Tropical Forests Tomorrow - No future?

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Tropinet

Volume 15, No.1 April 2004 Supplement to BIOTROPICA Vol 36 No. 1

ASSOCIATION FOR TROPICAL BIOLOGY AND CONSERVATION

Organization for Tropical Studies

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Tropinet is accessible on the ATB Website at http://www.atbio.org.

Production Editor: **Carol Mozell**, OTS
Design by **Katherine Hartman**

"If human societies can then exercise the self-restraint to utilize rain forests by working within their natural limits the cries of doom and gloom of the late 'eighties will have served a useful purpose. This is a big 'if'." Timothy Charles Whitmore (1990, p. vi) (1935-2002).

Forty years ago, in the French movie "That Man From Rio" (1964, by film maker Philippe de Broca), Jean-Paul Belmondo played a French airforce pilot who sets out to rescue his girlfriend, who has been taken to Brazil to help locate a lost treasure in the mythic Amazonian rainforest. In the beginning of this Hollywood-like adventure, one sees Adrien running through the young city of Brasilia, passing modern, concrete and futuristic buildings, driving along concrete, strip avenues. For a few seconds, behind the action, one can glimpse a tropical forest at the city edges. At nearly the same time, in 1963, the Association for Tropical Biology [and Conservation] (ATBC) was created. In parallel, Tim Whitmore was starting his promising career. More than a year after he passed away in 2001, Whitmore was celebrated and honoured during the ATBC-British Ecological Society meeting held July 7-11, 2003 in Aberdeen, Scotland, UK (www.atbio.org). Now, at the turn of the second Millennium, we learn that deforestation rates in the Amazon steadily increased between 1990-2000. Unfortunately, future scenarios, either pessimist or optimist, still suggest a grave loss of tropical habitats. Paraphrasing Tim Whitmore in his famous book *An Introduction to Tropical Rain Forests* one may ask, is there a future for tropical rainforest?

Indeed, the penultimate ATB annual meeting, entitled "Tropical Forests: Past, Present, Future," was held July 29- August 2, 2002 in Panama City, Panamá. Coincidentally or not, the title recalls the last chapter of Whitmore (1990), entitled "Tropical rain forests yesterday, today, and tomorrow." Time indeed is an important, if not crucial factor in science, especially for the conservation of tropical forests. Forty years clearly means nothing for those giant trees of the tropical rainforests, but it encompassed virtually the entire career of Tim Whitmore, who dedicated his life to the study of the southeast Asian tropical rainforests, their diversity and their conservation (Chazdon 2002). Tropical giants are indeed disappearing, in the double sense, and we are facing the future with that strange bitter taste in the mouth. What have we done so far during these past four decades? What remains to be done during the next 20, 40 years? What is our next challenge? In other words, how much time do we have left to study, protect and conserve what will soon remain of tropical forests? At the scale of the forest one may answer, "so little;" at the scale of human life, the answer may be "so much." But these questions have been the focus of many papers and symposia at the recent ATBC meetings in Panamá and Aberdeen.

Years ago, as Chazdon and Whitmore's edited book reminds us (Chazdon and Whitmore 2002; Zagt 2003), tropical biologists like Daniel Janzen (Janzen 1970), honoured 2002 ATBC fellow, and Joseph Connell (Connell 1971; Connell 1978), 2003 ATBC fellow, inspired many young biologists to focus their work to increase our understanding of tropical forest systems. Over these past three decades, a plethora of scholarly works have been published on the biology and ecology of tropical forests. Meanwhile, roads have been laid and forests cleared (e.g. Laurance 1999). In the early 1970s, fragmentation and logging were not generally issues being debated by biologists. The ATB was just beginning, with only a few members, nearly all from the neotropics. As early as 1970, Joe Connell was inspired to start long-term studies on seedling recruitment, ending recently with 30 years of data (Connell and Green 2000). In the 80's, ecological processes were starting to be studied and published, especially emphasizing plant-animal interactions. Young researchers started permanent plots (Hubbell and Foster 1983), which have resulted in a substantial body of published

work (Hubbell et al. 2001), and have also inspired work on many other subjects related to tropical forest biology (Harms et al. 2001; Harms et al. 2000; Wright et al. 1999).

