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CROP PROTECTION

First record of *Cerchysiella insularis* (Howard, 1897) (Hymenoptera: Encyrtidae) parasitizing *Lobiopa insularis* (Castelnau, 1840) (Coleoptera: Nitidulidae) on strawberries

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ABSTRACT: Strawberry is one of the most socially and economically important small fruits in Brazil, with strong demand by the food industry driving high levels of production. However, phytosanitary problems, especially insect damage, can hamper strawberry cultivation. A pest of great concern is the strawberry sap beetle, *Lobiopa insularis* (Coleoptera: Nitidulidae), which damages the fruits. Chemical control has not been effective against *L. insularis*, as it makes harvesting and marketing the product unfeasible. Parasitoids have been effectively utilized to control various strawberry pests and support sustainable production. We report the occurrence of the wasp *Cerchysiella insularis* (Hymenoptera: Encyrtidae) as a parasite of *L. insularis* on strawberries in São José dos Pinhais, Paraná, Brazil. Samples of strawberries (San Andreas cultivar) attacked by *L. insularis* were collected from February to March, 2019. *Lobiopa insularis* larvae were individually placed in rearing pots, fed on San Andreas strawberries, and checked weekly for symptoms of parasitism or parasitoid emergence. Parasitism rates were 33.85% in March and 45.90% in February. The sex ratio varied between 0.88 and 0.86. All parasitized larvae were infested by *C. insularis*. The natural parasitism rate above 33% and high sex ratio of *C. insularis* in strawberry crops indicated that it may have the potential in the control of *L. insularis*.
Key words: integrated pest management, biological control, arasitoid wasps, *Fragaria x ananassa* Duch.

Primeiro relato de *Cerchysiella insularis* (Howard, 1897) (Hymenoptera: Encyrtidae) parasitando *Lobiopainsularis* (Castelnau, 1840) (Coleoptera: Nitidulidae) em morangueiro

RESUMO: O morango é uma das pequenas frutas de maior importância social e econômica no Brasil, com forte demanda pela indústria alimentícia, o que impulsiona altos níveis de produção. No entanto, problemas fitossanitários, principalmente danos causados por insetos, podem dificultar o cultivo do morango. Uma praga de grande preocupação é a broca do morangueiro, *Lobiopainsularis* (Coleoptera: Nitidulidae), que danifica os frutos. O controle químico não tem sido eficaz contra *L. insularis*, pois inviabiliza a colheita e comercialização do produto. Os parasitoides têm sido efetivamente utilizados para controlar várias pragas de morangueiro, em um sistema de produção sustentável. Relatamos a ocorrência da vespa *Cerchysiella insularis* (Hymenoptera: Encyrtidae) como parasita de *L. insularis* em morangos em São José dos Pinhais, Paraná, Brasil. Amostras de morangos (cultivar San Andreas), atacados por *L. insularis*, foram coletadas durante o período de fevereiro a março de 2019. As larvas de *L. insularis* foram colocadas individualmente em vasos de criação, alimentadas com morangos San Andreas e verificadas semanalmente quanto aos sintomas de parasitismo e à emergência de parasitoides de *C. insularis*. As taxas de parasitismo de *C. insularis* foram de 33,85%, em março, e 45,90%, em fevereiro. A razão sexual variou entre 0,88 e 0,86. Todas as larvas parasitadas estavam infestadas por *C. insularis*. A taxa de parasitismo natural acima de 33% e alta razão sexual de *C. insularis* em cultivos de morangueiro indicam que este parasitoide pode ter potencial no controle de *L. insularis*.
Palavras-chave: manejo integrado de pragas, controle biológico, vespas parasitoides, *Fragaria x ananassa* Duch.

Among small fruit crops, strawberry (*Fragaria ×ananassa* Duchesne, 1766) (Rosaceae) stands out for its global economic importance (SIMPSON, 2018) due to its widely consumed berry. However, despite considerable demand for strawberries by the food industry, productivity has been affected by damage caused by insect pests (ZAWADNEAK et al., 2018).

