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Chemical Prospecting: An Evolutionary-Biogeographical Approach—Mesoamerican Cloud Forests as an Example

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Biochemical prospecting involves exploration for new, hopefully useful, chemicals from organisms. Though biochemical prospecting could be antagonistic to conservation through uncontrolled exploitation of a new resource, it also has the potential to benefit biodiversity conservation. Sustainable harvesting of a species from its natural environment requires the preservation of its habitat. Discovery of a species with rare and\or important chemicals can help justify an area's preservation. Chemical prospecting and biodiversity conservation should focus on the same community parameters: threat of extinction, taxonomic diversity and endemism.

Obviously, if an area is threatened with destruction, it needs to be explored and preserved before it is too late. Since limited resources are available for these tasks, how does one evaluate and decide on which areas to focus efforts? Ideally, one should have a complete list of all taxa from each area and know which taxa are endemic. This does not exist for any site in the world, especially not for the highly diverse tropics. (An ambitious project with this goal was begun in Costa Rica, but was cancelled). Consider that probably more than 90% of the world's insects have yet to be discovered (ref. 1). Most of these insects are found in the canopy and soils of tropical forest ecosystems. So, which tropical forest ecosystems should have priority for preservation and biochemical prospecting?

It is to be expected that unique biochemicals have evolved as organisms have speciated. Natural selection can play an important role by, for example, selecting for an enzyme that will overcome a plant's chemical defenses, thus allowing an herbivorous insect to colonize a new host. Speciation of the herbivore may result. Another process, random mutations in small, isolated populations, may result in the fixation of genes for new substances which may or may not be selected for. In either case, geographic isolation promotes speciation and chemical differentiation. The use of these geographically restricted chemicals may reduce the possibilities of international patent disputes.

Cloud forests tend to be areas with high diversity and a high degree of geographic isolation on tropical mountains. In many cases, this isolation is more pronounced now than when

*Invited lecture presented at the International Conference on Biodiversity and Bioresources: Conservation and Utilization, 23–27 November 1997, Phuket, Thailand. Other presentations are published in *Pure Appl. Chem.,* Vol. 70, No. 11, 1998.

glaciars were present during the last two million years. At the height of the glaciations, cloud forests were probably more extensive; during interglacial periods, such as now, cloud forests retreated up the mountainsides, in many cases forming isolated montane cloud forest "islands." Since these glacial advances and retreats occurred cyclically throughout the Pleistocene, each period of isolation provided a period for speciation. Areas separated for longer periods should be more differentiated.

In order to determine degree of differentiation and endemism, one can use indicator organisms. These are taxa that correlate in their distributions with various other taxa , circumscribing areas of endemism, or biotic areas (ref. 2). This can be illustrated in the case of cloud forests in northern Mesoamerica. Here we used beetles of the family Passalidae as indicator organisms which correlate with salamander and some plant distributions (ref. 2). Each biotic area is separated from others by regions of lower elevation, drier forest types. Further studies in this region allow me to define 8 major areas between Chiapas and western Honduras (map 1). Faunal differences occur within each area as well, based on elevation and forest types. Differences among areas are not complete; some species, though now restricted to the areas, are found in more than one area, e.g. *Proculus mniszechi* (map 2). These populations of *P. mniszechi* have been isolated for sufficient time for biological differentiation between populations to occur as well (ref. 3).

On a more detailed level, we analyzed 27 cloud forests in Guatemala in terms of degree of endemism and number of species of passalid beetles present. These results (map 3) combined with data on degree of protection available, can be used to select areas for biochemical prospecting as well as to prioritize areas for conservation (ref. 4).

In summary, prioritization for biochemical prospecting, as well as for conservation, can be determined by studies of endemism and diversity using indicator organisms, such as passalid beetles for cloud forest ecosystems, combined with information on degree of protection or threat of destruction of the forest resource.

