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Riverine forest in the Jubba Valley: A vegetation analysis and comments on forest conservation

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SUMMARY

Detailed vegetation surveys were carried out in two riverine forest areas in the Jubba Valley, southern Somalia. Results of an ordination and classification suggest that the forests can be split into several soil/ hydrological types with characteristic species. Variation in composition within the forests is strongly related to distance from the river edge. There was evidence of regeneration of forest trees and shrubs throughout the study areas although several tree species were extremely scarce. The forests share many common elements with those of the Tana river in Kenya and are most similar to the more mature levee forests. Changes in river flow caused by the proposed dam at Baardheere are likely to cause gradual changes in the composition and structure of floodplain forests. Greater impacts on the forest are likely as a result of agricultural settlement in the valley. It is recommended that Shoonto and Barako Madow forests should be protected from any further degradation since they are the largest and most intact forests left in the Jubba floodplain.

INTRODUCTION

Most of the remaining forests in East Africa are small and fragmented and few are effectively conserved. Recently, there has been an acceleration in the loss of tropical moist forest along perennial rivers as a result of water resource development and the spread of agriculture (Andrews et al. 1975, Hughes 1984). Although the local knowledge of natural resources in these riverine areas is great, agricultural projects and foreign-aided development schemes usually fail to consider or make use of this knowledge. Assessment of the agricultural suitability of the floodplain areas is therefore rarely complemented by an assessment of the local and national values of natural ecosystems. Detailed studies of floodplain ecology are needed to predict the likely effects of destroying floodplain habitats, provide guidelines for sustainable agricultural use and point to the benefits of conserving scarce natural resources.

There is a great diversity of forest types along river courses in Africa, depending on the local physical and climatic conditions (Hughes in press). Here, I assess the current status and composition of the least-known and northernmost floodplain forests in the East African lowlands, those of the Jubba Valley, Somalia. Little attention has been paid to the floristic composition of these forests. Italian foresters visited the Middle and Lower Jubba in

1948 in search of high quality timber trees which could be used as a substitute to mahogany or teak (Luchini 1945). They were surprised by the richness and productivity of the floodplain forests and found twelve high quality timber species. Pichi-Sermolli (1957) identified the dominant trees of the forests of the Jubba and Shabeelle. However, no systematic botanical surveys have been carried out in the floodplain forests which would allow an assessment of their status and comparison with other forests of the coastal lowlands of East Africa. It is shown here that these forests are worthy of conservation since they are representative of the formerly more extensive floodplain forests of Somalia.

FOREST LOSS

Recent examination of aerial photographs of the Jubba river valley, taken in 1960, 1983/4 and 1987 at 1:200,000, has shown a drastic loss of forest along the river levees. Forest clearance has been most dramatic in the Lower Jubba Valley (south of Fanoole) over the last thirty years, where cropland expansion has been assisted by irrigation schemes. In addition to natural increases in population growth, rural populations have been augmented by the gradual, partial settlement of nomads and a general immigration into southern Somalia. During this time, livestock numbers have increased, putting further pressure on the riverine vegetation during the dry seasons (LRDC 1985).

The aerial photographs of 1987 show that only a tiny fraction of the once extensive floodplain forests are now left along the River Jubba (see Table 1). Over half of the remaining forest occurs in the Middle Jubba (between Bu'aale and Fanoole), where the floodplain widens. Here, heavy clay soils make the floodplain poorly accessible and unsuitable for irrigation. The population density is relatively low in this part of the valley and the villages rely on small-scale flood irrigation farming in shallow depressions between the levees and the floodplain edge (locally called *dhesheegs*). Now, approximately 40% (350 ha) of the remaining forest occurs in two main patches in the Middle Jubba at Shoonto and Barako Madow (see Figures 1 and 2). Both of these forests are locally recognised as Forest Reserves, controlled by the National Range Agency of the Ministry of Livestock, Forestry and Range.

