

THROUGH SOME FORESTS IN AFRICA, WEST INDIA (GOA), THE CARIBBEAN AND CENTRAL AMERICA, IN THE CONTEXT OF CLIMATE PERTURBATIONS

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Abstract. The paper represents a biological briefing of the author's travels through some tropical forests from an environmental perspective. It begins with the Romanian Trans-African Expedition, starting point of his biological journey, and arrives at the Costa Rican forest, trying to draw some parallels. At the same time, the presentation is a tiny tribute to tropical forests, so important in global climate regulation, but unfortunately underestimated and subordinated to immediate economic interests. The author's sincere thanks to the organizing team of this conference, because it gave him the opportunity to present the paper and to meet the former members of the Romanian Trans-African Expedition, a major action performed with enthusiasm and minimal financial expenses.

Keywords: tropical forests, mangrove, rainforest, Romanian Trans-African Expedition, climate perturbation.

Rezumat. Prin unele păduri din Africa, India de Vest (Goa), Caraibe și America Centrală, în contextul perturbărilor climatice. Lucrarea constituie o scurtă schiță biologică din perspectiva mediului ambiant, pe baza expedițiilor efectuate de autor prin unele păduri tropicale. Aceste investigații au început cu Expediția Română Trans-Africană și au ajuns în pădurile din Costa Rica, evidențiind unele paralele. În același timp, autorul adresează sincere mulțumiri colectivului care a organizat această Conferință, deoarece ea oferă posibilitatea de a prezenta această lucrare și reîntâlnirea cu membrii Expediției Române Trans-Africane, o acțiune majoră executată cu entuziasm și cheltuieli financiare minime.

Cuvinte cheie: păduri tropicale, mangrove, reîmpădurire, Expediția Română Trans-Africană, perturbări climatice.

The Romanian Trans-African Expedition and the Museum "Gr. Antipa" Expedition in Tanzania were held almost 50 years ago, when climate disturbances had begun to worry the international community. The gradual desertification of the Sahel was one of the main elements that triggered international interest. The idea then emerged of the possible influence of human activity on the planetary-scale climatic changes. The euphoria of limitless openness and unorganized development of mankind, the recovery after World War destruction, began to shake. Initially shy, environmental science began to impose itself in the face of the harsh reality. It was not classical ecology, but a combination of natural sciences with economics, demography, social sciences.

The two Romanian scientific missions, I took part in, conducted in the midst of this world-wide environmentalist effervescence, gave us the opportunity to cross several African ecosystems already subject to anthropogenic pressures. Forests, we saw a few during the Trans-African expedition, but in Tanzania the mission focused more on coral fauna, so we only saw them in the terrestrial coastal region. I then continued exploring forests in Western India (Goa), the Caribbean, Florida and Central America.

The **Mangrove forest.** In my early school years, I was reading passionately about this amphibian ecosystem, very interesting for the interface particularities, with multiple adaptations of biocoenotic components (Pl. I, Figs. 1; 2).

Aerial root networks provide excellent shelter for juvenile fish, crustaceans and molluscs, essential for feeding local populations; moreover, all these root networks strengthen coastal land and provides protection from hurricanes and big waves (including tsunamis). The tsunami that hit Bali in 2004 did the most damage where the mangrove forests had been replaced with beaches and in 1990 India and Bangladesh escaped the monsoon floods due to new mangrove forest plantations (Belt Iberica 2013). Research in Malaysia has shown that mangrove ecosystems, across the globe, are the largest natural well of atmospheric CO₂ capture and contribute to the reduction of the the greenhouse effect by – 110 Kg/ha/day (GONG & ONG, 1990; FAO, 1994; 2010).

The surface of mangrove forest soil is like a sponge, full of crabs galleries (*Uca* especially). Crabs (Pl. I, Fig. 3) are essential to the existence of the forest (CORCORAN et al., 2007; LINDQUIST et al., 2009). They break up freshly fallen organic matter, creating mounds of carbon-rich microhabitats, maintaining a microflora favourable to edaphic fungi.

Although the mangrove forests are particularly important for biodiversity and regulating the climate, they are threatened to disappear. This ecosystem, one of the most sensitive, decreased by 35% in the last 30-50 years (FELLER et al., 2010).

