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Coastal upwelling and distributional pattern of West African vegetation

Výstupné mořské proudy a charakter rozšíření západoafrického rostlinstva

Jan Jeník

Dedicated to S. Hejný, Corresponding Member of the Czechoslovak Academy of Sciences, on his 60th birthday.

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In the coastlands of Guinea, vegetation varies under the impact of oceanographic and climatic events around Cape Palmas and Cape Three Points. Off-shore Ivory Coast and Ghana, two centres of coastal upwelling of cold water affect lower rainfall totals and rainfall seasonality of the coastal climate, thus splitting the latitudinal zones of vegetation, and inducing a longitudinal diversity of rainforest, semideciduous forest, tree savanna and grassland. Quaternary paleoclimatic fluctuations either smoothed down or emphasized this distributional pattern, but even in a perhumid period a discontinuity of evergreen forests in the Dahomey Gap did not cease existing.

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INTRODUCTION

Vegetation maps of Africa, such as compiled by AEFAT (1958) and Unesco (1981), show clear latitudinal zonation in the sub-Saharan region. The only major irregularity appears to be a wedge of savanna formations splitting the closed canopy forest in the interval between Accra and Lagos. The prevailing southeasterly trade winds and movements of the Inter-Tropical Convergence Zone perpendicularly to the West African coastline tend to suggest that, were they not disturbed by exceptional factors, tropical forests would "normally" stretch as a homogeneous belt, from Sierra Leone in the west to the Cameroons in the east. No wonder that many sketch-maps of West Africa (CLARK 1967; CUMMING 1982) keep drawing parallel vegetation zones sown to the Gulf of Guinea.

In geobotanical terms, SCHIMPER (1898 : 299–300) possibly, was first to report on "manifold variation of forest and savanna" along the western coast of tropical Africa. His scientific message, understandably, merely reflected common experience of indigenous African people, and the knowledge of European sailors and colonizers arriving to West Africa since the 15th century (HARRISON CHURCH 1963). Drier savanna portions of the coast (Gold Coast, Slave Coast) naturally, contrasted with the humid districts infested by malaria. Consequently, even botanical exploration of West Africa started, at the end of 18th century, in the semiarid Danish Guinea, the present-day southeastern Ghana and Togo (HEPPER 1976).

Early descriptions of vegetation pattern in West Africa employ rough physiognomic units, such as "virgin forest", "parkland" or "savanna". Pioneers of the botanical research, lacking reliable topographic maps and adequately described flora, necessarily, produced only small-scale charts (THOMPSON 1910; CHEVALIER 1912; ENGLER 1925) showing the boundary of closed-canopy forests. Later on, investigations into the vegetation proceeded separately in the anglophone and francophone countries, and political boundaries kept inhibiting the generalization of scattered results achieved by individual scholars and teams in various parts of West Africa.

Formations of the closed-canopy forest (also "high forest" in English, and "forêt dense" in French) represent the southernmost vegetation belt in the coastlands of Guinea. Upon the first approach, the closed-forest formation can be interpreted as a single vegetation type, such as "unterer Regenwald" (ENGLER 1925) or "Moist Forest" (AETFAT 1958). A pioneer sketch-map by THOMPSON (1910), based on extensive travelling on foot in Gold Coast, distinguished three closed-canopy forests: Rainforest, Monsoon Forest and transition between Monsoon and Savannah Forest. Using four different units of "Monsoon Climax" not normally subject to inundation, and three "Seral Units" of forests subject to inundation, CHIPP (1927) extended this classification. In the neighbouring Ivory Coast, AUBRÉVILLE (1936) distinguished between "rainforest" and "deciduous forest" (see also SCHNELL 1950 : Fig. 8).

After the World War II, MANGENOT and co-workers (1948) and SCHNELL (1952) attempted to introduce phytosociology into the classification of forests in Ivory Coast. While the former work resulted into classification of three dominant "associations" (*Tarrietia-Mapania*, *Berlinia-Heisteria* and *Triplochiton-Mallotus*), the latter provided a broad nomenclatoric frame for phytosociological syntaxa of the whole West Africa: the *Pycnanthetea* class with two orders (*Lophiretalia* for rainforests, *Triplochitetalia* for mesic closed forests), the *Parinarietea* (for montane forests), and the *Mitragyno-Raphietea* (for swamp forests).

In the anglophone countries Chipp's eco-physiognomic classification has further been developed. In Nigeria, KEAY (1953) employs three units: "rainforest", "dry forest" and "derived savanna". TAYLOR (1952, with minor alterations also in 1960) divided the Ghanian forests into one association referring to rainforest (*Cynometra-Lophira-Tarrietia*) and three associations covering the moist semi-deciduous forest (*Lophira-Triplochiton*, *Celtis-Triplochiton*, and *Antiaris-Chlorophora*, named along the gradient of decreasing rainfall).

