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**LUMPY INTEGRATION OF TROPICAL  
WILD BIODIVERSITY WITH ITS SOCIETY**

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**Philosophy**

Wildland biodiversity: use it or lose it. Use it without damaging it, without lasting impact. This is biodevelopment - development of wildland biodiversity as wildland biodiversity. Be a real estate developer. Bug Acres. Swampy Hollow. Froggy Woods. Monkey Haven. Ocean View Heights. Save it, know it, and use it are the three commandments.

Conservation is place-based. Solutions are developed from the biodiversity and sociocultural traits of the place being conserved. The particular biodiversity development site I will discuss here is the Area de Conservación Guanacaste (ACG) in northwestern Costa Rica (<http://www.acguanacaste.ac.cr>). As one moves to other tropical places, the nouns change but the verbs stay largely the same - decentralization, science-based decision-making, adaptive management, biodevelopment, ecosystem approach, honor thy neighbor, pay your bills on time, honest pricing. All tropical wild biodiversity is owned by some society. Integration of a conserved wildland is with that specific society, not generic society. The ACG is not a model, but rather a pilot project in biodiversity-friendly tropical real estate development.

Biodevelopment of the ACG (Allen 2002, Janzen 1999a,b, 2000a,b, 2002) is focused on what to do with a wildland once conserved, rather than on choosing a place to conserve. The conserved wildland is a sociobiophysical lump, and it always will be a sociobiophysical lump. It is a land use. And that land use must be allowed to integrate with its society if it is to persist. It must pay its bills, come to meetings on time, and send its kids to school. This is lumpy integration. This is the gardenification of nature. It grows wilds. They can be grouped as biodiversity services and as ecosystem services. The components are multicropped. They are multitasked. They have multi-users. The conserved wildland is explicitly wildland real estate development.

I do not wish to denigrate the intrinsic value and human importance of the wild biodiversity that is sprinkled throughout the urban and agricultural landscape. However, my triage view is that the great bulk of such biodiversity is fated to be tools in the toolbox, persisting at the serendipity of its direct usefulness or inconspicuousness to the owners of that landscape. Its agrobiodevelopment and its survival are another theme.

## **The Lump**

The Area de Conservación Guanacaste is a UNESCO World Heritage Site of about 43,000 marine hectares and 110,000 terrestrial hectares crossing nine Holdridge Life Zones in its continuous 90 km transect from marine through Pacific coastal dry forest to cloud forest (1500-2000 m) to Atlantic rainforest in northwestern Costa Rica (<http://www.acguanacaste.ac.cr> and [http://janzen.sas.upenn.edu/caterpillars/RR/rincon\\_rainforest.htm](http://janzen.sas.upenn.edu/caterpillars/RR/rincon_rainforest.htm)). It is a decentralized portion of the Sistema Nacional de Areas de Conservación of the Ministerio del Ambiente y Energía of the government of Costa Rica, and it contains about as many species as does the continental United States (Janzen 1996).

The entrance sign to the ACG says "Area de Conservación Guanacaste, fuente de vida y desarrollo". The key word is "development" and today this is the only national park in the tropical world with such a mission statement on its entrance. If it is to biodevelop while conserving, it must remain a lump that does not dissolve into the agroscape.

What are the biodevelopment products? We have spent 10,000-plus years making the agroscape productive, but we are still in kindergarten for the wildland garden. The ACG began its transformation only 15 years ago (Janzen 1988). Some products are, however already visible. And they can be formalized (e.g., Constanza et al 1997, Daily 1997). I will outline them briefly: biodiversity products, ecosystem products, and the megaproduct, saving the library of life.

## **Biodiversity Products**

**Ecotourism.** The ecotourist is a better kind of cow. The "Guide to the Birds of Costa Rica" (Stiles and Skutch 1989) is fertilizer for the ecotourist crop. The conserved forest is the pasture. A carefully developed herd of ecotourists is easily competitive with the more traditional herd of cattle. Can they destroy a wildland? If it is small they can, just as too many cattle can trash a pasture or a water hole. To suggest that the ecotourist crop should not be developed as a wildland crop is to suggest that a dairy herd should not be maintained because too many cows can destroy a pasture. Also relevant is that humans are highly social - their impact is concentrated in only a small percent of a wildland's area, while their development benefits can be distributed throughout. And both the Smithsonian Institution and

INBio's INBioParque (<http://www.inbio.ac.cr>) demonstrate that ecotourism need not be developed entirely on-site. Lest tourism be viewed as trivial, it should be noted that it brings more foreign income to Costa Rica than do the entire national coffee and banana crops combined.

