PHYLLOCAULIS GAYI (PULMONATA: SYSTELLOMMATOPHORA):
A NEGLECTED GRANIVORE IN CHILEAN TEMPERATE FORESTS?

PHYLLOCAULIS GAYI (PULMONATA: SYSTELLOMMATOPHORA):
¿UN GRANIVORO DESCONOCIDO EN LOS BOSQUES TEMPLADOS DE
CHILE?

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ABSTRACT

Evidence is advanced suggesting that *Phyllocaulis gayi*, a large slug in the temperate forests of Chile, might be a significant but overlooked granivore. In a short-term experiment, up to 18% of seeds are preyed upon by *P. gayi*. The intensity of seed predation is significantly reduced in forest fragments.

KEYWORDS: Forest fragmentation, granivory, invertebrates, *Nothofagus*, *Phyllocaulis*.

RESUMEN

Presentamos evidencia que *Phyllocaulis gayi*, una babosa de gran tamaño, podría ser un granívoro ignorado en los bosques templados de Chile. En experimentos de corto plazo, un 18% de las semillas son depredadas por *P. gayi*. La magnitud de la depredación es significativamente reducida en fragmentos de bosque.

PALABRAS CLAVES: Fragmentación de bosques, granivoría, invertebrados, *Phyllocaulis*.

INTRODUCTION

Slugs are generalist herbivores (Cates & Orians 1975). Although they include fruit in their diet and even may act as seed dispersers (Gervais *et al.* 1998), they have been largely neglected as seed predators (Hulme 1998). In the temperate forests of Chile for instance, rodents, birds, some insects and even fungi are regarded as seed predators (Bustamante 1996), but no data is available on the potential role of slugs as frugivores or granivores.

Phyllocaulis gayi (Fisher 1871) is a terrestrial slug inhabiting forests from Valparaíso south to Chiloé in Chile (Stuardo & Vega 1985). This large slug (up to 10 cm long, 2 cm wide) might be one

such neglected granivore. While assessing granivory rates in fragmented forests in central Chile, we recorded several individuals of this species consuming seeds. Herein, we report such finding aiming to understand the ecological roles of slugs in temperate forests.

MATERIALS AND METHODS

As part of a comparative research on the effects of forest fragmentation upon granivory in temperate and tropical forests, we have assessed the rate of seed removal in continuous forests and nearby fragments in central Chile (temperate forest) and

Beni, Bolivia (tropical forest). To properly compare such rates, we have used the same seed in both forests, but this seed is novel to all consumers herewith avoiding differences in removal rate resulting from previous exposure to the seed. As test seed we used cotyledons of peanuts (*Arachis hypogea* L.). Our study site in Chile comprised a large tract of Maulino forest, dominated by *Nothofagus glauca* (Phil.) Krasser protected at the Reserva Nacional Los Queules (35° 59'S, 72° 41' W) and four small fragments located in their immediate vicinity.

During January 2001, 160 stations were set up in continuous forest, and another 160 stations in forest fragments, 40 stations per fragment. Each station comprised 10 cotyledons of *A. hypogea*. At each locality, half of the stations (80) were protected against vertebrates with a wire mesh, and half of these (40) were also protected against insects with a stick trap. This design attempted to discriminate between removal by vertebrate and invertebrate consumers, respectively. Seed consumption was evaluated after 24 h.

In order to explore if *P. gayi* preys upon native seeds and fruits, during the fruiting season of 2002, we run a laboratory experiment, offering seeds of three common species from the Maulino forest: *Aetoxicum punctatum* R. et Pav., *Cryptocarya alba* (Mol.) Looser and *Persea lingue* (R. et Pav.) Nees ex Kopp to five captive *P. gayi*. These seeds are similar in size to the cotyledons of *A. hypogea* offered under field conditions. Five seeds of each species were simultaneously offered to single individuals of *P. gayi*, caged in plastic boxes (35 x 25 x 6 cm), with forest litter as substrate. Consumption was evaluated after 48 h.

RESULTS AND DISCUSSION

Under field conditions, unequivocal evidence of seed consumption by *P. gayi* was found either direct observation of the slugs eating seeds, by the eroded surface of the seed remains after *P. gayi* had fed on them, by the presence of slime around and over the seeds, as well as by following slime trails from the consumed seeds to the individual slug. In the cases where *P. gayi* was observed feeding on seeds, it always was a single individual. Under lab conditions, we considered

preyed those seeds with an eroded surface.

Overall, 6.6% (21 out of 320) seed stations set in the field were preyed upon by *P. gayi*, accounting for 14.2% of all seed stations preyed upon by all consumers (21 out of 148). Seed predation by *P. gayi* was slightly but not significantly lower in stations protected against vertebrates (wire exclosure) than in open access stations: 8 vs 13 cases, respectively (proportion test, $z = 1.1$, $P = 0.13$). There was no difference in the number of stations preyed according to protection with sticky traps: seeds from 10 stations with sticky traps were preyed versus 11 stations without sticky traps preyed upon. However, granivory by *P. gayi* was twice as high in the continuous forest than the forest fragments (9.4% vs 3.8%, out of 160 stations respectively; proportion test, $z = 2.0$, $P = 0.02$). Regarding preyed stations only, *P. gayi* accounted for 18.3% of seed predation in the continuous forests and 9.1% in the fragments (proportion test, $z = 1.6$, $P = 0.05$).

In the lab experiment, all five slugs consumed seeds of native trees but discriminated among them. No single seed of *P. lingue* was consumed, but 48% (12 out of 25) of *C. alba* seeds and 60% (15 out of 25) of *A. punctatum* were preyed upon. On average, each slug preyed on 2.4 ± 0.8 *C. alba* and 3.0 ± 0.4 *A. punctatum* seed / 48 hrs.

Although our field experiment was based on a seed type exotic to the temperate forests of Chile, coupled to our lab experiment, it suggests that *P. gayi* is a potential granivore of the propagules of native plant species. Granivory by *P. gayi* accounts for a significant fraction of the seeds preyed upon in the continuous forest, suggesting that its effect upon seed survival should not be overlooked when assessing forest regeneration (Donoso 2000). This is particularly important when unraveling the changes upon plant-animal interactions brought by forest fragmentation. In the Maulino forest, a severely fragmented and threatened forest (Grez *et al.* 1997), seed predation is higher in forest fragments than in the continuous forest, possibly due to higher abundance of granivorous insects, small mammals and birds there (Donoso 2000). In contrast, forest fragmentation seems to depress granivory by *P. gayi*, perhaps if affecting habitat conditions, as fragments are drier than the continuous forest (Hernández 2002), which may impinge upon the abun-

dance of *P. gayi*. Whatever the cause, like other slugs capable of affecting seed germination rates as well as the distribution of plants (e.g. Gervais *et al.* 1998, Bruelheide & Scheidel 1999), *P. gayi* might impinge upon forest regeneration, and like other terrestrial molluscs, should no longer be neglected as granivore, deserving closer attention than hitherto they have been given.

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