Though the classification of individual countries were refined, there was no attempt to find reasonable coincidence of boundaries of vegetation units in two neighbouring states. For example, there are some discrepancy in the separate mapping of Ivory Coast and Ghana (compare TAYLOR 1952, and MANGENOT 1956). Phytogeographically, the diversity of the Upper Guinea forest block has been examined by GUILLAUMET (1967); his monograph describes the wet evergreen forest lying near the Liberia-Ivory Coast boundary, and analyzes the occurrence of the so-called "Sassandrian" floristic element in three wettest forest areas of West Africa. Remarkably, one of these obvious centres of rainforest, the region astride the southern Ivory Coast-Ghana boundary, is missing on a sketch-map published by KNAPP (1973 : 35).

Forests on the territory of Ghana have recently been classified by HALL and SWAINE (1976, 1981). Using detailed floristic sampling and sophisticated ordination procedure, these authors have defined seven types forest, and produced a map of their distribution. This classification, achieved by fairly objective method, reflects the diversity of West African forests and the steep gradient that develops to the east of the Cape Three Points.

With regard to the northern delimitation of the West African closed forest, all small-scale maps indicate the 8° northern latitude as an average limit against the Guinea savanna. Most of them show two remarkable irregularities: (1) An interruption of the forest belt by a wedge of savanna vegetation reaching the Gulf of Guinea between Accra and Lagos. (2) A marked wedge of savanna vegetation penetrating into the closed forest of Central Ivory Coast. (Both abnormities are discussed in the following chapter.) However, there is a notable disagreement in the delimination of the southern boundary running along the coastline. Starting with the conception of CHEVALIER (1912) and ENGLER (1925), a continuous marginal zone of "coastal savannas" is repeatedly assumed to separate the closed forest from the sea. However, observations in south-western Ivory Coast, southern Ghana and the Cameroons suggest that, unless disturbed by human action or inhibited by waterlogged soils, rainforest can reach right to the coastline, often bordered by a marginal scrub catching the salt-spray (e.g., *Chrysobalanus orbicularis*). To the east of Takoradi in Ghana, all recent maps, in agreement with past observations, confirm a potential strip of coastal thickets and savannas, nowadays heavily disturbed by farming.