**Bioliteracy.** The bioliterate ACG neighbor pays with votes and employment capacity for the lessons learned in elementary school and high school decades earlier. The ACG annually provides a field-based biological education in the forest to all 2,500 schoolchildren living within about 20 km of the area. When a child touches a harmless snake for the first time, compares leaf shapes, and counts the birds in her aural space while blindfolded, she is learning to read the oldest and largest book of all. This book's content rivals that of all the world's libraries - hard copy and electronic - forever. A large conserved wildland is a Web site containing hundreds of thousands of variously integrated Web sites. I will bet any day on the bioliterate person against the bioculturally deprived, be the arena second-guessing the Nasdaq, walking a beat, or writing ad copy for the iMac. The intelligent Web site will obtain the same value-added from being bioliterate. And perhaps being bioliterate just might keep the carbon-based Web site in the game a bit longer as we go about our homogenization of humanity and machine.

**Bioprospecting.** Biodiversity prospecting by humans (Reid et al 1993, Dutfield 2000, Svarstad and Dhillon 2000) has been going on as long as there have been grandmothers and shamans, and other mammals and birds have long done it before us. There is no big mystery in the technology, be it blind search or biorational. The mystery lies in how to construct the income stream so that some portion of the prospecting profits are paid back to the wildland garden itself, thereby internalizing the cost of those wildlands. A one-cent charge on every cup of coffee - a rainforest drug if there ever there was one - would pay all tropical conservation costs forever. For coffee, though, it is too late to install such a payback process. The challenge in biodiversity prospecting lies not so much in more scientific knowledge but rather in building a conservation payback structure into the development of future drugs, pesticides, fertilizers, crop manipulators, perfumes, and other wildland crops.

## **Ecosystem Products**

**Water.** All conserved wildlands are upstream from someone - a someone who simply must come to recognize the water factory for what it is. The ACG forested mountains provide water to more than 100,000 people. While straightforward, this factory is a hard lump to swallow. First, humanity has long viewed water as a free good, though access to it has long been a source of competitive strife. The water factory does not speak for itself; it is much in need of lawyers and accountants. Second, many of water's users dance on the very edge of their profit margins. Payment for this presumed free good will generate bankruptcies. Should the users be subsidized at the cost of eventual bankruptcy of the water factory? The tragedy

of the commons raises its ugly head. Ecosystem services are particularly susceptible to such communal theft.

**Carbon farming.** We all know that there is too much carbon in the air. We can stop putting it up there, and we can start pulling it down. The regenerating forest in a conserved wildland is a green scrubber for the world's smokestacks and exhaust pipes. The ACG was born with 50,000 ha of centuries-old marginal pastures, ripe for restoration to dry forest through fire control. No, global warming won't be solved by putting forest back onto even all the tropical marginal farmlands where society is willing to grow a carbon crop (any more than national debt problems are solved with debt-for-nature swaps). However, in solving whatever small percent of the carbon problem we can with the green scrubber of forest restoration, we are capitalizing the wildland garden. Whether in a 5-ton tree or a 5-gram hummingbird, all that exquisitely formed carbon is a self-financing and self-replicating ecosystem service on which we mount a biodevelopment industry that is both further production and insurance that the carbon will stay put.

**Biodegradation.** The compost heap is hardly a novel concept. Give microbes their due. Biodegradation of clean agricultural waste by hungry wild biodiversity on tropical forest restoration sites is a first-class environmental service offered to the agroscape, a win-win situation. Three hectares of old pasture, nestled among ACG forest, can eat 1000 truckloads of processed orange peels in two years, and jump-start forest restoration in the process (Fig. 1; Janzen 1999a, 2000b, Daily et al 2000).

But when biodegradation for management and biodevelopment is conducted in a "national park" owned by a society primed for massive environmental protection, it sets up both the agroindustry and the national park to be sanctioned by a hostile urban court and competing agroindustry owners for sullyng a national park (Escofet 2000). A robust government staff indeed is required to withstand the accusation that "government funds are being used to aid my competitors," and it takes a respected and science-driven conservation area staff to argue forcefully and effectively that they are doing the right thing in wild biodiversity restoration and management by designing it to eat thousands of tons of agricultural waste. Janitorial custodians are not up to the task. The sense of self that is required can come about only through decentralization, something that a centralized government discourages. The self-understanding conservation area is a lump that is hard for centralized power to swallow.

