NOTA

Occurrence of galls in *Microgramma mortoniana* (Polypodiopsida: Polypodiaceae) from a subtropical forest, Brazil

Ocurrencia de agallas en *Microgramma mortoniana* (Polypodiopsida: Polypodiaceae) en un bosque subtropical, Brazil

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ABSTRACT

The galls are structures formed of plant tissues in response to the activity of different types of organisms, especially by insects. As a consequence of an intimate relationship with their host plants, most of these insects have a very narrow host range. In this study we report for the first time the occurrence of galls on *Microgramma mortoniana* (Polypodiaceae). Morphological characteristics and field observations are presented. The study was carried out in a seasonal semi-deciduous forest fragment, located in the São João do Oeste municipality, Santa Catarina, southern Brazil. The galls present a fusiform shape and similar indument to the rhizome. In the region of occurrence of the galls, a widening of the rhizome was observed, reaching an average of 9 mm (±1mm), whereas in a rhizome with normal growth the width is 4 (±1 mm). The gall is unicameral, with the following dimensions: 7 mm (±1 mm)

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x 2 (±1 mm). The larvae observed into the chamber are about 0,7 mm long, being representative of the species *Tortrimosaica polypodivora* (Lepidoptera: Tortricidae). In all cases, the rhizomes with galls do not presented continuous development and, consequently, the rhizome has its limit of growth defined by the occurrence of the gall. As the galling insect is the same that *Microgramma squamulosa*, we discuss briefly the differences between both species.

Keywords — Epiphytic fern; insect; Lepidoptera; Trotricidae.

RESUMEN

Las agallas son estructuras formadas por tejidos vegetales en respuesta a la actividad de diferentes tipos de organismos, especialmente insectos. Como consecuencia de la íntima relación con sus plantas hospedadoras, la mayoría de estos insectos tienen un rango muy definido de huéspedes. En este estudio reportamos por primera vez la aparición de agallas en *Microgramma mortoniana* (Polypodiaceae). Se presentan características morfológicas y observaciones de campo. El estudio se llevó a cabo en un fragmento de bosque semi-caducifolio estacional, ubicado en el municipio de Sao João do Oeste, Santa Catarina, sur de Brasil. Las agallas presentan una forma fusiforme e indumento similar al rizoma. En la zona de aparición de las agallas, se observó un ensanchamiento del rizoma, alcanzando un promedio de 9 mm (± 1 mm), mientras que un rizoma con crecimiento normal el diámetro es 4 (± 1 mm). La agalla es unicameral, con las siguientes dimensiones: 7 mm (± 1 mm) x 2 (± 1 mm). Las larvas observadas en la cámara tienen aproximadamente 0.7 mm de largo, perteneciendo a la especie *Tortrimosaica polypodivora* (Lepidoptera: Tortricidae). En todos los casos, los rizomas con agallas no presentan una continuidad de desarrollo y, en consecuencia, el rizoma tiene su límite de crecimiento definido por la aparición de la agalla. Debido a que el insecto galícola es el mismo que en *Microgramma squamulosa*, discutimos brevemente la validez de ambas especies.

Palabras clave — Helechos epífitos; insecto; Lepidoptera; Tortricidae.

INTRODUCTION

The galls are structures formed of plant tissues in response to the activity of different types of organisms, especially by insects (Hartley, 1998; Nabity, 2016). Galls are considered one of the more complex forms of atypical growth (Kraus, Montenegro, Kim, 1993), altering the physiological, morphoanatomical and phytochemical state of plant tissues, particularly the larvae feeding area the so-called nutritive tissue (Shorthouse, 1986). Development of such structures by the galling larva needs a continued physical contact and finely tuned relationship with the host plant. As a consequence of an intimate relationship with their host plants, most of these insects have a very

narrow host range, attacking a specific organ in one or a few closely related plant species (Abrahamson, Melika, Scrafford, Csóka, 1998; Stone & Schönrogge, 2003).

The occurrence of galls has been well documented for angiosperms (e.g. Silva & Almeida-Cortez, 2006; Maia & Silva, 2016) with some records dating from the upper Tertiary and Cenozoic periods (Srivastava & Srivastava, 1998). Although the ferns comprise the second largest group of vascular plants (Moran, 2008), the occurrence of galls associated with this group is still poorly known.