Their enemies: overfishing crabs for market, timber extraction for firewood or construction, pollution (mangroves are very sensitive) and the expansion of shrimp trade (replacing forests with temporary ponds for aquaculture).

During my travels I have often seen affected mangrove forests and crabs for sale (even in Senegalese markets).

The importance of mangrove forests included them in the topics that will be addressed by the UN Conference on climate in December 2015 in Paris – "**2015 – Mangrove Year**".

The mangrove forests I visited (Pl. II, Fig. 4), circum-Atlantic (African – Senegalese, Caribbean, and Central American) or Indo-West Pacific (Tanzania – Rufiji, India – Goa) were affected either by exploitation or by pollution.

In India, in 1971, the whole coast of Goa was contaminated with iron-ore from the exporting of thousands of tonnes of ore by ships. In Florida and Central America they were affected by domestic pollution.

The mangroves encountered by the Romanian Trans-African Expedition were an ecosystem developed in a salt marsh that was formed in a dried tributary of the Senegal River (NDONG, 1995) (Pl. II, Fig. 5). This kind of mangrove ecosystem is created by the occasional flooding with seawater of dry riverbeds during the high tide. The salt marsh mangroves have *Rhizophora*, crabs and “Atlantic mudskipper” fish, *Periophthalmus barbarus* (Pl. II, Fig. 6). This amphibious fish, with peduncle eyes, for view in both media, and fins serving also as feet, is very quick. The fish had a behaviour different from the one of the other *Periophthalmus* subsequently encountered on the trip. It was able « to predict » our action (us trying to catch it) and, a fraction of a second before, jump 1-2 cm farther. We were 8 people with nets around a small puddle and we were not able to catch even one. We could only collect one thanks to a rifle and the hunting ability of Cataranciuc.

The **Tropical dry forest** (Pl. II, Figs. 7; 8) is an inter-tropical plant and animal association, deciduous or semi-deciduous, dependent on two seasons (dry and rainy) – BRINSSON, 1977; BULLOCK et al., 2009. Its climate is most favourable for human life, agriculture, livestock farming, and urban development, for which reason the forest is the most exposed to deforestation. This ecosystem contains 42% of the inter-tropical vegetation of the planet (MURPHY & LUGO, 1995).

However the dry forest is often subject of climate perturbations. The Romanian Trans-African Expedition encountered the north of this forest in southern Senegal and in northern Nigeria. We only saw a forest gallery, like the one in Niokolo Koba National Park (Pl. III, Fig. 9). This forest was in some places exploited in an artisanal way, a few larger trees cut by individual farmers (Pl. III, Fig. 10), or, in others, more affected by the advancing of the Sahel and savannahs, which had drastically reduced the number of the park animals. The forest of Costa Rica is a typical dry tropical forest, the largest of its kind in Latin America (JRS Biodiversity Found 2012).

The forest looks like a checkerboard due to fragmentation (Pl. IV, Fig. 11). Until 2000, its development was aimed exclusively at agricultural export. Forest land now occupies only 2% of what it did before the Spanish colonization. Gradually, the forest has been subjected to the pressure of human activity. All generations of settlers cleared to expand or to make pastures but the fertility of soil obtained in this way is lost after only two generations (HERNÁNDEZ et al., 2005).

In the rainy season, tropical storms produce runoffs, landslides and floods, in the dry season winds increase the dryness effect (Banco de occidente, 2006) (Pl. IV, Fig. 12). In terms of biodiversity, fragmented ecosystems act as archipelagos: the largest are biodiversity hotspots (Banco de occidente, 2006). The forest fragmentation reduces available habitats for flora and fauna, eliminating species that require more territory, resulting in a selection and changing of former biocoenosis.

Lands we visited years ago, where we had noticed that the process had started, are now worsening continuously. Ecosystems change. In Africa, there is a tendency for dry tropical forests to turn into savannah-shrubs (XIV AETFAT Congress, 1996), and in Central America, despite efforts to create buffer zones, fragmentation continues. The increase in water deficiency in fragmented tropical forests installs meso-xerophilic conditions and leads to cacti “infiltration” (Pl. IV, Fig. 13). Cacti can be found in many dry tropical forests of Costa Rica and Nicaragua.

