

local store and homogenized in 6% perchloric acid with a polytron tissue grinder (Kinematica GmbH, Luzerne, Switzerland). After centrifugation (20,000 × g, 15 min) the clear supernatant was neutralized with 5 M potassium carbonate and re-centrifuged to remove the potassium perchlorate. A volume equivalent to 0.4 mg of dry seed was derivatized with OPT and subjected to HPLC. Figure 3A shows the chromatogram of fava bean and 3B that of alfalfa seed. The latter contained approximately 0.4% canavanine (peak 5). The aforementioned observations led to the following analytical design.

When alfalfa seed extract (see fig. 4A) was incubated in 10 mM Tris, pH 9.3, containing 0.7 U Mn<sup>++</sup> activated calf liver arginase (Boehringer Mannheim No. 102881) the appearance of canaline (peak 8) and ornithine (peak 9) were clearly demonstrated (fig. 4B). Preincubation with pyridoxal phosphate prior to OPT derivatization caused a reduction of canaline but not that of ornithine (fig. 4c). A similar experiment conducted with fava bean extract showed only the formation of ornithine (data not shown).

By utilizing a combination of arginase treatment, OPT derivatization and RP-HPLC it is possible to detect, identify and quantitate canavanine and/or canaline. The procedure is relatively rapid compared to previous methods<sup>15, 18, 19</sup> and the two amino acids can be assayed simultaneously in the picomole range.

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## How to grow a tropical national park: basic philosophy for Guanacaste National Park, northwestern Costa Rica

1 All tropical regions should have national parks, rather than have national parks occur as historical afterthoughts, or as emotional reactions to the last fragments of a dwindling majesty. Today, for many very large areas of the tropics, the possession of a national park requires a philosophy and technology of park reconstruction, of restoration ecology. That is to say, a national park is up there along with schools, public health, electrical services, etc.; it can be put in place, and for the same reasons.

2 Given that a major habitat is to be restored into a National Park as part of its preservation process, to which vegetation types shall we restore it?

- a) There are many possibilities, and if they have an endpoint in common, it is tens of centuries down the road (e.g., winds vs vertebrate-generated forests invade abandoned pastures)
- b) What kinds of habitats will give the highest yields of biodiversity preservation? What kinds of habitats will make the park the most user-friendly (community involvement value, recreational value, interest-generating value, example value, seed and gene stock value, tourist income value, watershed value)?
- c) What are the degrees of irreversibility of the various habitat possibilities (can introduced species be eliminated, what life forms are hard to remove or control)?
- d) The existence of restoration alternatives calls for a whole new level of action and decision-making presently absent from the planning and realization of tropical national parks.

3 Why are we restoring a tropical dry forest national park?

a) Because there is no pristine vegetation left of this major forest type (it once occupied more than half of the tropics), and the vegetation remnants are being rapidly obliterated.

Less than 2% of the western Mesoamerican dry forest (it once occupied an area the size of France) is even approximately intact, and 0.09% has conservation status. In a few areas, such as the one occupied by Guanacaste National Park (GNP), there are sufficient population and habitat fragments to fully restore the 700 km<sup>2</sup> dry forest block and its rain forest refuges.

b) Because this is the only way to conserve the approximately 30,000 species of insects, 500 birds, 3,000 plants, 160 mammals and 200 herps that occupy the GNP area.

c) Because by returning introduced and artificial grassland pastures to forest, we eliminate the risk that the forest will be roasted off the map by human-generated fires; virtually all of the fire problem originates in the pastures and then moves into the forest.

d) Because the active process itself allows

1. explicit construction of a user-friendly biological system and
2. community participation in the planning of the structure itself, and in the mechanics of its growth, thereby engendering a desire to retain it aside from its innate or taught attractiveness.

4 The tropical dry forest is 40–90% as species-rich as is the rainforest (e.g., 2800 species of moths at one light over the year). However, the dry forest once covered more of the tropics than did rainforest. It species are not replicated in the rainforest, and its habitats and life forms are not either.

5 The restoration process can proceed at minimal cost and management, through nothing more than stopping the hunting and the fires. Or, it can be speeded up in proportion to the amount of money that someone wishes to invest in labor or minimal technology.

**6** GNP will be highly zoned, a distinctive mosaic, and sensitive to the fact that conservation of dry forest ecosystems and species is a number one priority, with user-friendly education development as a collaborative priority. A major reason why the park must be large is to allow zoning such that the pieces are large enough to fill their respective functions.

**7** A dry forest park needs to be large because dry forest is extremely heterogeneous, and large size is needed to encompass enough internal small pieces to add up to a sufficiently large area for any given habitat to survive.