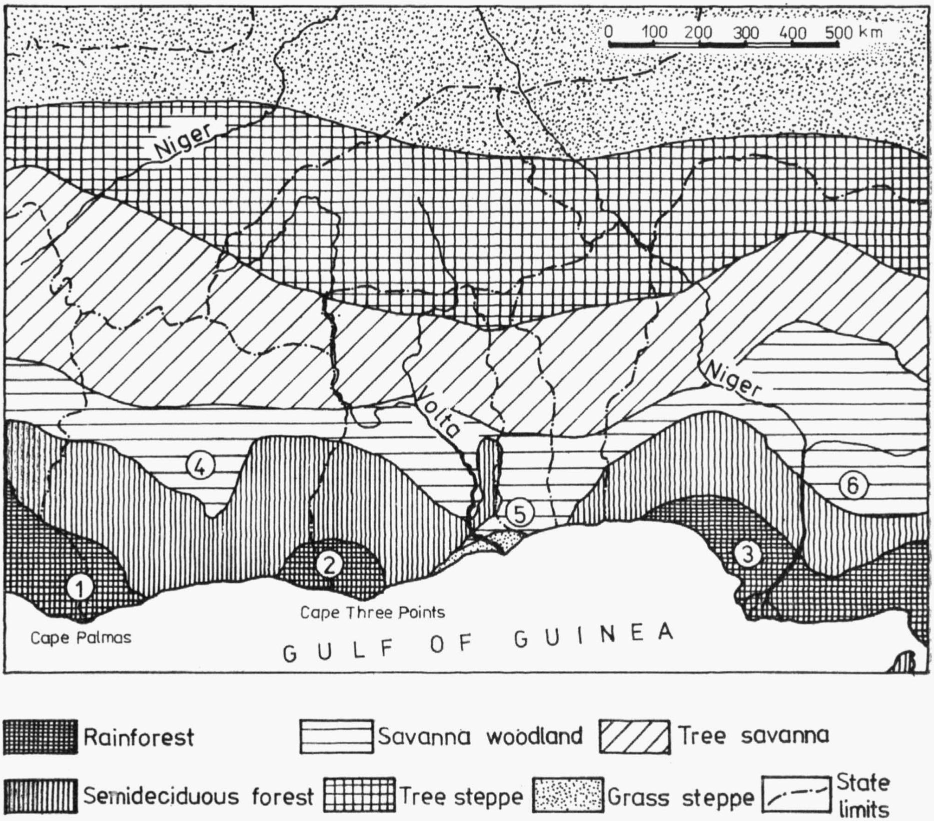

Fig. 1. — Sketch-map of distributional pattern of vegetation affected by Cape Palmas and Cape Three Points: 1, 2 and 3 centres of wet evergreen forest (*Lophiretalia*), 4, 5 and 6 promotories of tree savanna (*Andropogonetalia*); dotted patch marks the dry steppe (*Vetiverietea*); 4 marks the Baoulé V, 5 is called the Dahomey Gap.

So far, no detailed map has been published showing the delimitation between rain (evergreen) and drier (semideciduous) closed-forest types over the entire West Africa. A few small-scale maps of both anglophone and francophone authors agree, however, that the heavily exploited closed forest displays three centres of evergreen rain forest: (1) Liberia and SW corner of Ivory Coast, (2) SE corner of Ivory Coast and SW corner of Ghana, and (3) Region around Benin in Southern Nigeria. In Ghana and Ivory Coast, the boundaries between the evergreen and semideciduous forest run at a constant distance from the outer boundary of the closed forest. Therefore, the savanna wedge of Baoulé V in central Ivory Coast is replicated by a larger wedge of semideciduous forest (*Triplochitetalia*) reaching the coast and interrupting the belt of evergreen forests (*Lophiretalia*).

Taking into account only a simple classification of the closed-canopy forest, we cannot disregard a marked longitudinal component in the variation of West African vegetation (see Fig. 1). For large-scale surveying, altitudinal aspect, too, cannot be neglected, as shown, for example, by SCHNELL (1952) for Nimba mountains, or by HALL and SWAINE (1981) for even less prominent elevations.

DISTRIBUTION AND VARIATION OF THE SAVANNA

In the coastlands of Guinea, two savanna districts attracted attention of many scholars: the so-called Dahomey Gap and Baoulé V.

Early botanical collections by ISERT and THONNING (HEPPER 1976) implied, and pioneer expeditions of CHEVALIER and THOMPSON confirmed that, to the east of the Ashanti land, tropical forests cease to thrive, and various kinds of savanna vegetation spread over plains and hills. Stretching eastwards across the present-day eastern Ghana, Togo and Benin (formerly Dahomey), this savanna and open woodland merge in closed tropical forest eastward of Lagos, in the neighbourhood of the Bight of Biafra. Splitting the Guinea closed-forest block in two parts, this savanna wedge is being called by biologists and geographers as "Dahomey Gap", "Dahomey Corridor", "Volta Savannah-corridor", "Dahomey Interval", etc.

The other conspicuous savanna region in West Africa is a wedge penetrating 200 km southward into the closed forest of central Ivory Coast. This phytogeographical anomaly was recognized already by ANGOULVANT (1908, sec. PELTRE 1977 : 117) and clearly outlined in the ENGLER's map (1925). Later, this feature received the name of "Baoulé V" ("V Baoulé" in French).

Precise delimitation and geobotanical explanation of both the Dahomey Gap and Boulé V vary substantially. With regard to the situation, SCHNELL (1950) indicated that the Dahomey Gap extended between western Ghana and Lagos in Nigeria. PHILLIPS (1959 : 100) put it as an interval "between Sekondi in Ghana... across the Volta, through Togoland and almost to the Dahomey-Nigeria border". BAKER (1962 : 157 et Fig. 46) wrote on "non-forest area between Volta and Togo-Dahomey borders". PAPADAKIS (1966 : 12) described "the dry coast of eastern Ghana, Togo and western Dahomey". A confusion remains in the characterization of dominant vegetation types represented in the Dahomey Gap. Facultative terms like "forest-savanna mosaic", "thicket", "coastal scrub", "open woodland", "coastal savanna" and "coastal steppe" are loosely used in literature. With regard to the sub-Saharan latitudinal zonation, the Dahomey Gap appears as an outlier of the Guinea savanna woodland, or a forepost of the Sudan savanna or even an exclave of the Sahel zone (AUBRÉVILLE 1949 : 157).