The first are semi-epiphytic cacti: seeds, delivered by bird droppings on branches of large trees, germinate and develop roots that descend on the trunks and penetrate into the ground. The roots are grouped into root bundles, e.g. *Strophocactus* or *Hylocereus*, (cactus of “dragon fruit”). (Pl. IV, Fig. 14)

The forest fragmentation impacts ecosystem productivity. Floral resource reduction greatly influences the biology of the pollinators and the efficiency of the pollination, acting on plant breeding and the mating system of the populations. The main pollinators, bats *Glossophaga*, *Leptonycteris* and *Micronycteris* suffer from guidance problems and confuse yards for deforested area often falling prey to domestic animals (QUESADA et al., 2014). Kevin shows a *Glossophaga* bat, disoriented and saved *in extremis* from dogs in our yard (Pl. IV, Figs. 15; 16). The bat is quiet and asleep, a moment often fatal.

Large trees can also be found in the Mesoamerican dry forest, as vestiges of former forests covering 90% of the territory. Large trees have no special value in the furniture industry, but are very useful in fixing CO₂ and matter transfer: *Ceiba pentandra*, *Paquira quinata*. These, among others, are the subject of **replacement with commercial species** which would bring rapid income, such as oil-palm *Elaeis guineensis*. (Pl. IV, Figs. 17; 18)

Cutting of native trees to replace them with plantations of trees intended for the furniture industry (teca or melina) (Pl. V, Fig. 19).

Fragmentation and wind (sometimes very strong), resulting from massive tree cutting, expose the remaining trees to uprooting and to many fires (Pl. V, Fig. 20). It is undeniable that, from one year to the other, the climatic situation in the deforested areas of the tropical dry forest deteriorates; this can be seen not in a rise in temperature, but especially in the arrival of sometimes very strong gusts of wind.

Increasingly more Central American countries, like Costa Rica and Nicaragua, seek to capitalize on this by installing wind fields (Pl. V, Fig. 21).

On several occasions I saw **the rain forest**. It encompasses more than half of the global biodiversity, the richest biome in biodiversity. On 1 ha of forest there can grow 100 or more different species of trees and wildlife. Diversity is very high. Overall, the rainforest is an important natural carbon shaft: stock more carbon than they release, taking a large amount of CO₂ from the greenhouse effect. They also play an important role in water balance and form a physical barrier in the path of drafts. The tropical rainforest actively intervenes in the Earth's climate.

The felling of large trees for valuable wood, mining, large development projects, in other words massive deforestation, makes FAO estimates the deforestation rate as being 13 million ha/y, 15 ha/ minute, **a risk of total loss by 2030** (*Jardin botanique nationale de Belgique, 2014*).

The **Romanian Trans-African Expedition** encountered its first rainforest near Bangui (capital of the Central African Republic; Pl. VI, Fig. 22). It was a **low altitude rainforest**, with thin trees that are fast growing and can reach up to 50 m high. This band of forest continued to Boali Falls, to the team's, especially Nicu COMAN's, satisfaction and excitement (COMAN, 1975).

This rainforest accompanied us along the northern Congo basin (Pl. VI, Fig. 23). Denser than in the Central African Republic, but also with large trees (many *Ceiba pentandra*) with buttresses. It was hard to photograph because of the darkness caused by the density of the trees and canopy. We could hear and feel bustling life up high, but it was inaccessible to our vision.

In Ituri forest (**hill rainforest**; Pl. VI, Fig. 24) the Romanian Trans-African Expedition reached the research and development resort EPULU, specialized in studying and saving a living fossil (Pl. VI, Fig. 25), the okapi (*Okapia johnstoni*), ancestor of the giraffe. The okapi, hidden in the depths of the forest, were known to pygmy tribes and Europeans rediscovered the species in 1901.

The **mountain rainforest**, with trees rarely exceeding 50 m in height, is the type of forest that I saw along the African Rift (in the Romanian Trans-African Expedition) and then in the Caribbean and in Central America (Pl. VI, Figs. 26; 27).

