60×. Drawings were made at 40× with the aid of a drawing tube (Nikon, Inc.),

One species of *Saprolegnia* was isolated from the samples: *Saprolegnia ferax* (Gruith.) Thuret. (Fig. 2a-c)

Culture., —In CMA with *C. sativa* seeds, the colonies appeared white, dense or compact with short filaments submerged on media.

Diagnostic. —Monoic thallus, Exposed hyphae with ramifications, curved and branched; variable diameter and length, Zoosporangia 42.4 × 8.0 μ, slender-fusiform. Primary zoospores absent; with secondary reniform laterally biflagellate zoospore (Fig. 2a). Oogonia not in chains, spherical, (Fig. 2b, c) 67.0 μ in diameter, laterally formed in thallus. Oogonial walls without ornamentation; with conspicuous scars, l.7–1.,3 µ in diameter. Mature (Fig. 2b) and immature (Fig. 2c) centric oospores. Mature oospores spherical or elliptical, 38.9 -41.2 μ in diameter. Without antheridial branches or antheridial cells,

Our isolate was compared with *S. delica, S. ferax* and *S. torulosa.* Oogonial shape was between *S. delica* and *S. ferax,* but different to *S. torulosa.* Oogonial wall showed many conspicuous scars similar in size to those of *S. ferax,* but different to those of *S. delica* and *S. torulosa.* Oospores were similar in quantity, size and shape like in *S. ferax,* but different from *S. delica* and *S. torulosa.*

Achlya americana Humphrey was found in 98% of the samples. Only 2% contained *S. ferax.* The low occurrence of *S. ferax* in Charco Azul differs from the results obtained by Kuehn and Koehn (1988) with water molds in Edwards Aquifer, Texas. However, the abundance of *S. ferax* was similar to that reported by Rossy-Valderrama (1956) and Galler-Rimm (1982) for other *Saprolegnia* species,

Deeper sampling into the El Convento Cave and at the stream sink should reveal whether the fungi reach the pool from the surrounding area, or come from surface streams above the cave.

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Preliminary Estimate of Landslide Disturbance in the Blue Mountains, Jamaica

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The disturbance regime and consequent regeneration dynamics of montane forests differ from lowland forests. In montane forests, treefall gaps are small (Murray, 1986; Lawton and Putz, 1988) and in some forests appear to be rare (Grubb and Stevens, 1976; Tanner, 1977). This is in part because the canopy height is typically quite short (< 20 m), and in some forests because trees predominantly die standing. In the Caribbean, hurricanes are a major agent of gap formation, however tree mortality even after severe hurricane strikes is frequently low (e.g., Frangi and Lugo, 1991; Bellingham et al., 1992); surviving trees rapidly refoliate through epicormic sprouts and as a consequence hurricane gaps tend to be highly transient, Large and persistent gaps are characteristically formed by landslides. We asked what is the potential importance of landslides for the regeneration of gap-dependent species in montane rainforest in Jamaica by estimating landslide disturbance and turnover rates for a section of the Blue Mountains, eastern Jamaica.

The Blue Mountains have a complex geology of igneous intrusive and extrusive rock, tertiary sandstone and shales, and limestone, Forests extend from 1300 m to the ridge crest on the leeward (southern) slopes of the range, and down to 500–1000 m elevation on the windward (northern) slopes. Slopes are steep, and the topography is highly dissected. Eight montane forest types have been identified, and are described in detail by Grubb and Tanner (1976).

Given the paucity of data on landslide occurrence in the Blue Mountains, and the lack of historical aerial photographs, we made an estimate of the area affected

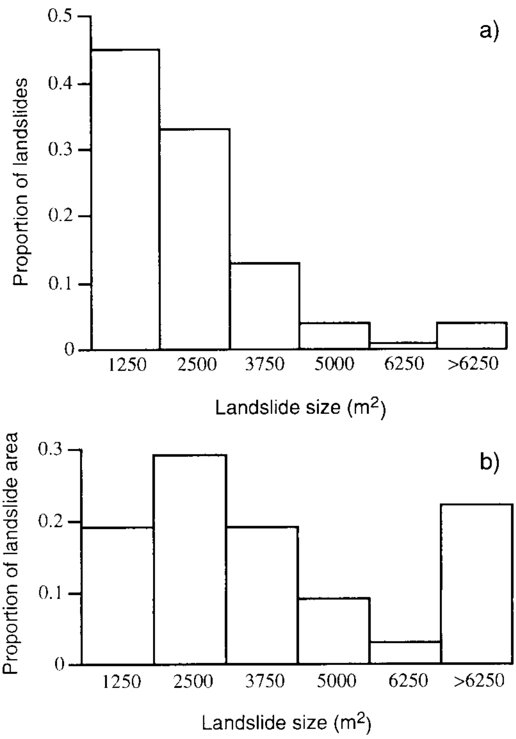

FIG. 1. (a) Frequency distribution of landslides by size class, (b) proportion of total landslide area by size class.

