Net Primary Productivity in Tropical Terrestrial Ecosystems

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Ranging from lowland evergreen rain forest to alpine tundra, the variety of terrestrial ecosystems lying within tropical latitudes exceeds that of any other region on earth. Our knowledge of net primary productivity (NPP) rates in tropical ecosystems must be described as fragmentary. The relatively few available data pertain to a diverse assortment of samples subject to different levels of precipitation and disturbance.

The published data on organic productivity are dispersed widely in the literature; recent efforts to review and summarize this information have, therefore, been welcome. Notable among the treatments of productivity on a worldwide basis are reviews by Odum and Odum (1959), Pearsall (1959), Lieth (1962), Westlake (1963), Rodin and Bazilevich (1967), Art and Marks (1971), Jordan (1971a), and Lieth (1972, 1973). Productivity in tropical ecosystems has been reviewed by Golley (1972), Golley and Lieth (1972), and Golley and Misra (1972). Other papers concern specific areas within the tropics: India (Misra, 1972), Nigeria (Hopkins, 1962), and the western Pacific region (Kira and Shidei, 1967). A paper by Bourlière and Hadley (1970) on the ecology of savannas reviews the productivity data for that important category of tropical ecosystem.

The objective of this chapter is to present and summarize the available data relating to annual NPP in tropical terrestrial ecosystems, including data too recently collected to have been included in earlier reviews.

KEYWORDS: Net primary productivity; terrestrial vegetation types; tropical region; geoecology.

Available Data

Table 11-1 contains data relative to NPP in a variety of tropical ecosystems. It should be emphasized that each category of tropical ecosystem included in the table is composed of a large variety of subtypes. Tropical grassland, for example, varies from short, sparse herbaceous communities in which bare soil is clearly visible, to tall and dense communities, depending upon local conditions. Because of variation within the categories of ecosystems, and in order to allow a more accurate interpretation of the data, each value of NPP is accompanied by information on the site from which it was obtained. The table includes geographic location in addition to annual rainfall and approximate length of growing season as defined by rainfall pattern when the data were available or could be estimated.

The estimates of total NPP in Table 11-1 are based upon a variety of methods of measurement. In many instances total NPP (aboveground + belowground) had to be estimated from information on some component of the total, such as aboveground NPP in grasslands and leaf-litter production in forests. The factors used in adjusting the original data to obtain total NPP are specified in the footnotes to Table 11-1.

Grassland

The NPP of grasslands varies widely depending on the total annual rainfall and its distribution by seasons. Walter (1954) demonstrated a direct relationship between water availability and aboveground productivity for arid and semiarid desert and grassland in southwest Africa where annual rainfall ranges from 100 to 600 mm. In certain geographic areas, India for example, a prolonged dry season of up to 9 months duration greatly restricts the growing season and consequently the total annual NPP.

Figure 11-1 shows the relationship between total annual rainfall and total annual NPP for tropical grasslands in India, Australia, and Africa. Most of the published reports of productivity in tropical grasslands are based upon the periodic harvesting of aboveground replicated samples and do not include data on belowground parts. Varshney (1972), however, reported that belowground parts accounted for ≈ 40% of total NPP in grassland near Varanasi, India. For lack of more extensive information, Varshney's value is assumed to be representative for tropical grassland; data on aboveground NPP were adjusted accordingly for inclusion in Table 11-1 and Figure 11-1. It is apparent from Fig. 11-1 that grassland productivity on sites that receive less than 700 mm of annual rainfall is low. The lowest value reported is 40 g/m²/year for grassland at Jodhpur, India, for a dry year in which rainfall totaled only 92.7 mm (Gupta et al., 1972). On sites that receive between 700 and 1000 mm of rain annually, total annual NPP ranged from 650 to 3810 g/m²/year. The large variations in NPP within this relatively small range of rainfall may be related to any one or a combination of factors including periodicity of rainfall, rate of evapotranspiration, soil permeability and fertility, species characteristics, and grazing pressure. Of the published data for unirrigated grassland, the maximum site value is