The first attempt at a worldwide review of the occurrence of galls on ferns was undertaken by Docters van Leeuwen (1938), who included Houard's pioneer contributions from different continents (Houard, 1908, 1922, 1933). Balick, Furth, Cooper-Driver (1978) reported the occurrence of galling insects associated worldwide to eight fern species. Hanson & Gómez-Laurito (2005) recorded galling insects associated to 17 fern species only for the Costa Rica. Considering the Brazilian region, Santos & Maia (2018) reported galls for 16 fern species, including the first record of galls for the Cyatheaceae family, made by Farias *et al.* (2018) for *Cyathea phalerata* Mart. in the northeastern region of Brazil. Additionally, Farias *et al.* (2019) reported four new records of galls, including representatives from Gleicheniaceae and Hymenophyllaceae, expanding to 20 the number of fern species with gall occurrence in Brazil. Santos, Hanson, Maia, Mehltreter (2019) listed 93 worldwide species of lycophytes (Selaginellaceae) and ferns presenting association with galling insects, reinforcing the observations of Mehltreter (2010), that ferns might have been underestimated as host plants of galling insects. In consequence, basic information such as the identity of gall host ferns, the frequency and locations of the interaction are still poorly known (Farias *et al.*, 2019).

Attending to that, and as part of various studies of Southern Cone ferns and lycophytes, in this work we report the occurrence of galls on *Micrograma mortoniana* de la Sota, an epiphytic fern species of family Polypodiaceae. In addition, gall morphological characteristics and field observations are presented.

MATERIAL AND METHODS

The study was carried out in November of 2018, in a seasonal semi-deciduous forest fragment, located in the São João do Oeste municipality, Santa Catarina, southern Brazil (27°06'41"S, 53°35'47"W). The fragment is surrounding by an anthropic matrix (camping area and artificial lakes), comprising an area of approximately 5 ha. The climate of the region is classified as temperate, with absence of a dry season and marked by hot summers, classified as subtype *Cfa* (Peel, Finlayson, Mcmahon, 2007). Specimens were collected and herborized (*C.R. Lehn 2577*) using standard techniques (Windisch, 1992) and the voucher of the material was deposited in the SMDB herbarium (Thiers, 2019). Seven segments of different rhizomes were collected: the larvae from five of these segments (one gall per segment) were utilized for measurement and two segments were placed on a tree's branch, on the edge of a forest fragment, located in the urban area of the municipality of Panambi, RS, Brazil. In order to obtain galling adult specimens, these segments were isolated using

a 0.5 mm mesh net in early December of 2018 and during the observation period, remained exposed to external climatic variation. The morphological characteristics considered for the measurement were the number of cameras, shape and size (length x width) and presence/absence of indumenta for each gall observed. The shape of the gall was determined based on Isaias *et al.* (2014).

The identification of the plant material follows de la Sota (1973) and Cacharani & Martínez (2016), and Brown, Baixeras, Solózano-Filho, Kraus (2004) was consulted for the taxonomic identification of the moth.

RESULTS

The occurrence of galls was observed associated with 12 apexes (Figure 1), considering seven arboreal individuals with occurrence of the epiphyte *Microgramma mortoniana* on them. The galls presented a fusiform shape and similar indumenta (scales) to the rhizome. In the region of occurrence of the galls, a widening of the rhizome was observed, reaching an average of 9 mm (±1mm), whereas in a rhizome with normal growth a width varying in 4 (±1 mm) is observed. The gall is unicameral (Figure 2A), with the following dimensions: 7 mm (±1 mm) x 2 (±1 mm). The larvae observed into the chamber are about 0,7 mm long (Figure 2B).

After six months, one of the adults emerged from the gall in May of 2019 (Figure 2C), allowing taxonomic identification of the moth, which belongs to the species *Tortrimosaica polypodivora* Brown & Baixeras 2004 (Lepidoptera: Tortricidae).

