata (Say) (Coleoptera: cerambycidae). *Coleopterists Bulletin*, vol. 65, no. 4, pp. 405-410. http://dx.doi.org/10.1649/072.065.0417.

COPPEDGE, B.R., 2014. Twig morphology and host effects on emergence patterns and sex ratios of the twig girdler, Oncideres cingulata (Say) (Coleoptera: cerambycidae). *Southwestern Entomologist*, vol. 39, no. 1, pp. 87-96. http://dx.doi.org/10.3958/059.039.0109.

CORDEIRO, G., ANJOS, N., LEMES, P.G. and MATRANGOLO, C.A.R., 2010. Ocorrência de *Oncideres dejeanii* Thomson (Cerambycidae) em *Pyrus pyrifolia* (Rosaceae), em Minas Gerais. *Pesquisa Florestal Brasileira*, vol. 30, no. 62, pp. 153-156. http://dx.doi.org/10.4336/2010.pfb.30.62.153.

CORRÊA, C.A., BRÜGGER, B.P., ANJOS, N. and ZANUNCIO, J.C., 2024. Egg characterization and laying pattern of *Oncideres saga* (Coleoptera: Cerambycidae) in *Inga edulis* (Fabaceae). *Brazilian Journal of Biology = Revista Brasileira de Biologia*, vol. 84, p. e249528. http://dx.doi.org/10.1590/1519-6984.249528. PMid:34932623.

CORRÊA, C.A., GARBELINI, L., LEMES, P.G., ANJOS, N. and ZANUNCIO, J.C., 2022. *Oncideres saga* (Dalman, 1823) (Coleoptera: Cerambycidae) girdling and developing in *Plathymenia reticulata* Benth. (Fabaceae). *Brazilian Journal of Biology = Revista Brasileira de Biologia*, vol. 82, p. e263718. http://dx.doi.org/10.1590/1519-6984.263718. PMid:36350937.

COSTA, E.C. and MARQUES, E.N., 1988. Aspectos etológicos de *Oncideres impluviata* (Germar, 1824) em Bracatinga. *Revista do Centro de Ciências Rurais*, vol. 18, pp. 219-228.

DIODATO, L., DARCHUK, A., NOTARIO, A. and CASTRESANA, L., 1997. Estudio sobre el comportamiento de oviposición del "cortapalos" *Oncideres futtulata* Thompson (Coleoptera: Cerambycidae) sobre "quebracho colorado", *Schinopsis quebracho colorado* (Schlecht) Bark et Meyer. *Boletin de Sanidad Vegetal, Plagas*, vol. 23, pp. 257-261.

FORCELLA, F., 1984. Trees size and density affect twig-girdling intensity of *Oncideres cingulata* (Say) (Coleoptera : cerambycidae). *Coleopterists Bulletin*, vol. 38, pp. 37-42.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA – IBGE, 2019 [viewed 20 June 2023]. *Produção agrícola municipal* [online]. Instituto Brasileiro de Geografia e Estatística. Available from: https://sidra.ibge.gov.br/

LEMES, P.G., ANJOS, N. and CORDEIRO, G., 2011. Injúrias e oviposição de *Oncideres impluviata* (Germar) (Col.: Cerambycidae) em *Piptadenia gonoacantha* (Mart.) Macbr. *Comunicata Scientiae*, vol. 2, no. 1, pp. 53-56.

LEMES, P.G., ANJOS, N., JORGE, I.R. and LEITE, H.G., 2014. Twig morphology effects on the number of egg incisions and reproductive success of *Oncideres ocularis* (Coleoptera: cerambycidae). *Studies on Neotropical Fauna and Environment*, vol. 49, no. 1, pp. 41-49. http://dx.doi.org/10.1080/01650521.2014.912541.

LINK, D., COSTA, E.C. and THUM, A.B., 1994. Bionomia comparada dos serradores, *Oncideres saga saga* (Dalman, 1823) e *Oncideres dejeani* (Thomson, 1868) (Coleoptera: Cerambycidae) em *Parapiptadenia rigida*. *Ciência Florestal*, vol. 4, no. 1, pp. 137-144. http://dx.doi.org/10.5902/19805098303.