The variety of climatic and soil conditions, necessarily, differentiates the vegetation types involved. On the territory of Benin (formerly Dahomey) (ADJANOHOUN 1965, 1966) and in Ghana (BRAMMER 1967) numerous vegetation units have been classified. Consistently with the varied "soil associations", BRAMMER (op.c.) distinguished tall, medium and short grassland, with a varied admixture of trees, tree clumps and thickets. Applying the methodology of the Zürich-Montpellier-School, JENÍK and HALL (1976) classified the vegetation of the Accra Plains within two separate phytosociological classes. The *Vetiverietes*, comprising the driest shortgrass vegetation of the Dahomey Gap, are further divided into the *Eragrostidetalia* (developed on acid gneiss) and *Vetiverietalia* (covering districts with black montmorillonite soils derived from basic gneiss). Comparative studies in Togo and Benin, together with the evidence provided by ADJANOHOUN's work, resulted in the conclusion that the Accra Plains represent the driest "core" of the Dahomey Gap.

Geobotanical studies in Baoulé V brought, similarly, a new insight into the diversity of this savanna region. AVENARD and co-workers (1972) and PELTRE (1977) described a broad association with *Brachiaria brachylopha*, consisting of three subassociations: (1) Subass. with *Loudetia simplex* grows at the advanced end of the wedge in the centre of Ivory Coast; (2) Subass. with *Loudetia arundinacea* covers the middle portion of the wedge; (3) and subass. with *Panicum phramitoides* extends over the northern margin near the Sudan savanna zone. PELTRE (op.c.) calls the vegetation of Baoulé V as "pre-forest savanna", and speculates about its origin. Referring to "favourable relief and soils" he assumed that savannas of the Baoulé V represent a paleoclimatic relict of drier Holocene period. MENAUT and CESAR (1982) consider the southern part of Baoulé V as a forest climax liable to be invaded by forest species if fire is excluded.

Other parts of West African savanna regions, too, raised manifold questions regarding their classification and delimination. Particularly the savanna belt bordering the closed-forest zone is suspected to be a product of longlasting and effective man-induced transformation. Following KEAY (1953) this belt is being called "derivedsavanna". It was this broad and ambiguous concept that frequently obscured the identity of vegetation in the Dahomey Gap and Baoulé V.

ECO-GEOGRAPHIC FACTORS

Causative factors in the distributional pattern of West African vegetation, were seldom analyzed as a whole. Yet, particular climatic, edaphic or biotic factors have been emphasized in order to explain anomalous phenomena in the closed forest or savanna distribution (SCHNELL 1976 : 128—129).

Common experience, and, later, results of meteorological monitoring of temperature and rainfall (see their summarization in WALKER 1962, HARRISON CHURCH 1963, FULLARD 1966) made it possible to relate the forest and savanna types to monthly means and annual totals recorded at meteorological stations. The isohyets, supported by only a few points of measurement, may not be reliable, but there seems to be a good coincidence between "exceptionally wet portions of maritime Guinea" (Phillips 1959 : 97) and evergreen closed forest, and between "anomalous coastal dry zone" (White 1954 : 46) and open savanna and grassland. Along the approx. 5° northern parallel, variation of rainfall within a short distance, is astonishing: over 4000 mm on the coast of Liberia in contrast to 700 mm on the Accra Plains. Consequently, the distributional pattern of vegetation was explained as a straightforward adaptation to given climatic factors (Chipp 1927) or bioclimatic regions (Phillips 1959).

Detailed surveying of forest and savanna in West Africa also pointed out decisive impact of local relief, soils and drainage. Unlike the "strip survey" of foresters (Taylor 1962 : 115) ecological classification tends to distinguish between climatic and edaphic climax (Chipp 1927) or between climatic climax and seral communities (Taylor 1960). The soil+vegetation catenas are also reflected in the phytosociological units described for closed forest by Schnell (1952) and savanna by Jeník and Hall (1976).

While pursuing the problem of general distributional pattern, we are more interested in the large-scale effects of prevailing parent rocks that could affect weathering, soil texture and properties of clay minerals. In this sense Mangenot and Miège (in Mangenot 1958, mappa) identified and surveyed "forêts pélo-hydrophiles" and "forêts psammo-hydrophiles" in Ivory Coast. For the savanna and grassland of the Accra Plains, Brammer (1967) and Jeník and Hall (1976) assessed far reaching correlation between floristically defined plant communities and underlying "soil associations"; basic and acid gneisses weather and develop into ecologically different substrata. On the other hand, within the closed-forest zone Hall and Swaine (1981 : 23) have not found any recognisable influence of parent rock on the pattern of forest types.