In parallel, starting in the late 70's, visionary scientists concerned by the destruction of tropical forests started long-term projects related to agriculture and forest fragmentation (Lovejoy et al. 1984). The BDFF project alone, today, has gathered more than 22 years of data, and has generated over 500 papers and theses (Bierregaard et al. 2001, Laurance et al, 2001) (Figure 1). One may additionally remark that over the 80's, ecological processes, such as pollen and seed dispersal, remained poorly analysed in all these fragmentation studies. The Janzen-Connell 'seeds' were maturing, passing from one generation to another toward the end of the Millennium. Then, in the 90's, the vast deforestation rate of the last decades and the dedicated work by hundreds of biologists bore fruit, and the "seeds" reached adulthood, disseminating quickly into all scientific communities. At last, foresters and managers started to acknowledge that trees recruited poorly beneath or away from parent trees, a simple matter of fact for most ecologists as early as in the 80's. As often emphasized during the Aberdeen meeting on "Biotic interactions in the tropics," seeds that are not dispersed away from the parent are heavily attacked by vast populations of invertebrate and/or vertebrate seed and seedling predators that are no longer limited by top-predator pressures. How long will these trees survive without effective dispersal? Dan Janzen said that such isolated standing trees were reproductively dead (Janzen 1971), and later, Kent Redford coined the empty forest concept (Redford 1992). Today, the future of tropical rainforests, especially that of the Amazon (Laurance et al. 2002a) seems quite uncertain. In other words, are today's rain forests dying, transformed into collapsing fragments with no possible resilience?

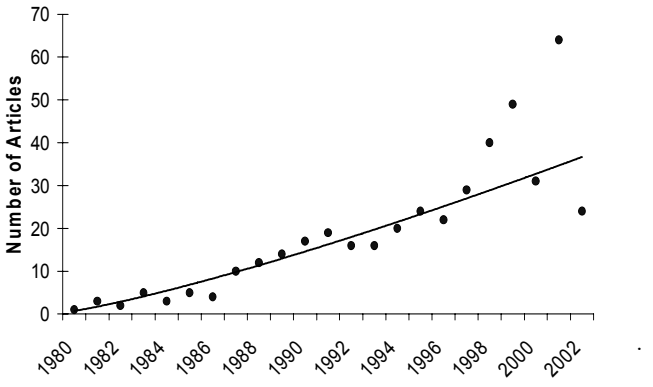

Figure 1. Publication rates (1980-2003+ in press) of the Biological Dynamics of Forest Fragments Project in Manaus, Brazil (database online at www.inpa.gov.br/pdbff). (Power function: $R^2 = 0.872$, $df = 1,22$, $F = 150.33$)

The 80's generation, those who are now 40+ years old or so, were very young, virtually babies when ATB was created, and our challenge was to study tropical ecology, in a time when we had many more questions than answers. The unknowns of the tropics were what drew us. We put together a vibrant scientific community studying seed and seedling biology, and then, facing increasing demand by managers, we progressively shifted our questions to more applied topics, studying the effects of logging, fragmentation, edge effect, land use, etc... We thus became tropical conservation biologists, just as the ATB's name officially changed to ATBC this year. Our initial goals and purposes have also changed, as shown by the increasing interest in studies on fragmentation, hunting and other human impacts, restoration, land use and management of forest production, conservation, remote sensing and global climate change during the most recent ATB(C) annual meetings. We urgently need to protect and conserve the forest, especially to save those small and large seeds without which forest restoration and maintenance of diversity is impossible. In the majority of cases, without dispersers, most seeds are dying, and then without seedlings, there is no recruitment. Fragmentation affects gene and seed flow, while logging, hunting and other human pressures dramatically affect animal and tree communities as a whole.

Let's take an example, that of a so-called 'sustainable resource.' Giant Brazil nut trees (*Bertholettia exelsa*, Lecythidaceae) are bee- pollinated (Mori and Prance 1990) and rodent-dispersed (Peres and Baider 1997). We now know that forest fragmentation affects both of these crucial plant-animal relationships for plant regeneration via disappearance of native pollen- and seed-dispersal agents (Bierregaard et al. 2001; Dick 2001; Powell and Powell 1987). The 'seed' resource is then no more sustainable for animals, as it is for the forest or for humans. Though cutting trees is illegal, standing trees in pasture are indeed reproductively dead *sensu* Janzen (1971). And there is virtually no hope that those giant isolated trees will be dispersed and will recruit (See Peres et al. 2003) in such empty forests *sensu* Redford (1992). The challenge is even greater than in the early 60's or 70's, but time is passing so fast, too fast at human scales. Amazonian forest has disappeared rapidly during the last ten years (Laurance et al. 2001). The Biological Dynamics of Forest Fragments Project (BDFFP) started 24 years ago, and we have learned many lessons from that important program (Bierregaard et al. 2001). In the last decade since the release of the first edition of Whitmore's book (1990), the publication rates of the BDFFP have steadily increased, with up to 71 Ms and Ph.D. theses, 482 articles and book chapters (updated September 2003, Figure 1) on the effect of forest fragmentation in the Amazon (Laurance et al. 2001). At the same time, paradoxically, deforestation rates also continue to increase, especially during the last decade (1990-2000).