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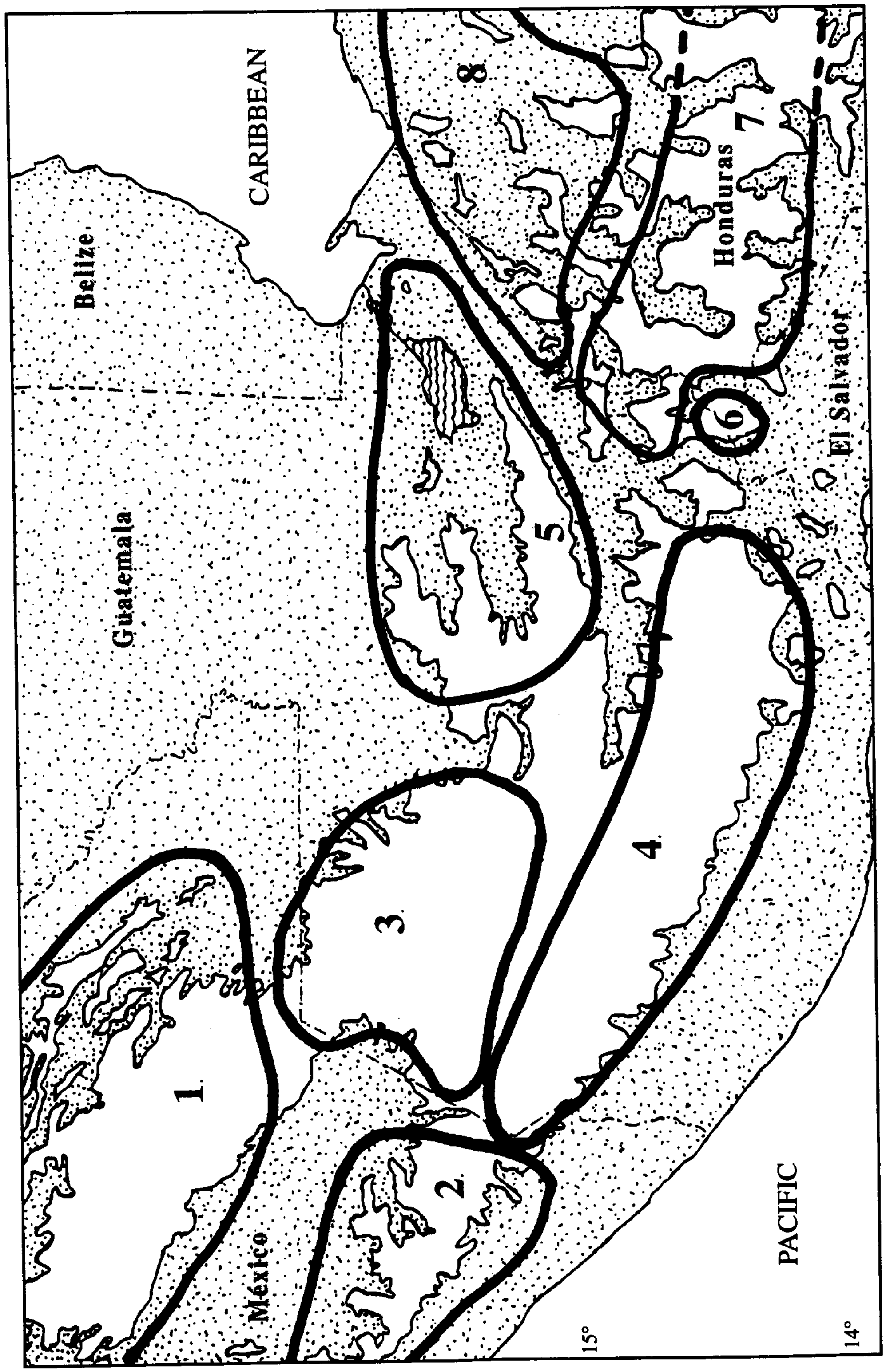
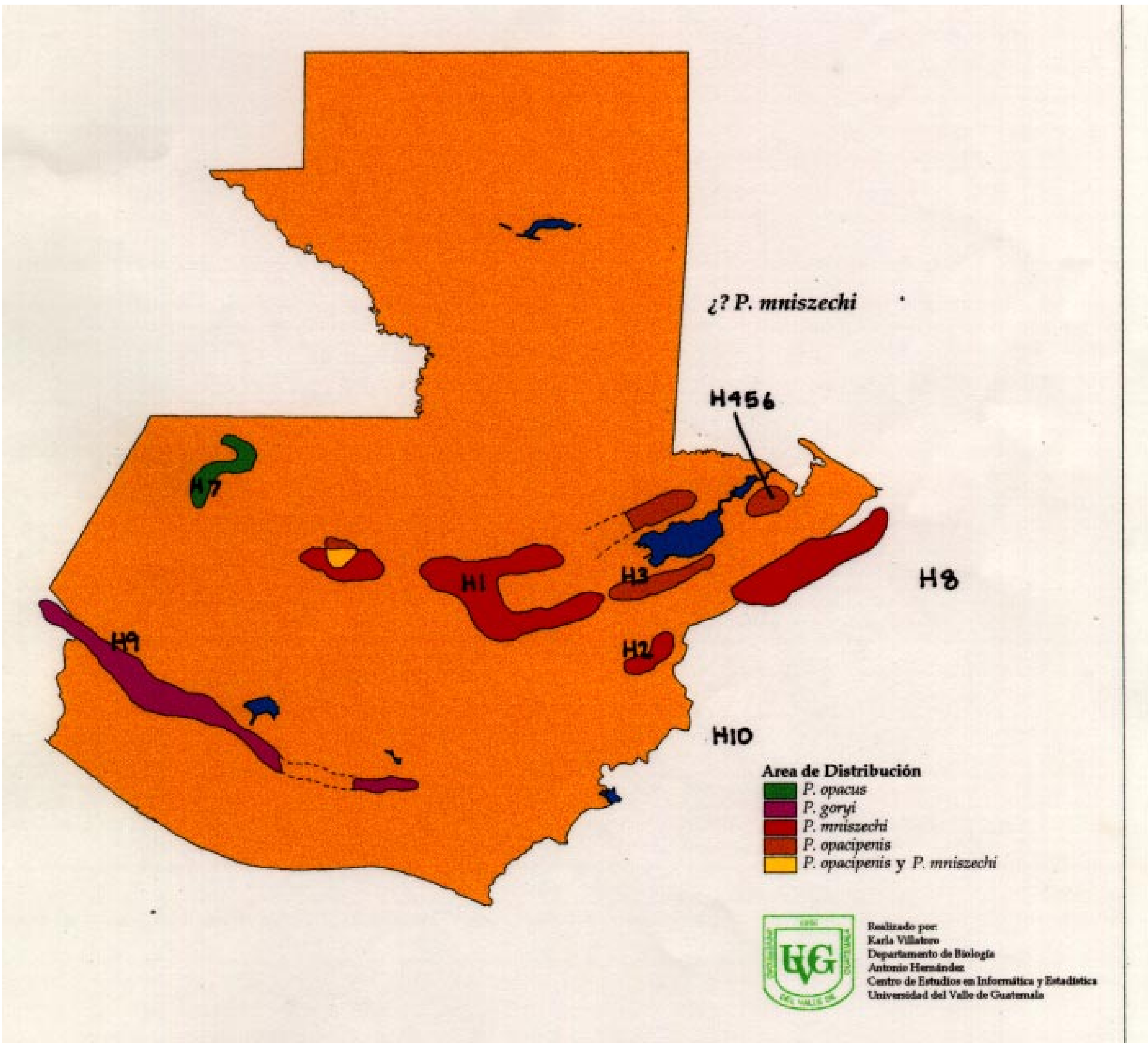


Biotic areas of Nuclear Central America based on passalid beetle distributions. White area is above 1000m. altitude. 1= Northern montane Chiapas, 2= Southern montane Chiapas, 3= Cuchumatan-Cuilco region, 4= Volcanic chain, 5= Sierra de las Minas-Sierra de Santa Cruz, 6= Trifinio, 7= La Unión-El Portillo, and 8= Cerro Azul-Cusuco-Yoro.

Map 1.

Map 2. Distribution and haplotypes of ND5 for the species of *Proculus*. (Courtesy of the Licentiate theseis of Karla Villatoro, Biology Dept., Universidad del Valle de Guatemala.)



Map 3. Geographic distribution of passalids in cloud forests of Guatemala.