As mentioned above, with respect to the relief, vegetation of West Africa shows obvious adjustments to the altitude reached by high mountains, e.g. by Loma Mts. (1946 m) in Sierra Leone, and Mt. Nimba (1854 m) situated near the triple landmark between Ivory Coast, Liberia and Guinea (Jaeger et Adam 1971, 1975). Even lower ridges, such as Atewa Range (738 m) and Tano Ofin (693 m) in Ghana, cause variation of the forest cover; Hall and Swaine (1981) described an "Upland Evergreen Forest-type". Nearby, in the Dahomey Gap, the Togo Hills (886 m) possess a variety of semideciduous forests and savannas (Jeník et Hall 1966; Hall et Swaine 1981).

Biotic factor themselves were suspected to act as decisive factor in the vegetation pattern. Chipp (1927 : 24) even suggested that the mass of vegetation ifself is liable to produce modification of the local climate and reinforce the vitality of wet evergreen forest. On the other hand, established grasslands on the top of mountains or near the coast are suspected to resist the invasion of forest communities due to unfavourable soils (Adjanohoun 1965; Hall et Swaine 1981).

With regard to large transformation of West African landscape by human populations, an essential question must be raised: Are not the anthropogenic factors themselves responsible for the shifting of boundaries between major vegetation zones? According to Davies (1964) paleolithic industries were present in West Africa at least 50 000 B.P. Mesolithic arrived to the Guinea savanna at the onset of relatively dry climate about 4 700 B.P.; Neolithic appeared shortly B.C. Both forest and savanna regions were scarcely inhabited, yet hunting and agriculture, coupled with intentional burning of combustible dry grasses and leafless scrub, supported extension of the savanna vegetation and retreat of forests (Schnell 1971 : 594—603). No evidence, so far, refers to the shifting of boundaries between various closed-forest types. For example, the peopling of the forested part of Ghana is a comparatively recent affair, about 1000 to 1600 A.D. (Ward 1966). Howewer, in the few last centuries, shifting cultivation caused major alteration in the composition of the primeval forests.

OCEANOGRAPHIC FACTORS

Rainfall amounts and rainfall seasonality, the two highly efficient eco-geographic factors in vegetation pattern of West Africa, are conditioned by seasonal migration and pulsation of Tropical Maritime Air and Tropical Continental Air (Harrison Church 1963 : 21—22). The prevailing south-westerly trade winds and counteracting currents of the Sahara cause that the general orientation of the Inter-Tropical Convergence Zone follows the geographical parallels. This general exchange of air masses should create uninterrupted latitudinal zonation of vegetation. In order to clarify the obvious longitudinal variation in the distributional pattern, sea currents and coastal upwelling must be taken into account.

Longhurst (1962) and more recently Houghton and Mensah (1978) reviewed the features of the Guinea current streaming throughout the year in the west-east direction in the Gulf of Guinea. The speed and temperature of this sea current vary seasonally. East of Cape Palmas and east of Cape Three Points, two areas of cold surface water occur whose origin was broadly discussed. According to the latest views, the chilled water is of local origin and not advected into the area from the southwest Africa by the Benguela current. The chilling effect results from coastal upwelling arising (1) due to huge eddies of the wind-driven current in the "wake" of the above named capes, or (2) due to more complicate interaction of surface winds, surface current above the shelf, and currents in the neighbouring deep sea. A relief map produced by a radar altimeter on satellite (Canby 1983) shows abrupt fall of the West African coast and the prominent Cape Palmas and Cape Three Points. Necessarily, these promontories demarcate regions of distinct hydrography in the Gulf, and related geographical processes in the coastlands of Guinea.

The impact of cool water on the climate of the neighbouring land is well understood in other parts of the Tropics (e.g., the effects of the Humboldt current on the coast of Peru); the interaction between coastal upwelling and both marine and terrestric ecosystems have also been studied (Dragesund 1971; George et al. 1970; Heydorn 1972). When transported landwards by the prevailing wind or by the sea breeze, the water-saturated and chilled air loses capacity for precipitation, above the warm land surface. In regions of great temperature differences, an arid coastal region may develop, such as Atacama Desert in South America, semi-desert zones on the Galapagos Islands, or Accra Plains in West Africa.

The effect of an upwelling of cold water off the coast was reasoned about already by Chipp (1927 : 24) while explaining the dryness of littoral regions of Ghana and Togo. Portères (sec. Schnell 1976 : 129) used similar explication for the wedge of Baoulé V savannas. The same ideas appears in a variety of geographical and biological studies, e.g., MANSHARD (1961 : 16), WALKER (1962 : 11), HARRISON CHURCH (1963 : 54—55) and HOWELL and BOURLIÈRE (1964 : 633).