by landslides using one set of color aerial photographs taken in March 1992 at a scale of 1:25,000. Based on our ground-surveying experience in the Blue Mountains, we subdivided the images according to recently human-disturbed and undisturbed areas. Subsequently, only undisturbed areas were considered. Individual landslides were examined stereoscopically, and then the planar areas calculated assuming a rectangular shape. The minimum resolvable area of individual landslides on the image was 1 mm^2. This corresponded to a planar area of 625 m’.

A total of 166 landslides were recorded with a combined planar area of 40 ha. The total planar area surveyed was 21.806 ha. and the area affected by landslides was 0.19%. Most landslides were in the smallest size class <1250 m^2 (Fig. la), while landslides in the 1250-2500 m’ size class accounted for the highest proportion of the total area affected (Fig. lb). We assume that landslides would be visible on aerial photographs for ten years (after ten years the erosion surface of landslides changes color following the establishment of a lichen sward, and the deposition zones are fully revegetated; Dalling, 1994). This yields an estimated landslide disturbance rate of 1.9% per century.

Our results are similar to published data of landslide disturbance, excluding earthquake-caused landslides (Table 1). Guariguata (1990) also found that in the Luquillo Mountains of Puerto Rico the highest frequency of landslides was in the small size class of 200-400 m^2, while the largest area affected was for landslides >1800m^2. Differences in mean landslide size between the Luquillo Mountains (700 m’) and the Blue Mountains (2400 m’) may as much be due to a skewing of the size distribution we report here arising from an inability to distinguish landslides <625 m^2, than to any real difference in landslide sizes in the two areas. Nevertheless, the disturbance rate we estimate is an order of magnitude greater than that reported by Guariguata (1990). In contrast, Larsen and

TABLE 1. Comparison of landslide disturbance rates.

Site	Disturbance	Total area in landslide	Percentage of area affected	Disturbance rate (% per century)
This study	hurricane/erosion	40 ha	0.19	1.9
Puerto Rico[1]	hurricane/erosion	3.25 ha	—	0.08-0.3
Puerto Rico[2]	hurricane	6,63 ha	0.11	1.1
Venezuela[3]	erosion	2.3 ha	0.2	2.0
Papua New Guinea[4]	erosion	—	—	3.0
Panama[5]	erosion	—	—	2.0

[1] Data from Guariguata (1990) from 52 year aerial photograph chronosequence. Landslide areas estimated from 1:20,000 topographic map.

[2] Data from Larsen and Torres Sánchez (1992) for Luquillo Mountains following Hurricane Hugo.

[3] Data from Cannon (unpublished undergraduate thesis, University of Cambridge, UK). Area calculated from photographic projections, and landslide age determined from 1:20,000 aerial photographs.

[4] Data for Berwani and Toricelli Mountains in Simonett (1967), disturbance rate calculated by Garwood et al. (1979).

[5] Data from Garwood et al. (1979) based on estimates of landslide area from aerial photographs.

Torres Sánchez (1992) calculated a much closer disturbance rate of 1.1% per century also for the Luquillo Experimental forest, post Hurricane Hugo. They attributed the low disturbance rate of Guariguata (1990) to the poor quality of aerial photographs used, and the low number of landslides mapped. Comparisons of our data with Larsen and Torres Sánchez's data post-hurricane are also more appropriate because our photographs were taken three and a half years following Hurricane Gilbert, a storm of comparable magnitude. However, we were unable to distinguish landslides pre-existing the hurricane from those triggered by it.

Guariguata (1990) reported that light demanding ferns, herbs, and the mature forest tree species *Cyrilla racemiflora* almost exclusively benefit from landslide openings, In the Blue Mountains of eastern Jamaica a range of mature forest tree species establish on landslides and are absent from the forest understory, or treefall gaps that lack soil disturbance. These species include *Cyrilla racemiflora, Vaccinium meridionale, Lyonia octandra* and *Myrica cerifera* (Dalling 1994). Although these species may not regenerate exclusively on landslides, landslide disturbance rates do seem sufficient to account for the regeneration of some montane forest species. These disturbance rates are much lower than those recorded for treefall gaps (generally around 100% per century, Brokaw, 1982; Hartshorn, 1990), but landslides are far more persistent gaps. Landslides within our study site in the Blue Mountains were estimated to persist for 500 years (Dalling, 1994). Consequently, the time period during which plants can successfully establish on landslides is much longer.

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