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HOLDRIDGE'S WORLD CLASSIFICATION OF LIFE ZONES--A REAPPRAISAL

SUMMARY OF SEMINAR
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In 1947 Holdridge, after working for several years in the Caribbean area, published a system or classification scheme of world plant formations based on simple climatic data (11). Prior to that date he had applied his system to classifying the vegetation of part of Haiti (21). In successive years many studies, including vegetation maps based on that system were done in other countries by Holdridge and his students and/or followers.

In 1950 the map of Guatemala was published together with an extensive forestry report, later followed by those of El Salvador in 1953 (14), Costa Rica in 1953 (25), the Venezuelan Andes in 1955 (26), Panama in 1956 (27), Peru in 1960 (44), Honduras in 1961 (15), Nicaragua in 1962 (16), and Colombia in 1963 (36). The map for Ecuador is in print, and a detailed map for Venezuela is under way. Moreover, a less detailed map for Venezuela had been published in 1961 and has been extensively used in different forestry aspects (6).

Lately, Holdridge has mapped Eastern United States (this has not yet been published), and at this stage about 5% of the world land surface has been mapped according to this system.

APPLICATIONS AND USAGE:

As can be seen from the geographic coverage, considerable mapping has been carried out, but only in the American tropics, although the system is world-wide in scope. Together with the maps, reports have been published with more detailed descriptions. Numerous applications have been derived especially in relation to the determination of atmospheric water movements as published by Holdridge (10, 13, 23). Studies on leaf physiognomy (43), the number of strata of natural vegetation associations and the heights of the dominant trees on climatic associations, have also been derived from the system (10, 45). In similar fashion the system has been used for descriptions of regional vegetations, (17, 24) for distribution of species (3, 20, 35, 46) and for the classification of natural habitats in need of preservation (2). It has led to recommendations for pasture management (19) silvicultural treatments (18) and better land use systems for the tropics in general (12, 28) and more specifically for Peru (5, 44) and the Central American countries (27, 30, 31). It has been applied to watershed management in Colombia (38) and Costa Rica (34). Correlations with the system were also established with the diameter distribution of trees, the heights of the stands, the number of trees, the basal area and the volume of stands, allowing, among others, the possible application of the system in carrying out inventory studies (45).

The system has been taught at the Graduate School at Turrialba--together with other systems--and many students have followed it up in their thesis and later in their home countries. In fact, Holdridge's ecology course, originally mimeographed at Turrialba, has been reproduced in formal publications in Venezuela and Peru and it is a standard text in several schools of forestry (9, 22).

RECEPTION IN NORTH AMERICAN AND EUROPEAN SCIENTIFIC CIRCLES.

Most of the literature so far has been in Spanish, especially the ecological maps, and circulation of the published material has often been poor as far as the scientific world is concerned. An exception has been Tosi's work in Peru (44) which, although published in Spanish, has received recent reviews in the U.S. and Europe, generally very favorable (7, 33, 37) except for one case where the whole system was more or less dismissed (8).

For several years now I have had opportunities to apply and discuss the system with ecologists. Many of these discussions, either verbally or through correspondence, have been very useful and constructive. As is to be expected, some objections were expressed by some scientists and these seem particularly worthy of consideration.

1. The system does not take into account the variations in rainfall patterns, saturation deficit or soil moisture (1) which do influence natural vegetation. It does not do justice to slope, soil variations and anthropogenic factors such as, for instance, fire over millenia, or even wild animals, as, for instance, in Africa. This objection is usually applied to the terminology of Holdridge's diagram which refers to a type of vegetation for each life zone. It is quite obvious that very often the vegetation actually seen on the ground does not correspond at all to the terminology, although such vegetation appears relatively stable.

This is by far the most common objection, especially from scientists trained in countries where detailed maps of the actual vegetation already exist.

In connection with these objections it must be stated that Holdridge's scheme should not be interpreted as a classification of actual vegetation but rather the expression of the higher categories of the hierarchy used for the classification of vegetation. The hexagons on his scheme are broad groups called natural life zones for which allowance for subdivisions is made. They do, however, give climate a higher rank than to soils and biotic influences, a matter generally accepted by ecologists today (see, for instance, Richard's recent papers on climatic and soil factors and the ensuing discussions [40, 41]). Each natural life zone is subdivided into different associations, which may be (a) climatic, (b) edaphic when special soil conditions are present, (c) <u>hydric</u> when special ground water relationship modify the picture; and (d) <u>atmospheric</u>, when special factors such as **very strong** winds, or "unusual" rainfall, humidity conditions or other unusual atmospheric factors intervene. There is only <u>one</u> climatic association in each life zone, but there may be many edaphic, hydric or atmospheric associations or combinations of those. <u>This single climatic association gives its name to the life zone</u>. It should also be borne in mind that disturbance of this climatic association--or any of the other associations--either through biotic activities (man, fire, animals) or other phenomena (hurricanes, lightning fires, destructive floods, etc.) immediately establish successional patterns which may change drastically the picture of the vegetation.

