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Land planarians (Platyhelminthes, Tricladida, Terricola) as indicators of man-induced disturbance in a South Brazilian rainforest

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SLUYS (1998) (1) proposed the usefulness of terrestrial flatworms as bioindicators of the state of soil and forest conservation. He suggested that by comparing Terricola diversity between disturbed and undisturbed ecosystems, the forest conservation status could be inferred. He also proposed this taxon as a good indicator of areas of high general biodiversity (2).The present study aimed to answer two main questions: **a)** is land planarian diversity affected by human disturbance? **b)** are there groups of land planarian that might indicate such disturbance?

The study site, the National Forest of São Francisco de Paula, Southern Brazil, was originally covered by a mixed subtropical rainforest with araucaria pine (*Araucaria angustifolia*). We selected four habitats based on increasing levels of disturbance: subtropical rainforest with araucaria (NA), subtropical rainforest with selective araucaria logging (N), reforestation with araucaria (A), and reforestation with the allochtonous *Pinus elliottii* (P). In each habitat we selected four transects, and in all the resulting 16 transects were conducted 2 surveys per month throughout a year. We calculated the Shannon-Wiener diversity index, *H*' (3) for each habitat. The Morisita's index, C_λ, (3) was used to estimate the similarity between habitat species composition. These indexes were compared to detect significant differences between diversity indices of pairs of habitats (*t* test: 4). The *G* test was applied to detect differences in species composition among the four transects of the same habitat and among the four habitats (4). We used the software program PC-ORD, version 3.18 (5), for the hierarchical cluster analysis of the transects and for species and transects ordination (detrended correspondence analysis, DCA).

We found 402 individuals, 23 of which could not be identified. The other 379 specimens belong to 28 species (Table 1). The greatest number of individuals was recorded in (A) (47.2% of the observed total), and the lowest number of individuals (14%) in (P). *Geoplana ladislavii* Graff, 1899 (32.4% of the total) and *Geoplana* sp. 1 (18.7%) were the most abundant species in the four habitats. The diversity indexes, *H*', of the habitats could be arranged in the following ascending order: H'_P=2.849; H'_A=2.856; H'_{NA}=3.272; H'_N=3.467. The highest similarity index among habitats was C_λ=1 039, between (NA) and (N); the smallest one, C_λ=0 823, between (N) and (P). We detected significant differences between diversity indexes (*t* test) for the following pairs of habitats: (N) and (A), and (N) and (P) [$p<0.01$ for both pairs]. Significant differences were found in the specific composition of the four habitats [G=179.569, p=0.000], and of the transects of two habitats, (NA) [G=67.896, p=0.015] and (P) [G=51.090, p=0.010]. We did not find significant differences in the specific composition of the other two habitats, (N) [G=60.755, p=0.102] and (A) [G=58.552, p=0.141]. The ordination and the hierarchical cluster analysis of the species composition of each transect showed the existence of three main groups. The *G* test confirmed this transect grouping. The main axis of the DCA corresponds with a decreasing disturbance gradient, with best preserved transects/habitats located on one side and the most disturbed ones on the other. We identified two groups of species correlated with the main axis: the first group is composed by species, significantly and positively correlated with that axis: *Geoplana* sp. 2, *Geoplana* sp. 7, and possibly Geoplanidae 3 and *Notogynaphallia* sp. 2., with a marginally significant level (p=0.054 and p=0.057, respectively). Species belonging to this group occurred almost exclusively in non-disturbed habitats and may be indicating less altered forest. The second group is composed of species significantly and negatively correlated with that axis: *Choeradoplana* sp. 1, *Geoplana* sp. 3, *Notogynaphallia marginata*: Marcus, 1951 and *Xerapoa* sp. 1. These species showed a preference for disturbed areas and may represent indicators of more disturbed habitats. Our results suggest that terrricolan distribution is dependent on habitat disturbance. The low species abundance and richness in (P) may be explained by its small complexity and paucity of refuges. Contrarily, there seems to exist a high number of favorable microhabitats for terricolans in (A), probably because of the less compacted soil and the great number of araucaria fallen logs. Despite the low number of individuals observed in (NA) and (N), the flatworm diversity

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TABLE 1

Abundances of species of geoplanids (Platyhelminthes: Tricladida: Terricola) in four habitats of the National Forest of São Francisco de Paula, RS, Brasil. (A): reforestation with araucaria pine; (N): subtropical rainforest with selective araucaria pine logging; (NA): subtropical rainforest with araucaria pine, *Araucaria angustifolia*; (P): Reforestation with *Pinus elliottii*.

Species	**(A)**	**(N)**	**(NA)**	**(P)**	**TOTAL**
Geoplana ladislavii Graff, 1899	73	16	17	17	123
Geoplana sp. 1*	37	10	16	8	71
Geoplana sp. 2*	11	13	13	-	37
Choeradoplana sp. 1*	5	3	7	7	22
Geoplana sp. 3*	4	4	4	8	20
Geoplana sp. 4	17	-	-	-	17
Notogynaphallia marginata Marcus, 1951	6	1	2	5	14
Geoplana sp. 5*	3	3	4	2	12
Geoplanidae 1**	5	3	-	-	8
Geoplana sp. 6	1	3	3	1	8
Choeradoplana sp. 2*	4	1	-	1	6
Geoplanidae 2**	1	2	3	-	6
Notogynaphallia sp. 1*	5	-	1	-	6
Geoplanidae 3	-	4	1	-	5
Notogynaphallia marginata Graff, 1899	2	-	1	-	3
Notogynaphallia sp. 2*	2	1	-	-	3
Pasipha sp. 1*	-	-	2	-	2
Choeradoplana sp. 3*	-	2	-	-	2
Notogynaphallia sp. 3*	-	2	-	-	2
Geoplanidae 4	2	-	-	-	2
Xerapoa sp. 1	-	-	-	2	2
Notogynaphallia sp. 4*	-	1	1	-	2
Geoplanidae 5**	-	-	1	-	1
Pasipha sp. 2	-	-	1	-	1
Geoplana sp. 7	-	1	-	-	1
Geoplana pavani? Marcus, 1951	1	-	-	-	1
Geoplana sp. 8	-	-	-	1	1
Geoplanidae 6	-	-	-	1	1
not identified	4	11	5	3	23
TOTAL	183	81	82	56	402
Specimen proportion	47.2	18.8	20.3	14.0	100.0
Species richness	17	17	16	11	28
Diversity index (*H'*)	2.856	3.467	3.272	2.849	-

* sp. nov.
** gen. nov., sp. nov.

was high, probably reflecting a larger variation in habitat characteristics.

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