One of the main pests in strawberry cultivation is the strawberry sap beetle, *Lobiopa insularis* (Castelnau, 1840) (Coleoptera: Nitidulidae) (MYERS, 2019; BOTTON et al., 2014). *Labiopa insularis* is polyphagous, occurring mainly in fruit crops, a contributing factor to difficulties in controlling outbreaks (GRECO et al., 2017). This insect causes direct and indirect damage to the fruits, which cannot be sold or consumed once damaged by the pest (GUIMARÃES et al., 2009; ANDZEIEWSKI et al., 2018). Severe infestations of *L. insularis* can

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cause economic losses of 20 to 70% (FORNAZIER et al., 1986; BOTTON et al., 2014).

Beetle larvae and adults cause direct damage by feeding on the fruit and causing superficial and deep perforations. Meanwhile, the beetles also cause indirect damage associated with the spread of rot-causing spores of microorganisms (RONDON et al., 2011; BOTTON et al., 2014) (Figure 1B).

Managing this pest is challenging since they prefer to feed on ripe fruits, sheltering inside the fruit (SOUZA et al., 2019; DORZENONI et al., 2019). Since strawberries are harvested every day during the harvest period, chemical products cannot be used on ripe fruits due to the high risks entailed by chemical residues in the fruits (DORZENONI et al., 2019).

Thus, there is a need for alternative control strategies that do not interfere with harvesting frequency. Biological control is one of the main alternatives used in integrated pest management (IPM), often employing parasitoids to control the main agricultural pests.

The wasp *Cerchysiella insularis* (HOWARD, 1897) (Hymenoptera: Encyrtidae) is a gregarious endoparasitoid of Nitidulidae species (COLER et al., 1986). In Brazil, the presence of *C. insularis* was recorded in *Psidium araca* (Linnaeus, 1753) (Myrtaceae) fruits in the city of Campinas, São Paulo, in 1939 (SAUER, 1946) and in a collection carried out by F. Plauman in the city of Nova Teutônia, Santa Catarina, in 1935 (NOYES, 1979). The last record of this parasitoid occurred between 1983 and 1984, in which *C. insularis* was reported on coleopteran larvae present in pod fruit (*Spondias lutea* Linnaeus, 1762) (Anacardiaceae), guava (*Psidium guajava* Linnaeus, 1753) (Myrtaceae), fig (*Ficus carica* Linnaeus, 1744) (Moraceae), and carambola (*Averrhoa carambola* Linnaeus, 1753) (Oxalidaceae) in the cities of Valinhos and Limeira, São Paulo (COLER et al., 1986). The parasitoid has not been recorded or studied in other hosts for several decades.

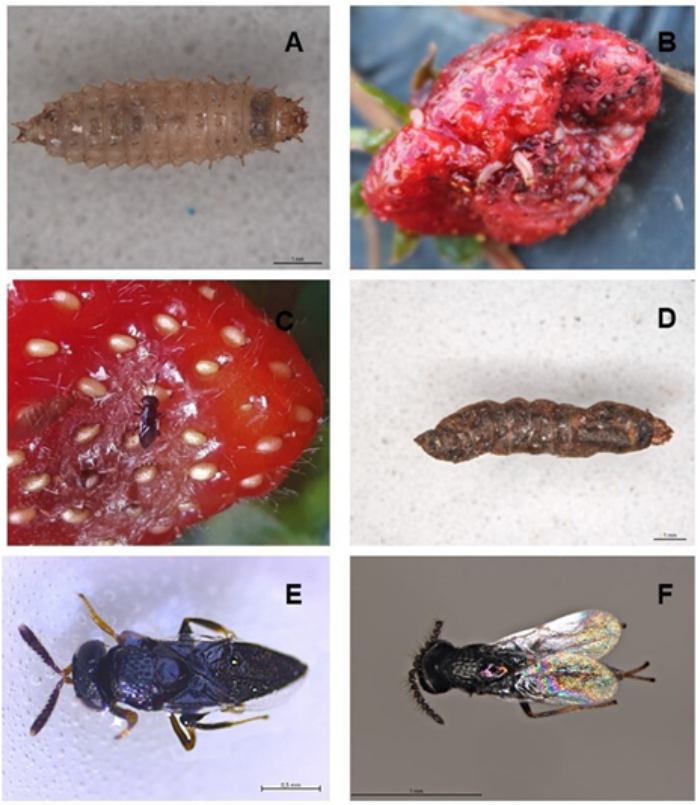

Figure 1 - (A) *Lobiopa insularis* Larvae; (B) Damage of *L. insularis* larvae; (C) *Cerchysiella insularis* (Howard) (Hymenoptera: Encyrtidae); (D) Parasitized larvae of *Lobiopa insularis*; *Cerchysiella insularis* adult: (E) female; (F) male.