MAGISTRALI, I.C., COSTA, E.C., GARLET, J., BOSCARDIN, J. and MACHADO, L.M., 2013. Danos de *Oncideres saga* em plantios de *Acacia mearnsii* no Rio Grande do Sul, Brasil. *Pesquisa Florestal Brasileira*, vol. 33, no. 76, pp. 463-467. http://dx.doi.org/10.4336/2013.pfb.33.76.378.

MANKIN, R.W., BURMAN, H., MENOCAL, O. and CARRILLO, D., 2018. Acoustic detection of *Mallodon dasystomus* (Coleoptera: Cerambycidae) in *Persea americana* (Laurales: Lauraceae) branch stumps. *The Florida Entomologist*, vol. 101, no. 2, pp. 321-323. http://dx.doi.org/10.1653/024.101.0226.

MARQUES, C., 2001. Importância econômica da família Lauraceae Lindl. *Floresta e Ambiente*, vol. 8, pp. 195-206.

MORAL, R.A., HINDE, J. and DEMÉTRIO, C.G.B., 2017. Half-normal plots and overdispersed models in R: the hnp package. *Journal of Statistical Software*, vol. 81, no. 10, pp. 1-23. http://dx.doi.org/10.18637/jss.v081.i10.

ONO, M. A., 2015. *Dinâmica de infestação em Acacia mearnsii e ecologia de Oncideres impluviata (Coleoptera: Cerambycidae) Maria*. Piracicaba: Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, 68 p. Dissertação de Mestrado.

PARO, C.M., ARAB, A. and VASCONCELLOS-NETO, J., 2011. The host-plant range of *twig-girdling beetles* (Coleoptera: Cerambycidae: Lamiinae: Onciderini) of the Atlantic rainforest in southeastern Brazil. *Journal of Natural History*, vol. 45, no. 27-28, pp. 1649-1665. http://dx.doi.org/10.1080/00222933.2011.559601.

RICE, M.E., 1989. Branch girdling and oviposition biology of *Oncideres pustulatus* (Coleoptera: Cerambycidae) on *Acacia farnesiana*. *Annals of the Entomological Society of America*, vol. 82, no. 2, pp. 181-186. http://dx.doi.org/10.1093/aesa/82.2.181.

SALGADO, J.M., DANIELI, F., REGITANO-D'ARCE, M.A.B., FRIAS, A. and MANSI, D.N., 2008. O óleo de abacate (*Persea americana* Mill) como matéria-prima para a indústria alimentícia. *Food Science and Technology*, vol. 28, pp. 20-26. http://dx.doi.org/10.1590/S0101-20612008000500004.

VALÉRIO, D.A., TRES, A., TETTO, A.F., SOARES, R.V. and WENDLING, W.T., 2018. Holdridge life zone classification for the southern Brazilian state "Rio Grande do Sul". *Ciência Florestal*, vol. 28, no. 4, pp. 1776-1788. http://dx.doi.org/10.5902/1980509835337.

VENABLES, W.N. and RIPLEY, B.D., 2002. *Modern applied statistics with S*. 4th ed. New York: Springer-Verlag. http://dx.doi.org/10.1007/978-0-387-21706-2.

VULCANO, M.A. and PEREIRA, F.S., 1978. O gênero Oncideres Serville, 1835 no sul do país e países limítrofes: séria praga dos pomares e da silvicultura. *Studia Entomologica*, vol. 20, pp. 177-220.

WITECK NETO, L. and LINK, D., 1997. Cerambycidae associados a lauraceae, na região central do Rio Grande do Sul, Brasil. *Ciência Florestal*, vol. 7, no. 1, pp. 33-39. http://dx.doi.org/10.5902/19805098337.

WITECK NETO, L., LINK, D. and PASINI, M.B., 2013. Cerambycidae associados a *Ocotea puberula*. *Pesquisa Florestal Brasileira*, vol. 33, no. 76, pp. 455-458. http://dx.doi.org/10.4336/2013.pfb.33.76.357.

WITECK NETO, L., LINK, D. and PASINI, M.P.B., 2015. Bioecologia de *Oncideres cervina* (Coleoptera: Cerambycidae) em Canela-Guaicá (*Ocotea puberula*: Lauraceae) na região central do Rio Grande do Sul, Brasil. *Ciência Florestal*, vol. 25, no. 2, pp. 469-476. http://dx.doi.org/10.5902/1980509818466.