### **The megaproduct.**

**Save the library of life.** The biggest product of all from a conserved wildland is simply the conservation of its wildland biodiversity, and its ecosystems, for all of humanity into perpetuity (or at least for the next generation of intelligent Web sites). This biodevelopment product is a custodial act. A conserved wildland differs from anthropogenic development in that it cannot afford to go bankrupt. We can never forget that the goal of nondamaging biodevelopment is to pay the rent

and the parking tickets, to be a responsible citizen to ourselves and to the IRS, to be welcome at society's table. The ACG is the largest and longest employer in the area. However, it is not a parallel government aimed at solving all the woes of the agroscape and urbania. Its purpose is, in the limit, conservation of that which can survive in and on its lump of landuse.

### **Tools for the Wildland Garden**

Integration of a large conserved wildland into society requires two major sets of tools - those familiar to the biologist (e.g., taxonomy, natural history, ecology, evolutionary biology, science-based decisions, agriculture, biotechnology, computerization) and those not so familiar (e.g., zoning, legislation, marketing, profit sharing, decentralization, democratization, humanity).

But even when the tools are familiar, it can be startling to use them in biodevelopment of a conserved wildland. For example, when the ACG acquires adjacent properties for rainforest restoration, they come with old pastures intermingled with their forest patches. In contrast to the dry forest pastures that melt in the face of dry forest (re)invasion with the cessation of anthropogenic fires (Fig. 2), rainforest pastures (Fig. 3a) persist, and persist, and persist. Commercial rainforest pulpwood plantations, traditional demons to rainforest conservationists, offer a tool for the elimination of these pastures (and see Parrota and Turnbull 1997). The ACG is seeding commercial gmelina plantations directly into these pastures (Fig. 2a; Janzen 2000b). The fast-growing pulp fiber trees produce intense grass-killing shade. But shade-loving birds, bats and small terrestrial mammals generate a steady and diverse seed rain of rainforest shade-tolerant saplings, vines and understory shrubs (Fig. 3b). These understory "weeds" are then released to continue into the first stages of rainforest restoration by harvest of the gmelina trees at the end of their (first and only) 8-year rotation. And if one is market-lucky, the management endowment for the site even receives much needed resources from gmelina sales.

The Brave New World of computerized communication has given us a tool for gentle integration of a conserved wildland with society through the Web site, rather than brute integration through the chain saw and plow. We all know about Web sites. We also know about Yellow Pages. We are headed toward the melding of the functionality of the latter with the mind-blowing power of the former (Janzen and Gámez 1997, Janzen 1999a). The mechanical aspects - databases, authority files, interoperability, wireless internet, search engines - are moving forward (and see Butler 2000). The real resource now in short supply is the very wildland information itself - images, natural history, taxonomic description - to be integrated across society's needs. If our keyboard is to do the walking, someone has to have walked the forest to fill those databases, someone has to have taken the pictures, someone has to have cleaned up the names, one or more someones will have had to have been bioliterate to a degree that surpasses the writing in the New York

Times literary section.

More on this human resource to follow. Suffice to say it must be there and it must do its inventory, not so that we can count how many wildland species there are, but rather so that we can access them and understand what they do. A Yellow Pages is not constructed so as to be able to count the number of stores in London. The real function of bioinventory is not to select yet more sites to conserve - by and large, we already know where they are (e.g., Myers et al 2000) - but rather to access that conserved biodiversity for nondestructive biodevelopment so that those sites are allowed to remain conserved.

The implication of the biologists' unfamiliarity with the second toolbox, the more sociological toolbox, is that (1) much novel cross-sectorial teamwork will be required for the integration of any conserved wildland with its society, (2) some conserved wildlands will fail because biologists fail to steer them away from the collision between political parties and economic factions, and (3) the most essential ingredients of all - decentralization and science-based decision making - will be slow to arrive throughout the tropics. And, biologists will have to become teachers and administrators to other than graduate students and NSF grants. Bankers and bug collectors make strange bedfellows.