The promontories of Cape Palmas and Cape Three Points, however, do not appear as a strict landmark for either the rainfall or vegetation types. The upwelling and chilling of both the sea water and air are removed eastwards, and as clearly seen in Ghana, progressively effective in a certain distance to the east. Therefore the vegetation pattern eastwards of the Cape Three Points shows a "fan-shaped" zonation with a steep gradient of vegetation types (TAYLOR 1952, mappa; HALL et SWAINE 1981 : Fig. 2.4). Towards the west of the capes there is also a gradient of increasing humidity and corresponding vegetation types. The rainfall maxima and centres of wet evergreen forest are shifted westwards of Cape Palmas to the territory of Liberia, and westwards of Cape Three Points to the boundary zone between Ivory Coast and Ghana.

The coastal upwelling tends to be more pronounced in December—January and July—September. This seasonality reinforces the variation of vegetation pattern along the Gulf of Guinea. The *Lophiretalia* with the equably humid climate, on one side of the gradient, have an opposite ecosystem in the *Vetiverietea,* marked by two separate dry seasons (JENÍK et HALL 1976).

EVOLUTIONARY REMARKS

The characteristic outline of the coast with two prominent promontories was a constant feature of West Africa since the beginning of the continental drift. For our purpose, there is no need to speculate about its influence on coastal environment in the distant past, when the Equator was situated far from its present position. However, the interaction between oceanographic and eco-geographic factors along the coast of Guinea was an ancient phenomenon. The phosphatic deposits situated off-shore Ghana (TOOMS sec. DRAGESUND 1971 : Fig. 5) suggest that an coastal upwelling in this area might have influenced the neighbouring land for many million years.

Distribution of the sites of the Acheulian hunter-gatherers in sub-Saharan Africa (HOWELL et CLARK 1964 : Fig. 1), dated back to Middle Pleistocene about 100,000 to 150,000 B.C., shows a concentration in the present-day Dahomey Gap and absence in the closed-forest areas. The above authors (op.c. : 526) stated that there is no evidence that Acheulian populations occupied a country that is today arid, on one hand, or evergreen forest, on the other hand. Presenting a tentative scheme of absolute chronology for the coastlands of Guinea, DAVIES (1964 : 80—82) described fluctuation of humid and dry periods in the Middle and Late Pleistocene, which is reflected in the distribution and sequence of various industries. DAVIES (op.c. : 82) and more recently TALBOT (1981) report on an onset of arid conditions about 4500 B.P., which brought to the end the equable climates prevailing in West Africa during the earlier Holocene.

Climatic fluctuations, necessarily, led to subsequent alterations of vegetation pattern. In West Africa, similarly to other equatorial regions, during the peaks of glacial periods of the Pleistocene, the closed-forest zone disintegrated, leaving only small forest refuges (HAFFER 1982 : Fig. 2.2).