Hence any classification of actual vegetation through the Holdridge system should bring out the correct hierarchy of the community actually encountered on the ground; that is, it should establish the successional status of the community and then to which association it belongs and finally to which natural life zone. If the community is not disturbed, and there are no special factors of edaphic, hydric or atmospheric origin, then its appearance, physiognomy and structure--but not floristic composition--is similar in any analogous life zone of the world.

This type of classification is obviously based on a certain acceptance that vegetation can and should be classified on a worldwide basis because of striking similarities in structure and physiognomy in spite of geographical distances. As in other classifications, it implies that there are patterns, rules and deviations. It has the Clementsian approach of climatic climax, but not its limitation of only one climax since stable edaphic, hydric and atmospheric associations are recognized. Hence, when it becomes a matter of classifying the vegetation of swamps, or of a dry, calcaceous substratum, or of a tropical lowland area where moderate rainfall is more or less uniformly distributed over the whole year--a possible but rather unusual pattern--there is no question of finding the climatic association giving the name to the life zone, even if no disturbance has taken place over a long time. These are all cases of typical <u>hydric</u>, <u>edaphic</u> and <u>atmospheric</u> associations, respectively.

In support of the criticism of the system, it should be said that these points have not been sufficiently publicized, nor have Holdridge or his followers produced a detailed map of the actual vegetation based on the Holdridge system. In contrast to the climatically defined life zones, this would take a large amount of time and effort; however, it is intended to realize such a task in the future, especially with the help of aerial photographs. It would, of course, have to be on a much bigger scale than the present 1:1.000.000. Tropical vegetation is more complex than that of temperate zones and hence demands more output of money and technicians, hardly available in most of the countries where the system is presently followed.

However, it is a fact that the authors of all the ecological maps have discussed in their accompanying reports the various edaphic, special climatic and biotic--mostly anthropogenic in Latin America--factors which interplay in each life zone. Hence the criticism that soils, or more detailed climatic factors or anthropogenic influences are ignored, is certainly not valid. In fact one master's thesis produced in 1952 in Turrialba was essentially the description of the different associations within several life zones of Costa Rica (39).

2. Climate, as expressed by annual mean biotemperature and annual rainfall only, does not produce life zones with the sharp boundaries apparently implied in Holdridge's scheme. This is, in fact, often the case, especially in the lowlands in areas of similar biotemperature where only total rainfall is changing from one life zone to another. Hence large areas may be transitional as can be eloquently seen on the recently published map of Colombia (36). Moreover, transition zones are provided in Holdridge's scheme. However, when biotemperature changes, as in mountainous areas, sharp boundaries are the rule for climatic associations. It should also be understood that the more the vegetation has been disturbed, the more it is difficult to recognize the boundaries between associations or life zones. This is natural since disturbance will favor the spread of pioneers which will eventually dominate the landscape over a wide range of climatic and edaphic conditions, a befitting behaviour to be expected from pioneers.

There is a strong correlation between the total amount of rainfall and the length of the dry or rainy season or other climatic factors. This has been recognized by many ecologists, for instance Troll and his followers, notably Lauer. The latter, among many of his contributions, has produced a remarkable analysis and comparison of classifications of tropical vegetation in different areas of the world showing the intimate relationship between dry months and vegetation (32). If the total rainfall does not correspond to a certain number of dry months, or, when rainfall is seasonal and falls mostly during the colder months, then we have two typical cases of atmospheric associations.

3. The physiognomy of the natural vegetation is not always determined primordially by climate; historic plant geography may play a very important role. This argument is strong when, for instance, pines alternate with broadleaves under similar climatic and often edaphic conditions.

The accumulating evidence in connection with successional studies shows that it is not possible to consider pines as members of climatic associations on a permanent basis except on edaphic or atmospheric associations. In the long run if there is no intervention such as forest cutting, fire, man-induced grazing, landslides, glaciation, etc., pines are not able to compete with the broadleaves. In tropical areas, at least, pines are pioneers or, in some cases, older secondary species. They are, of course, a part of the landscape, but their niches are restricted to successional stages or special edaphic association from which they spread to disturbed areas. Such behaviour of pioneers has often been described (42) and may be compared to savanna species spreading towards opened areas. While it is easy to separate the early pioneers from the climax species, the difficulty increases when distinguishing species of later successional stages. However, it is becoming increasingly obvious that the time allowed for the separation of an old successional stage from what may be called a climax association is a long one--the natural age of dominants of the pre-climax sere spreading sometimes over several centuries or even millenia in colder climates. Fortunately, there are reasons to believe that a more thorough study of the successional process of a region may give reasonable clues to classify the vegetation in its proper successional sequence without actually observing the vegetation for such a long period (4).