Costa Rica's parataxonomists and paraecologists (Janzen et al 1993, Basett et al 2000) are perhaps worth a case study. They are the reply to the question of who is going to gather the biodevelopment information for conserved wildlands. If there is to be a biodiversity Yellow Pages, if there is to be biodevelopment, if there is to be science-driven decision making, then some human resource must, and must quickly, make careers of being field-based bioinformation gatherers, managers and iteration experts. Custodial management in a friendly world that highly values wildland existence for its own sake may well conserve for years and decades in the absence of understanding of what is being conserved. But the conservation area that is to survive through its biodevelopment cannot survive in ignorance. This human resource lump, this newly emerging guild at an already crowded table, must be sociologically and culturally absorbed or the conservation areas will be inoperative. However, no matter all their promise, the newly founded guild of parataxonomists and paraecologists has run awry of so many other legitimate and illegitimate social agendas that they are probably not a viable concept, except where they can be very directly nestled into larger decentralized entities that recognize their bioinventory value in spite of their conflict with established social structure. Putting administrative and scientific power in the hands of the working class is not universally welcomed in the tropics.

### **The Cattlemen's Parade**

The ACG has a very visible float in the annual cattlemen's parade in the nearby provincial capital. The ACG float is ACG staff - parataxonomists, program coordinators, sector caretakers, truck drivers - on horseback and carrying the

national flag, the provincial flag, and the ACG flag. Cowboys in front of them, cowboys behind. Huh? Hoof prints in the forest have long been a major enemy of tropical conservation. However, the second president of the Board of Directors for the ACG was the President of the Provincial Cattlemen's Association (and the first president was the owner of the largest sawmill in town).

That ACG float is saying "we are another ranch, right along side your ranch. Our wives shop in the same stores yours do, our sons and daughters go to school with your sons and daughters, we hire your teenagers and you hire our teenagers. We are all in this together. Our products may look different from your cows, but they are, nonetheless, garden produce."

### **The Next Generation**

The next generation of ministers of the environment, professors of biology, and bioentrepreneurs will not come from today's parataxonomists, paraecologists, and firefighters taught that keeping fire out of the old pastures leads to tropical dry forest restoration far faster than does planting trees. But all these adult biodevelopment managers have children and neighbors' children. These children grow up with biodevelopment managers as respected and respectable role models. Today's global conservation champions and policy makers are doing what they have been doing since childhood, just dressed in fancier clothing. From the children of those tropical paraecologists and ecotourist guides will come the next generation of tropical biodevelopment policy makers, as well as the biodevelopers in the field and forest.

### **Summary**

A conserved wildland lumpily integrated with its society is today portrayed in the Convention on Biological Diversity as "the Ecosystem Approach". The activities in the biodevelopment of the ACG from 1985 to the present, referred to earlier, may be condensed into the following summaries of this approach (from Janzen 2000c):

1) It must be allowed to work. Without a friendly government policy, and without people allowed to carry it out on site, conservation through biodevelopment will fail. The government policy is abetted by the global Convention on Biological Diversity and much else at the national and global levels. The people allowed to carry it out are abetted by decentralization and knowledge-based adaptive management.

2) It is place-based. A society has to decide what will be agroscape and urban, and what will be a conserved wildland. The ecosystem approach is not so much involved with choosing where these places will be as it is focused on how a wildland will survive once designated. The willingness of society to designate is, in large part, derived from perception of land-use value to society - a value to a conserved wildland that will usually be brought about through an ecosystem

approach. An ecosystem can be any size, and a given conserved wildland is likely to contain many ecosystems.

3) It is knowledge-based. Specific knowledge, which is largely science-based, of the place drives decisions. This knowledge - taxonomy, natural history, recovery rates, human impacts and uses, etc. - is possessed by the local human (experienced) resources (both biodiversity managers and neighbors) and possessed by society at large. Knowledge shifts and grows continually, as does the custodial challenge, leading to the essentiality of "learning by doing" and "adaptive management" toward a goal. The emphasis must be on keeping the goal at the fore and on learning the ways to that goal along the multiple possible paths. Rigid, long-term bureaucratic rules, no matter how appropriate at the moment of their invention, serve poorly as daily guidelines in this fluid biological and sociological environment.

4) It is community-based, participatory, decentralized. Both government and private sector institutional and human resources can and should be full participants, but a conserved wildland also requires relinquishing of centralized political power, acceptance of local civic responsibility, honoring of biophysical boundaries, and allowing, expecting, and training the staff of a conserved wildland to take full responsibility for it.

5) It is designed around the organic traits of the particular conserved wildland and its local, national, and international society. This means that each large conserved wildland will be unique in many respects.

6) It needs to be viewed as a biophysical object unto itself rather than as an artifact of legislative action. Actions taken need to make biological and ecological sense, which means that relevant national laws and regulations applying to the conserved wildland may have to be far more flexible and general than is traditional in society at large.