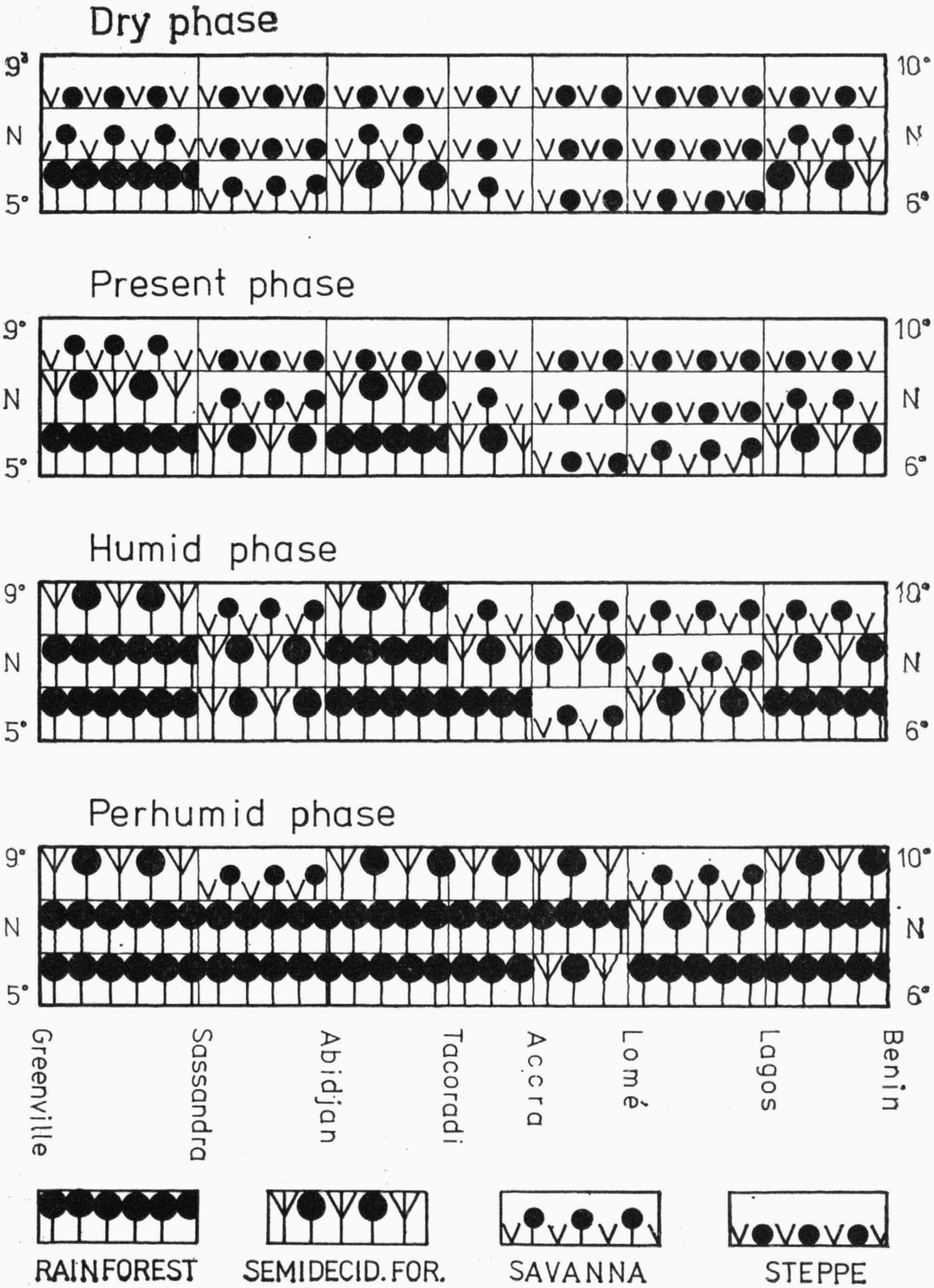

Fig. 2. — Schematical illustration of the hypothetical variation of West African vegetation during four climatically different periods in the Quaternary.

Temporary isolation of these refuges is well reflected in the present-day occurrence of various forest species, as recorded by HUTCHINSON and co-workers (1954—1972) and analysed by GUILLAUMET (1967), SCHNELL (1976) and HALL and SWAINE (1981). Duration and chronology of the forest refuges and savanna corridors can also be estimated according to the distribution of forest animals (GRUBB 1982).

GUILLAUMET (1967 : 165—168) did the first step to illustrate possible evolution of the entire vegetation pattern of West Africa. Using only two categories, "wet closed forest" and "non-forest", GUILLAUMET (op.c.: Fig. 50) left open the question of possible development of various types of closed forest and savanna. We have attempted to draw a diagram (Fig. 2) of the assumed evolution of vegetation types, in three latitudinal zones in the coastlands between Greenville in Liberia and Benin (town) in Nigeria. We believe that the oceanographic events off-shore West Africa never ceased influencing the "longitudinal" variation of vegetation types. Very likely, even in the perhumid phase of the Inter-Pluvial periods, a diversity and discontinuity of forest belt never ceased to exist, thus preserving a number of "Upper Guinea Endemics" (sensu HALL et SWAINE 1981) in the forest block lying to the west of the Dahomey Gap.

SOUHRN

V zemích kolem Guinejského zálivu se vegetační pokrývka utváří pod kombinovaným vlivem oceanografických a klimatických činitelů. Pro rozšíření hlavních vegetačních typů jsou významné výběžky pevniny v obvodu mysu Cape Palmas a mysu Cape Three Points, které před Pobřežím Slonoviny a před západní Ghanou způsobují vznik výstupných mořských proudů. Chladná voda z těchto okrsků ochlazuje vzduch, který vlivem převládajících jihozápadních pasátů i vlivem denní mořské brízy proudí nad ohřátou pevninu, kde klesá jeho schopnost kondensovat vodní páru. Rozdíl v teplotách je příčinou nízkých srážek a jejich nerovnoměrnost během roku, což kontrastuje s deštivým klimatem nedalekých oblastí. Tím je narušena šířková zonace rostlinstva a ve směru zeměpisné délky navozeno střídání vždyzeleného deštného lesa, poloopadavého lesa, stromové savany a krátkostébelné stepi. Paleoklimatické výkyvy v minulých dobách kvartéru zdůrazňovaly nebo tlumily tuto longitudinální složku diversity, avšak existence četných hornoguinejských endemitů napovídá, že deštný les netvořil ani v perhumidních interpluviálech souvislé homogenní pásmo.