DISCUSSION AND CONCLUSIONS

The occurrence of galls associated with the family Polypodiaceae was reported in other studies in Brazil. Sehnem (1970) reported the occurrence of galls in *Niphidium crassifolium* (L.) Lellinger; Santos & Maia (2018) reported galls associated to seven species of Polypodiaceae, including *Microgramma squamulosa* and *M. vacciniifolia*

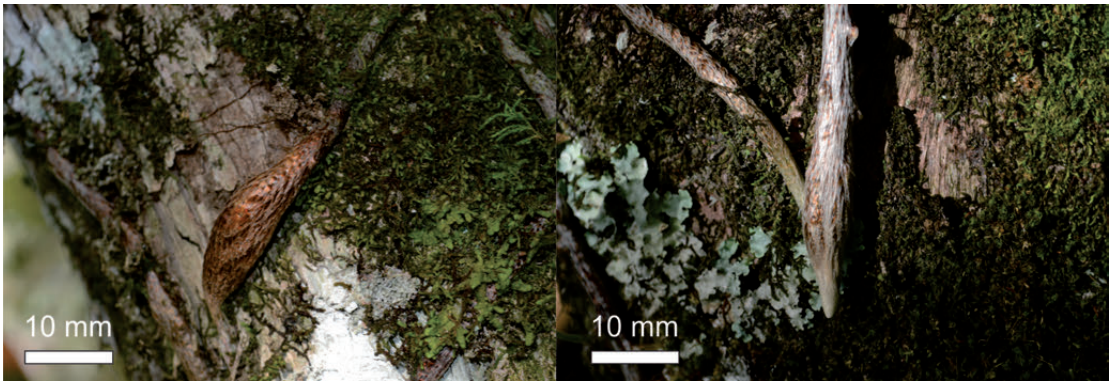

Fig. 1. Occurrence of galls in the rhizomes of *Microgramma mortoniana* (Polypodiaceae) in a Seasonal Semi-deciduous Forest fragment in the São João do Oeste municipality, Santa Catarina, southern Brazil (27°06'41''S, 53°35'47''W).

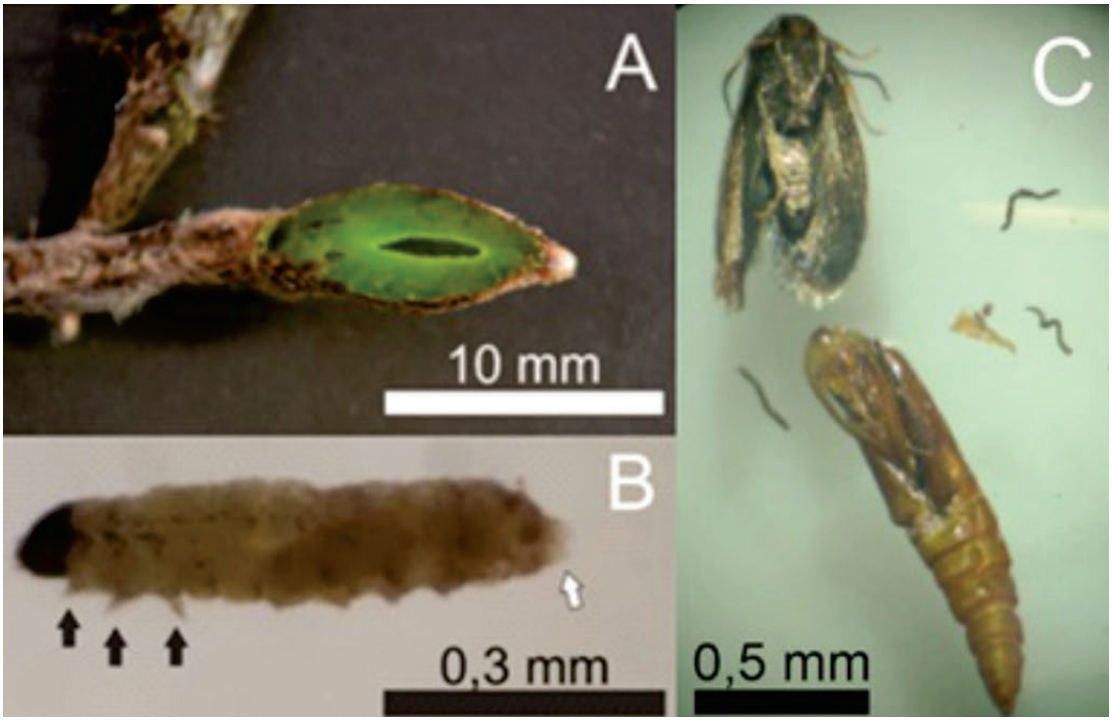

Fig. 2. A) Unicameral gall observed in the rhizome of *Microgramma mortoniana* (Polypodiaceae) in a seasonal Seasonal Semi-deciduous Forest in the São João do Oeste municipality, Santa Catarina, southern Brazil (27°06'41''S, 53°35'47''W). B) Larva of *Tortrimosaica polypodivora* (Tortricidae) observed within the chamber: black arrow indicating three pairs of legs and the white arrow indicating a pair of pseudopods. C) Adult (above) and pupa of *Tortrimosaica polypodivora* (Tortricidae) associated to *M. mortoniana.*