7) It is viewed as, and allowed to be, an entrepreneurial and directly productive sector. It is a productive form of land use, equivalent to the agroscape in general terms. An ecosystem approach applied to a conserved wildland is not passive custody (although some conserved wildlands may exist in relatively passive custody just as do some major art or science museums).

8) Establishment and maintenance are optimality questions. It must be explicitly recognized that, for example, there will always be human footprints and it is never possible to preserve "all" wildland biodiversity. Just as medicine treats a particular illness in the context of the person as a whole, a specific use of a conserved wildland needs to be viewed in the context of the entire wildland and its sociocultural placement.

9) The conserved wildland operates set of rules that are very different from those of the agroscape. This means that the way a species or ecosystem is treated depends on where it is encountered. A knife in the gut is a felony in one context and a life-saving surgeon's stroke in another.

10) Within the conserved wildland, survival of biodiversity per se, and its ecosystems, is the objective, with multiple multiused and multitasked byproducts. Within the agroscape and urbania, biodiversity and ecosystems are important tools in the creation and maintenance of a healthy and sane agroscape, but their survival and condition are generally not the overriding objectives and ecosystem uses are much more monomorphic than in the conserved wildland.

11) The conserved wildland cannot, and should not, be viewed as responsible for the environmental health of the agroscape. However, the conserved wildland's knowledge, its human resources, and at times its actual biodiversity and ecosystem service can be very valuable ingredients for intersectorial collaborations with the agroscape and urbania.

### **Challenges for a New Century**

Can tropical conservationists work with the rest of local, national and international society to biodevelop some real and functional large conserved wildlands that are widely recognized as legitimate land use, both to inspire and to be proof of concept? Can entrepreneurs and commerce accept and develop feedback systems that ensure that some serious fraction of the budgets and profits from conserved wildland biodevelopment go to those places and their owners/managers? Can the biologists among us derive joy and a sense of accomplishment from setting up wildland biodiversity and its ecosystems for nondamaging biodevelopment by local, national, and international society? And will the governments of the countries that (still) have massive biodiversity allow all this to happen? We do not have a century to meet these challenges. We have just until tomorrow.

### **Acknowledgments**

I am not saying anything new. This is a political commentary. It is advocacy for a land use policy. It is not a brilliant new idea. All I am doing is advocating the ideas and emotions already expressed by many people. Yet I do not cite them, credit them explicitly by name, as I would feel most comfortable doing. This is because I have found that advocating a policy is the blending of ideas, emotions, thoughts, and impressions from a blizzard of sources. As my hard disk ages, I can no longer remember from whence came this or that idea. Even when I think I know the more gentle among you remind me that it came from elsewhere. So I do very sincerely apologize to all from whom I have unabashedly taken ideas and impressions over all these years of watching the tropical forest melt in front of my eyes. I hope that your sense of my theft can be ameliorated by joy if this policy advocacy does even

a small amount for integration of tropical biodiversity with society.

## Literature Cited

Allen, W. 2001. Green Phoenix: restoring the tropical forests of Guanacaste, Costa Rica.

Cambridge University Press, New York. 310 pp.

Basset, Y., Novotny, V., Miller, S. E. and Pyle, R. L. 2000. Quantifying biodiversity: Experience with parataxonomists and digital photography in New Guinea and Guyana. *BioScience* 50:899-908.

Butler, D. 2000. Search engines. *Nature* 405:112-115.

Constanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt 1997. The

value of the world's ecosystem services and natural capital. *Nature* 387:253-260.

Daily, G. C., ed. 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*, Island Press, Washington, DC.

Daily, G. C., T. Soederqvist, K. Arrow, P. Dasgupta, P. Ehrlich, C. Folke, A.-M. Jansson, B.-O. Jansson, S. Levin, J. Lubchenco, K.-G. Mäler, D. Starrett, D. Tilman, and B. Walker. 2000. The value of nature and the nature of value. *Science* 289:395-396.

Dutfield, G. 2000. Intellectual property rights, trade and biodiversity: seeds and plant varieties. Earthscan Publications (for IUCN), London, 238 pp.

Escofet, G. 2000. Costa Rican orange-peel project turns sour. *EcoAmericas* 2(8):6-8.

Janzen, D. H. 1988. Guanacaste National Park: Tropical ecological and biocultural restoration. Pp. 143-192, in *Rehabilitating damaged ecosystems*, Vol. II, J. J. Cairns, ed., CRC Press, Boca Raton, Florida.