In Africa (Virunga – R.D. Congo) and the Caribbean (Commonwealth of Dominica), a bamboo forest grows at the edge of the mountain rainforest (Pl. VII, Fig. 29).

The presence of bamboo could be a reliable source of sustainable development. This grass (*Poaceae*) has special qualities, its strength, elasticity, specific weight, in addition to increasing the capacity of soil formation through its system of rhizomes. Being called “vegetal steel”, bamboo has been used for thousands of years in construction and is still used today. With very rapid growth, the plantation is almost maintenance free. It is an excellent plant for reforestation of desert or eroded grounds; bamboo is green, durable, robust and cost-effective. One hectare of bamboo captures 62 tonnes of CO₂ per year and regenerates after cutting in 3 to 5 years, while a plantation of young trees captures only 15 t CO₂ per year and regenerates after 30 years. Many countries that have this resource exploit it, and the ones that have it and do not exploit usually demonstrate a lack of expertise. Several times I was given this reply when trying to present its advantages; I am a big supporter of using bamboo (NASSAR et al., 2011).

In the mountain rainforest of Dominica, I often saw *bromeliaceae* on trees (Pl. VII, Fig. 28). At the base of the leaves, the plant gathers rainwater, making a little “pond” with a rich biocoenosis containing many water oligochaetes. In Central America, I saw a peculiar variant of mountain rainforest, the **cloud forest**. Everything is caught in fog and fine rain falling on all sides. It is not rain from the clouds (the sky is clear) but the water that comes out is from the ground and the sweat of vegetation.

Tropical deforestation seriously threatens the health of the planet. The role of tropical forests in gas exchange, in the cycle of matter, in atmospheric CO₂ storage and bioremediation are well known. It also has an increasingly more needed role in shielding against hurricanes and destructive waves (e.g. tsunamis). Finally, the need to replenish them for the global climate balance is recognized. The greatest connoisseur in the life of the rainforests, Dr. Francis Halé, estimates that natural recovery after massive deforestation may take 600 years, so the urgency of the situation requires reforestation by planting. All kinds of technologies have been tested, most of them targeting ways that provide fast recovery (fast growing species that provide also industrial recovery). More harmful than actual tree cutting is the conversion of tropical ground soil into plantation soil. Also, there is the monoculture problem. Dr. Akira Miyawaki, director of the Japanese Centre for International Ecological Studies came with a truly ecological concept:

« **NO MANAGEMENT = BEST MANAGEMENT** »

Plant native trees with extensive root system, with a quantity of local edaphic biocoenosis and leave time and selection to act. This concept comes after successfully planting 40 million trees in 15 different countries and official recognition that these forests saved from flooding hundreds of millions of hectares of land. Sebastiao Salgado, in Brazil, using a similar strategy, has succeeded in “rehabilitating” lands of significant size in Minas Gerais.

Coordinated action by the UN climate comity, the recent establishment of the interdisciplinary organization **FUTURE EARTH** with its international headquarters in Montréal (Canada) and holistic approaches to the environmental issues give greater hope to the tropical forests of our planet (NECULCE, 2013).

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Plate I



Figures 1, 2. Mangrove thickets.



Figure 3. Mangrove crabs.