(Langsd. & Fisch.) Copel.; Farias *et al.* (2019) reported galls associated to four species of Polypodiaceae. According with Santos, Hanson, Maia, Mehltreter (2019), the worldwide highest gall richness in ferns occurs in the recent clade of Polypodiales (specifically the Eupolypods), being Polypodiaceae the lineage with the highest gall records (21 spp. registered). Considering that *Microgramma* is represented in Brazil by 18 species (Flora do Brasil, 2020), and galls has been recorded in four *Microgramma* species (*M. percussa*, *M. squamulosa*, *M. vacciniifolia* and *M. mortoniana*, (Santos *et al.*, 2019 and this paper), it's possible that the number of inducing galls insects associated with the genus could be greater than currently recognized.

The galls observed in *M. mortoniana* present similar characteristics with those reported to *M. squamulosa* by Kraus, Montenegro, Kim (1993), also caused by an insect belonging to the family Tortricidae (Lepidoptera), erroneously cited as Gelechiidae (Brown *et al.*, 2004). However, in *M. mortoniana* the galls are smaller (12 mm x 9 mm) when compared to the galls observed in *M. squamulosa* (25.5 mm x 18 mm) (Kraus, Montenegro, Kim, 1993). In some works as Flora do Brazil (accessed 2020), *Microgramma mortoniana* is considered a synonym of *M. squamulosa*, whereas in Flora Argentina (Ponce & Arana, 2016) and Zuloaga *et al.* (2019), *Microgramma mortoniana* is considered a valid species. We prefer to follow Ponce & Arana (2016) treatment, because these species can be differentiated by many morphological characters; besides foliar dimorphism and sizes (de la Sota, 1973), *M. mortoniana* differs from *M.*

squamulosa in having rhizome scale margins sparingly ciliate, cilia never overlapping; glabrescent lamina and foliar scales ciliolate, and sori paraphyses slightly branched, with the branches as long as the stalk, and branch cells medium to long, at least twice as longer as wide (vs. rhizome scale margins markedly ciliate, cilia overlapping; lamina glabrous and foliar scales strong ciliate, and sori paraphyses very branched, with the branches shorter than stalk, branch cells short, almost as long as wide in *M. squamulosa*). Also, they differ in chromosome number (n= 74 for *M. mortoniana*, and n= 37 for *M. squamulosa*, de la Sota & Cassa de Pazos, 1980; de la Sota, Ponce, Cassá de Pazos, 1987). *M. mortoniana* present a more restricted distribution, ranging from Southern Brazil to Uruguay and Argentina.

Galling insects probably evolved from selective pressures which favored the manipulation and induction of tissues with better nutritional qualities, protection against environmental stresses and natural enemies (Price *et al*. 1987). These galling vectors, are usually species-specific occurring in only one host-plant species with extremely rare exceptions (Fernandes, Coelho, Santos, 2014), as is the case of the tortricid *Tortrimosaica polypodivora* Brown & Baixeiras, 2004, observed previously in the rhizomes of *M. squamulosa* and *M. vacciniifolia* (Santos, Hanson, Maia, Mehltreter, 2019) and now observed in *M. mortoniana*. Considering the hybrid origin of *M. mortoniana*, being *M. squamulosa* and *M. vacciniifolia* the putative parents, as reported by de la Sota (1973) and de la Sota *et al.* (1987), the questions could which arrive are if the biochemical interactions required to induce developmental changes in the host plant remain similar in fern close relative species; or if the species-specificity is lower in derived fern genera/species/groups, thus allowing that the same galling insect could present association with very close relative species. Another interesting question is if the geographic distribution of the gall-insect accompanies the distribution of associated species as *M. mortoniana*, which would expand the area of occurrence of *Tortrimosaica polypodivora* to a latitude close to 40º S, in Argentina. The sampling effort aimed to recognize and analyze new associations and interactions between galling inductors and ferns and lycophytes, is essential for answering these questions.

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