In conclusion the application of the system has met with relative success in the Latin American tropics, although from the mapping standpoint it has only covered broad life zones. It has been rather ignored by most of the American and European ecologists. The latter have been, as a whole, more active in the classification of world vegetation, especially in connection with the rather neglected but much more complicated tropical region. With better ways of presenting and communicating the Holdridge scheme to the scientific world in general, and in working out examples of classification and mapping of actual vegetation, it should receive the critical test that many feel it deserves, because at this stage we still do not have a universal system, with its proper hierarchy, adopted throughout the world, and which will eventually allow the classification and comparison of vegetation and life zones.

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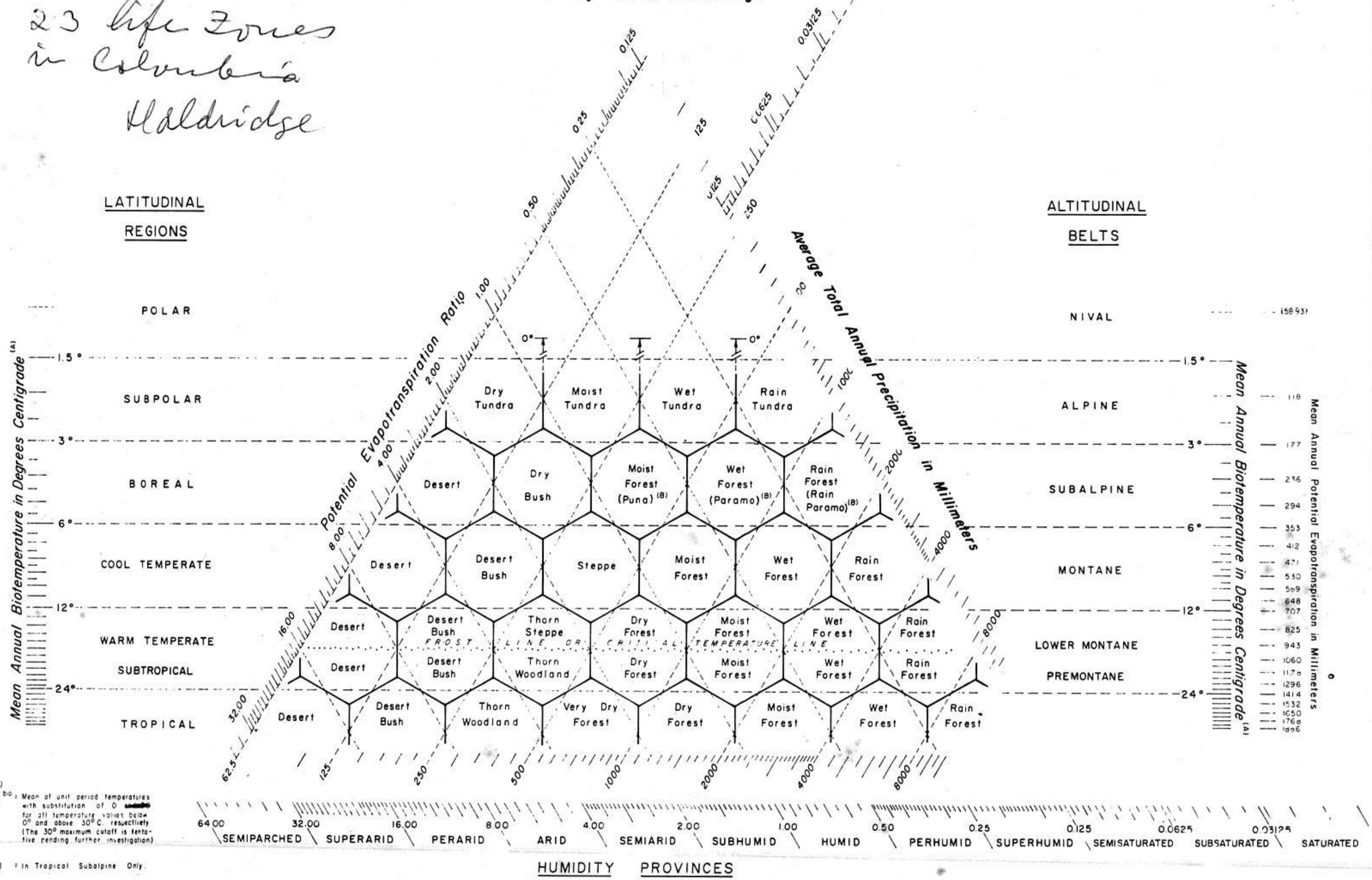
+ Represent contributions to, or applications of the Holdridge system.

DIAGRAM FOR THE CLASSIFICATION OF WORLD LIFE ZONES OR PLANT FORMATIONS

by L. R. Holdridge

23 Life Zones
in Colombia
Holdridge



(A) t_{bio}: Mean of unit period temperatures with substitution of 0 for all temperature values below 0° and above 30°C, respectively (The 30° maximum cutoff is tentative pending further investigation)

(B) = In Tropical Subalpine Only.

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