Plate II

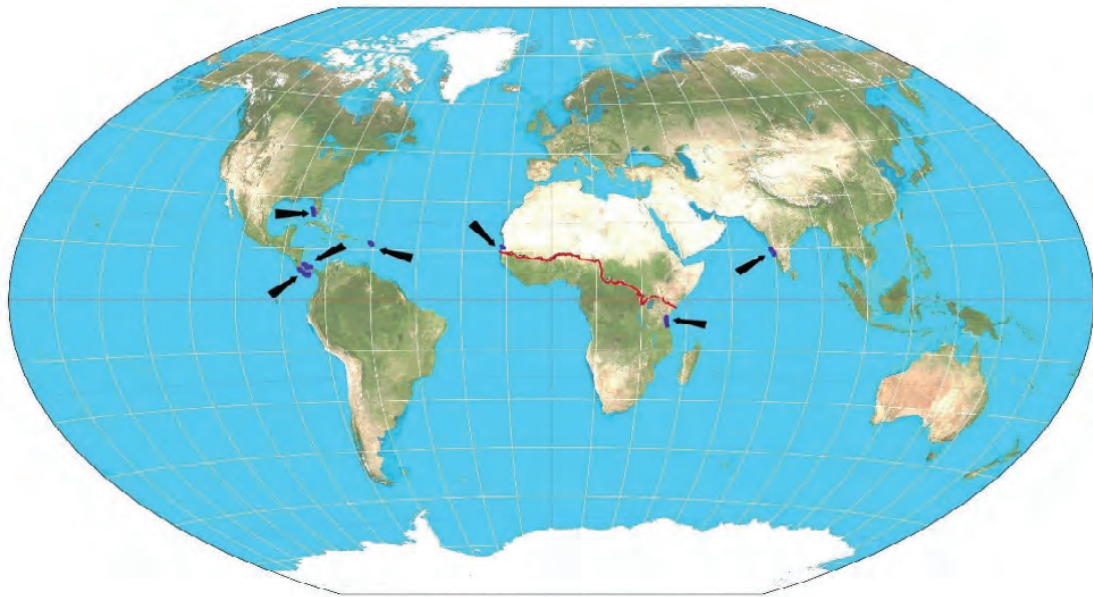


Figure 4. Visited mangrove sites.



Figure 5. Pond with *Periophthalmus*, Senegal.



Figure 6. *Periophthalmus barbarus*, Senegal.

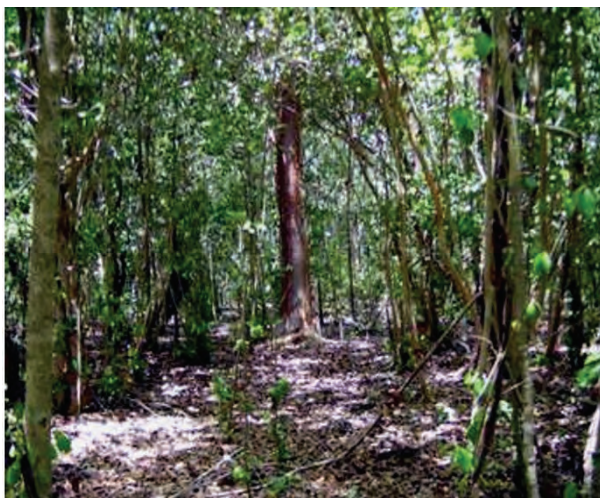


Figure 7. Dry tropical forest, Caribbean.



Figure 8. *Nephila claviceps*, in the dry tropical forest of the Caribbean. The thread of the web is stronger than steel and is excellent for neuronal regeneration in mammals; it is antibacterial and does not trigger immune rejection.

Plate III



Figure 9. Gallery forest, Senegal (Niokolo-Koba).



Figure 10. Ebony tree chopped down to make room for pastures, Senegal.



Figure 11. Forest fragmentation, Costa Rica.



Figure 12. Deforested land, transformed into pastures; it does not retain rain water anymore and starts degrading, Costa Rica. The deforested terrain is exposed to winds and dryness.

Plate IV



Figure 13. Cacti in a dry tropical forest, Costa Rica, Nicaragua.



Figure 14. At the limit of the forest, semi-epiphytic cacti start growing on trees (*Hylocereus* –pitahaya cactus, which bears the comestible dragonfruit).



Figures 15, 16. Disoriented *Glossophaga* bat saved in the yard by Kevin.



Figures 17, 18. Cutting down of secular native trees to replace them with *Elaeis guineensis* plantations, Costa Rica.

Plate V



Figure 19. Part of a native-tree-deforestation zone.



Figure 20. Dry tropical forest, pastures and wildfires induced by drought.



Figure 21. Wind farms, Guanacaste CR and Nicaragua.

Plate VI



Figure 22. Outpost of the tropical rainforest in Bangui (Central African Republic).



Figure 23. Tropical rainforest in the Great African Rift (Virunga).



Figures 24, 25. Ituri forest and one of the residents of Epulu Station and Okapi.



Figures 26, 27. Tropical rainforest in the Caribbean.

Plate VII



Figure 28. Bromeliaceae in the tropical rainforest of Dominica.



Figure 29. Bamboo forests at the edge of the tropical rainforest in Africa and Central America.