**8** The entire Costa Rican community, from President Arias to the owners of small farms, are for GNP.

**9** GNP is on horrible farm and ranch land, so essentially nothing is being taken out of production. It sits, however, immediately adjacent to very good farmland. So, we have an agricultural paradise but green intellectual hell, sitting next to one of the most complex libraries on earth. This will be a commonplace situation in the tropics.

**10** A major function of the educational development of GNP is to short-circuit the long and tortured route of biological information flow from the tropics to the temperate zones and back to the tropics. The short-circuiting is done by field biology education to groups ranging from kindergarten through adult civic groups, as well as to research apprentices and foreign visitors to the area. The primary audience is local, however. The educational information is generated by the national and international research community, and the information flow almost entirely by Costa Rican talent.

**11** While conservation must be based in education, it cannot be based in just any haphazard education. Certainly technical training is only a tiny fraction of this educational process. The goal is to put natural history back into the human repertoire. We are bioculturally deprived, we are as color-blind.

**12** The basic value of researchers to a national park is to  
a) produce the raw materials that will be used in the educational development of the park, and  
b) on demand or voluntarily provide experiments, opinions and data to aid the park managers with practical problems.

**13** This generation of the academic community has to step out aggressively and supplement the traditional conservation forces operating in the tropics, or the next academic generation won't have it to worry about. My thesis research area is today a sugar cane field, and the forests in which I learned about tropical biology are cattle pastures. A massive input of \$ and brains and time has to be infused, and this will require a collaborative effort from the graduate student to the college president. That is to say, the effort has to be legitimized.

**14** The tropical forestry industry has long overlooked the extremely diverse opportunities in forest product development using native trees. This has occurred in large part by the lack of research on the biology of tropical tree natural history and by the failure of the esoteric research community to aggressively divulge what it knows. This problem is especially acute with respect to understanding what it takes to grow native timber, firewood, etc. trees (e.g., *Enterolobium*, a major local timber tree, displays extreme resistance to drought).

**15** At the time that much dry forest was cleared, timber was cheap (and much of it was simply burned to get it out of the way). This leads to the modern illusion that dry forest does not grow a high volume of valuable timber. Furthermore, on today's markets, that dry forest timber is much more valuable than when the land was cleared, and is becoming even more so.

**16** Don't waste resources on the living dead. While it is gut-wrenching to see the last fragments of habitats, and animal and plant populations being cleared out of large expanses of heavily agriculturalized areas, it is not a wise allocation of scarce resources to desperately try to hold on to them. Triage is a harsh fact of today's conservation scene.

**17** That is to say, the figures of X% loss per year are extremely deceptive. The loss is not distributed evenly over all habitats, but proceeds from habitat to habitat, and thus the short-term rate of species loss is much greater than if all were being nibbled at equally. Dry forest goes before rainforest; flatland forest goes before montane forest; forest on good soil disappears faster than forest on poor soil does. The conservationists are wreaking havoc with their statements that 'about the area of the US remains in tropical forest' – that area is in many pieces, and as each piece goes under, so does an array of species.

**18** Stop the 'blame the hamburger connection' chant. The tropical conservation story has been co-opted by the radical community to which the act of protest is often more interesting and important than whether the protest is actually relevant to the problem at hand, or whether it actually has potential to alleviate the problem. The US public can handle a more sophisticated understanding of the tropics than is being presented to it. If cattle are eliminated as a crop, then some other crop will be grown, be it traditional (rice, cotton, sorghum, etc.) or a new crop for which a Nobel prize is given.

**19** The tropical decision-makers for 20–40 years hence are sitting in the schools right now, a captive audience. Academics, your profession is teaching. 20–40 years from now is when the crunch is going to hit. Your mission is obvious.

**20** Many tropical undeveloped countries are in fact developing very fast. Lets not worry about how their economic development can be brought about – there are many minds already focused on that. Lets worry about the intellectual development of its peoples, and specifically their understanding of the biological world beyond fields and pastures.

**21** We cannot base the preservation of the tropics on a cash base alone. The cash value of forest, etc. will not carry it through market fluctuations. There has to be a social sentiment to serve it in the idiosyncratic crunch events, events that escape in one way or another from market control for even a very short time. The difference between the natural world and human goods and services is that when a Wall Street blip erases fortunes, companies and individuals, they can be restored (if you wish) in a few days to a generation; biological systems erased are extinct and cannot be recalled or reconstructed.

This project desperately needs funds for the initial purchase of the marginal farmland on which to grow the park, and for a minimal endowment for annual management costs. All donations are tax-deductible and should be mailed to Nature Conservancy-Guanacaste Fund, 1785 Massachusetts Ave., NW, Washington, D.C. 20036. Detailed additional information may be obtained from D.H. Janzen, Department of Biology, University of Pennsylvania, Philadelphia, PA 19104 (215-898-5636).

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