Janzen, D. H. 1996. Prioritization of major groups of taxa for the All Taxa Biodiversity

Inventory (ATBI) of the Guanacaste Conservation Area in northwestern Costa

Rica, a biodiversity development project. *ASC Newsletter* 26:45,49-56.

Janzen, D. H. 1999a. Gardenification of tropical conserved wildlands: Multitasking, multicropping, and multiusers. *PNAS* 96:5987-5994.

Janzen, D. H. 1999b. La sobrevivencia de las areas silvestres de Costa Rica por medio de su jardinificación. *Ciencias Ambientales* No. 16:8-18.

Janzen, D. H. 2000a. How to grow a wildland: the gardenification of nature. Pp. 521-529 in *Nature and human society*, eds. P. H. Raven and T. Williams, eds., National Academy Press, Washington, D. C.

Janzen, D. H. 2000b. Costa Rica's Area de Conservación Guanacaste: a long

march to survival through non-damaging biodevelopment. *Biodiversity* 1(2):7-20.

Janzen, D. H. 2000c. Essential ingredients in an ecosystem approach to the conservation of tropical wildland biodiversity. Address to SBSTTA for COP 5, CBD, Montreal, 1 Feb 2000. (Spanish) <http://www.mesoamerica.org.mx/Janzen2.htm>

Janzen, D. H. 2002. Ecology of Dry Forest Wildland Insects in the Area de Conservacion Guanacaste, northwestern Costa Rica. In *Biodiversity conservation in Costa Rica: learning the lessons in seasonal dry forest*. Eds. G. W. Frankie, A. Mata, and S. B. Vinson, University of California Press, Berkeley (in press).

Janzen, D. H., Hallwachs, W., Jimenez, J. and Gámez, R. 1993. The role of the parataxonomists, inventory managers and taxonomists in Costa Rica's national biodiversity inventory. Pp. 223-254 in *Biodiversity Prospecting*, W. V. Reid, et al, eds., World Resources Institute, Washington, D. C.

Janzen, D. H. and R. Gámez 1997. Assessing information needs for sustainable use and conservation of biodiversity. In *Biodiversity information: needs and options*, eds. D. L. Hawksworth, P. M. Kirk and S. Dextre Clarke, CAB International, Wallingford, Oxon, UK, pp. 21-29.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403, 853-858.

Parrota, J. A. and Turnbull, J. W. (eds). 1997. Catalyzing native forest regeneration on degraded tropical lands. *Forest Ecology and Management* 99:1-290.

Reid, W. V., Laird, S. A., Gámez, R., Sittenfeld, A., Janzen, D. H., Gollin, M. A. and Juma, C. eds. 1993. *Biodiversity Prospecting*. World Resources Institute, Washington, D.C. 341 pp.

Stiles, F. G. and Skutch, A. F. 1989. *A guide to the Birds of Costa Rica*. Cornell University Press, Ithaca, New York. 511 pp.

Svarstad, H. and Dhillon, S. S. (eds.) 2000. *Responding to bioprospecting: From biodiversity in the South to medicines in the North*. Spartacus Press, Oslo, Norway.

Figure 1. a. 1000 truckloads of newly-deposited processed orange pulp and peel deposited on 14 April 1998. b. The same photograph on 21 December 1999, after the entire mass of orange pulp and peel has been biodegraded by wild fly larvae and microbes, and the first generation of more than 80 species of broad-leafed herbs and young trees invaded the resultant enriched soil (Modulo II, Sector El Hacha, ACG).

Figure 2. a. Several-centuries-old jaragua grass cattle pasture on 25 July 1972. b. The same view on 25 April 1999, after 15 years of elimination of man-made fires

and natural forest restoration from seeds dispersed into the site by wind and vertebrates (Cliff Top Regeneration Plot, Sector Santa Rosa, ACG).

Figure 3. a. Rainforest pasture planted in October 1999 with commercial gmelina trees to shade out introduced African pasture grasses (18 December 1999; Sector San Cristobal, ACG). b. Rainforest pasture after 6 years of unweeded gmelina plantation (the tall trees), with a dense naturally invaded understory of rainforest tree saplings, treelets, shrubs and vines, ready to be released as rainforest regeneration through removal of the gmelina overstory. Note person in lower right for scale (10 March 1999; Rincon Rainforest, adjacent to Sector San Cristobal, ACG, and see [http://janzen.sas.upenn.edu/caterpillars/RR/rincon\\_rainforest.htm](http://janzen.sas.upenn.edu/caterpillars/RR/rincon_rainforest.htm)).