Although, *L. insularis* is known to be a host of *C. insularis* (DE SANTIS, 1964; BENNETT & BARANOWSKI, 1981), the presence of this parasitoid has not been reported to date in strawberries. Given the above, this study reported the first record of *C. insularis* parasitizing *L. insularis* larvae (Figure 1C) in commercial strawberry production area in metropolitan region of Curitiba, Paraná, Brazil. This study was divided into three stages:1) collecting the fruits; 2) separation of larvae with symptoms of parasitism and 3) confirmation of parasitoid emergence and sexing.

In the first stage of this study, 60 ripe strawberries of the San Andreas cultivar were collected in February and March 2019, with signs of damage and infestation by *L. insularis*. The commercial production area is located in São José dos Pinhais (25°37'57'' S, 49°13'36''W), Paraná. Ripe berries were chosen because they are more likely to exhibit damage by *L. insularis* (SOUZA et al., 2019).

Posteriorly, strawberry fruits containing larvae of *L. insularis* (Figure 1A) were placed in a 1 L plastic container (9.3 cm height and 12.0 cm Ø), which was then closed with a lid. Small perforations (1 mm) were made in the lid to facilitate gas exchange. A 4 cm layer of vermiculite was placed at the bottom of the pot to absorb the disintegrated juice of the fruit and prevent insect mortality by drowning. The containers were kept under controlled conditions (25 ± 2 °C, relative humidity 70 ± 10%, and photophase of 14 hours). Every two days, a strawberry of the San Andreas cultivar was added at the 75% ripe stage in the container to feed the larvae.

Parasitism was confirmed by observing nodosities formed by the parasitoids on the host's tegument, which was disfigured, before the emergence of *C. insularis* (Figure 1D). Parasitized larvae were individually placed in a test tube containing moistened filter paper (2 cm^2) and sealed with hydrophilic cotton. The larvae were evaluated weekly.

After emergence, the parasitoids were placed in a polypropylene microtube with a capacity of 1.5 mL containing 70% ethanol. The total number of larvae and the number of larvae parasitized were counted on each fruit, and used to calculate the percentage of larval parasitism. The average number of parasitoids per larva was then calculated (Figure 1E), in addition to the sex ratio (number of females/number of females + number of males); and sexual dimorphism (Figure 1F).

The parasitoid species was identified based on NOYES (1979, 1982), NOYES & HAYAT (1984), and SUBBA RAO (1972). Voucher specimens (17 females and four males) were deposited in the Entomological Collection of Espírito Santo Federal University (Vitória, Brazil).

A total of 453 larvae of *L. insularis* were collected from February to March 2019. In February, 261 larvae were collected in 30 fruits (average of 8.7 larvae per fruit), and in March, 192 larvae were collected in 30 fruits (average of 6.4 larvae per fruit). In the first collection, the percentage of parasitized larvae was 45.9% (119 parasitized larvae out of a total of 261), the average number of parasitoids per larva was 7.55 ± 0.45, and the sex ratio was 0.86. In the second collection, the percentage of parasitism was 33.85% (65 parasitized larvae out of a total of 192), the average number of parasitoids per larva was 6.38 ± 0.60 and the sex ratio was 0.88.

Previous studies have indicated the use of parasitoids as a promising strategy for controlling different species of Nitidulidae in various crops as an alternative to chemical pest control (NOYES, 1982; WILLIAMS et al., 1992; KANGA et al., 2021). This approach is further supported by the endophytic habit of the larva, which increases the difficulty of conventional methods of controlling these pest insect species.

In conclusion, the high rate of natural parasitism of *C. insularis*, above 30%, combined with the sex ratio of over 0.8, indicates the potential of this species as a bioagent to control *L. insularis*, contributing to pest management in strawberry crops. However, more studies are needed to assess the ability of *C. insularis* to act as a biological control agent in IPM programs. Finally, new biological studies are needed to assess the interaction between host and parasitoid, understand the parasitoid's life cycle, and evaluate its ability to act as a biological control agent in IPM programs in strawberry cultivation.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

All authors contributed equally for the conception and writing of the manuscript. All authors critically revised the manuscript and approved of the final version.

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