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See also Plates XV and XVI in the Appendix.

K. Förster:

Das Phytoplankton des Süsswassers, 8. Teil, 1. Hälfte

Conjugatophyceae. Zygnematales und *Desmidiales* (excl. *Zygnemataceae*). E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart 1982, (8) + 543 str., 11 obr. v textu + 785 obr. ma 65 tabulích, váz. 174,— DM. (Kniha je v knihovně ČSBS.)

Spájivky, *Conjugatophyceae*, patří mezi obecně rozšířené, výhradně sladkovodní zelené řasy s charakteristickým pohlavním rozmnožováním, konjugací. Řadíme k nim jednak *Zygnematales* s převážně vláknitou stélkou a jednak krásivky (*Desmidiales*), které jsou převážně jednobuněčné.
Zástupci poslední skupiny vynikají výrazným tvarem buněk, bohatstvím druhů a ekologickou vyhraněností. Z těchto důvodů byly krásivky mnohokrát důkladně zpracovány. Recenzovaná monografie K. Förstera je jedním z posledních děl tohoto druhu. Vychází téměř současně s 1. dílem pojednání o evropských krásivkách (Růžička), s monografií o krásivkách Severní Ameriky (Prescott, Croasdale, Vinyard), s klíčem k určování krásivek SSSR (Palomar-Mordvinceva) aj. Její zvláštností je výběr planktonních druhů, což je dáno povahou edice, v níž kniha vychází. Srovnání Försterova pojetí taxonů s citovanými monografiemi a klíči ukazuje na postupné sjednocování názorů na vymezení taxonů. Zpracování krásivek je rozvrženo do dvou dílů. První z nich obsahuje obecný úvod, popisy taxonů, určovací klíče a kresebné tabule vysoké úrovně. Z velkých rodů jsou zpracovány *Closterium*, *Cosmarium*, *Euastrum* a *Micrasterias*. Druhý díl je plánován pro rok 1984, ale vzhledem k úmrtí autora lze očekávat určité zpoždění. Druhý díl přinese zpracování rodu *Staurastrum*, *Xanthidium* a vláknitých krásivek.
Recenzovaná kniha bude výbornou pomůckou pro všechny, kdož při rozborech planktonních vzorků tyto řasy určují.

T. Kalina

Plate XV. 1. — View of the rainforest (order *Lophiretalia*) in the valley of Ankobra river, south-western Ghana.
Plate XV. 2. — Interior of the rainforest in the Ankasa Forest Reserve, south-western Ghana.

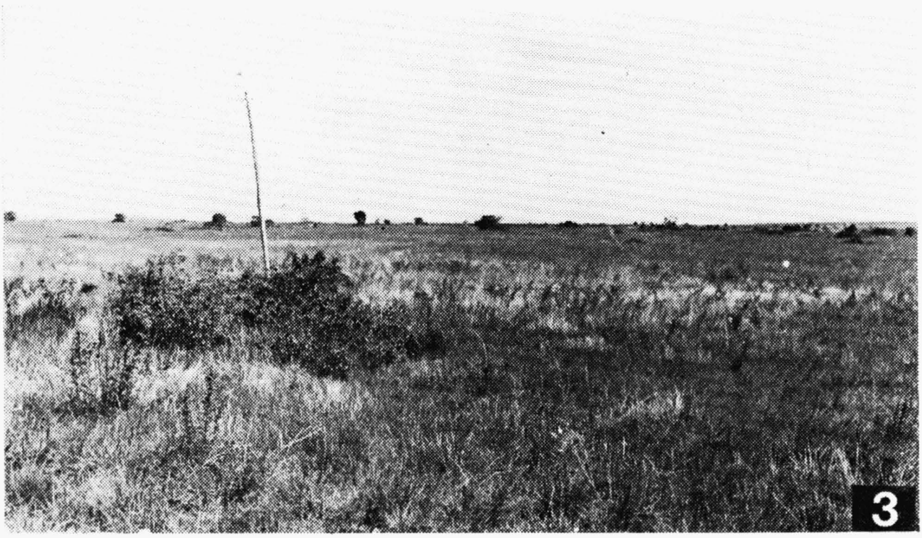

Plate XVI. 3. — Shortgrass steppe (class *Vetiverietea*) on the Accra Plains, south-eastern Ghana
Plate XVI. 4. — Tree savanna (class *Andropogonetea*) in the Mole Game Reserve, northern Ghana.