One might then question whether these two decades of intensive studies will help to slow down the process of deforestation in tropical rainforest as a whole, and in South America in particular? Hopefully yes, but maybe not. And we need to exert just as much effort today, to learn about the effects of human pressures on the forest, as was expended in the past, to decipher the effects of fragmentation. Paradoxically, the more we learn about rainforests, the faster they are disappearing, while the carbon from burning trees evaporates into the atmosphere or sinks into the oceans. According to predictions based on deforestation rates (Laurance et al. 2001) and rates of disappearance of the Amazonian forest flora (Laurance et al. 2000a) and fauna (Laurance et al. 2000b), twenty years from now it will be just too late. Despite the critical lack of studies to demonstrate it, one of the key conservation lesson we learned from the BDFFP is that "trees in fragments and surrounding altered habitats may play an important role in regeneration by providing a source of seeds and attracting seed dispersers out of nearby primary forest" (Benitez-Malvido 2001). We thus urgently need to conserve those reproductive trees, inside fragments and outside, and to replant those seeds, just as Kayapo Amerindians propagate plants in a variety of forest habitats (Posey 1992, and pers. comm.), just as do rodents in neotropical forests as a whole. Seeds need to be planted in more than one way. They need to be planted in people minds, to inspire and to change the daily routine of scientists in investigating tropical questions. But they also need to be planted in pasture, in secondary forest patches and fragments, and in green houses, which are our equivalent of zoos, but for disappearing plants. Large, recalcitrant tropical seeds cannot be stored in Museums, and it is indeed only through such extensive plantations that we may save the forests and prevent the mass extinction of species that is looming on the horizon. But then, if we can restore the forests, and maintain those large-seeded lynchpins of tropical diversity - then, animals will come back if they are still available in the surrounding 'full' forest.

In his second edition, Tim Whitmore modified the 10th and last chapter. He used it as a springboard to pose not just one, but two questions for our generation. "Tropical rain forests yesterday and today" was altered to become a new, 11th chapter entitled "Tropical rain forest at the cusp of the new Millennium." In this new version of Whitmore, emphasis on 'conservation' disappeared. Instead, his text mainly focused on 'management', 'forest certification', 'land use' (including forest production, plantation, and fragmentation), and 'priorities for action.'

And so here we are now. The third Millennium carpet is unrolling in front of us just as deforestation is leaving behind empty biotopes and collapsing forest patches. Some 40 years later, after re-reading the most recent papers of Laurance et al. (Laurance et al. 2001; Laurance et al. 2000a), and once again the 10th and 11th chapters of the two editions of Whitmore's

books, should we claim today that there is 'no future' for tropical rain forests tomorrow? After studying for nearly two decades in neo-tropical forests, I was actually lucky enough to be able to revisit seedlings, and I may still have some good chance to do that for the next 20 years.* Very few scientists may have such a great chance (Connell and Green 2000). Tropical rainforests and study sites are disappearing forever, just as is the exotic and fantastic Amazon which so much fascinated and intrigued the audience watching the tribulations of Jean-Paul Belmondo in Brazil in the early '60s. Perhaps we do best to recall, in closing, Tim Whitmore's words (first edition, p. 195) which somehow perfectly summarize our feeling in this early Millennium: "We live in an interesting Age. What will our descendents think of us as they look back? All is not yet lost of the world's tropical rain forests but it is difficult to be optimistic about their future."

Today, Tim Whitmore would certainly still be optimistic, especially after learning that the Brazilian government, on August 22, 2002, created the world's largest rain forest National Park in Northern Amazonia. The new park, 3,870,000 hectares in size, is located in Brazil's state of Amapa along the boundary with Guyana, Suriname and French Guiana. The protection of this tract of remote, unexplored Guianan-type rain forest is definitely a step forward in the conservation of this unique habitat. The size of Belgium, the park, however, protects an area that represents only 20 percent of the mature Amazonian forest that has been lost between 1990-2000, (i.e. more than 18 million hectares) (Laurance et al. 2001). We have much, much more that remains to be done. Our energy needs to be directed, all over the world, to studying the ecology and conservation of tropical forest diversity. And we need to do this now, and in the next 20-40 years, all the time working to be sure that, at the same time, this diversity will not then vanish forever.

*Post-scriptum: Since I wrote this paper, an important goldmining rush is expanding into the Nouragues Reserve, and the future of this Guianan forest has now, also, become very uncertain.

Acknowledgements. I am indebted to Rita Mesquita for sending me the most updated references from the BDFFP (www.inpa.gov.br/pdbff) and to Bill Laurance and Tad Theimer for encouragements to publish this essay.

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