STUDY SITES

Areas of forest identified from the 1983/4 aerial photographs occurring in the Middle Jubba, were visited by the Somalia Research Project team in

TABLE 1 - The extent (ha) and number of patches of forest (in brackets) in 1960, 1983/4 and 1987. Area is estimated from aerial photographs at 1:200,000. Source: Deshmukh 1987.

	1960	1983/4	1987
Middle Jubba	3009 (23)	1361 (18)	505 (9)
Jubba Valley	9364 (84)	2611 (44)	897 (21).

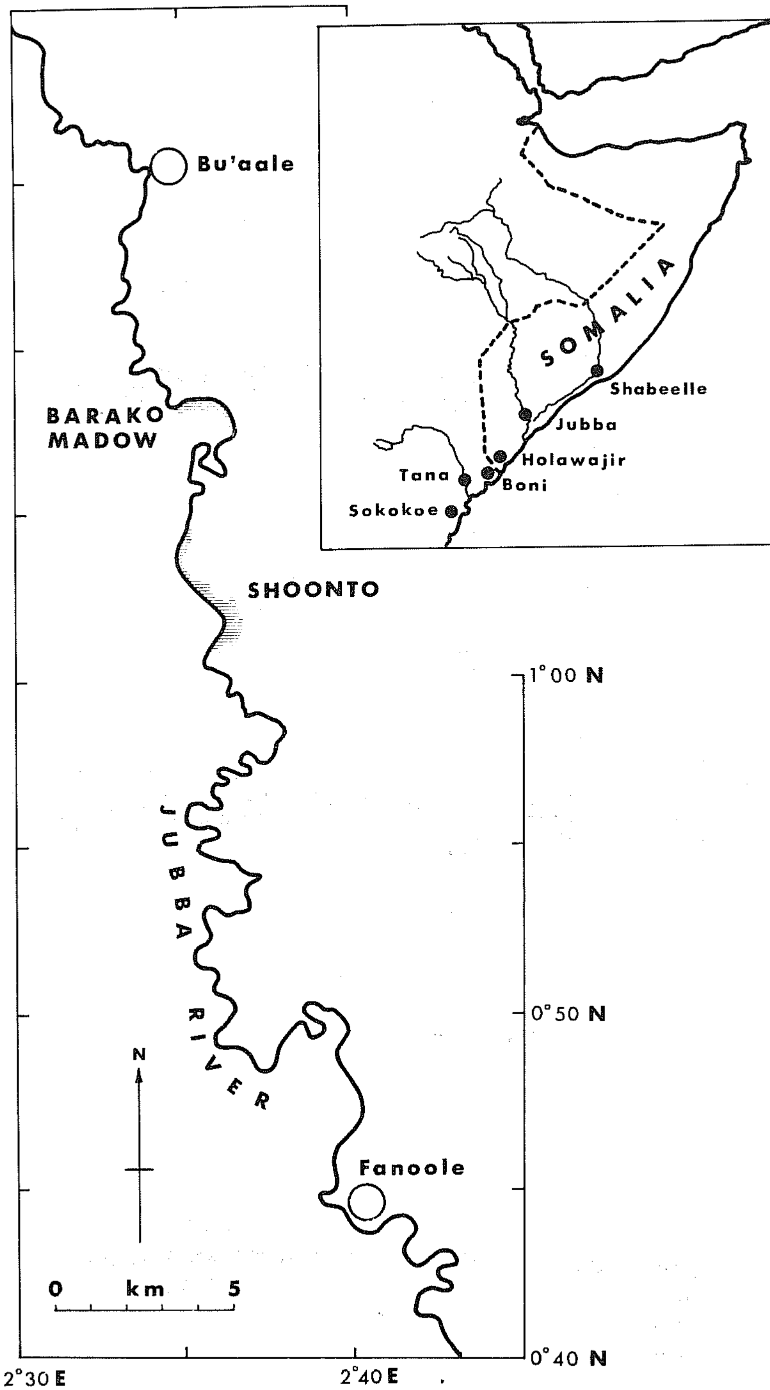


FIG. 1 - Location of Shoonto and Barako Madow forests with inset showing position of the Middle Jubba (star) in East Africa.

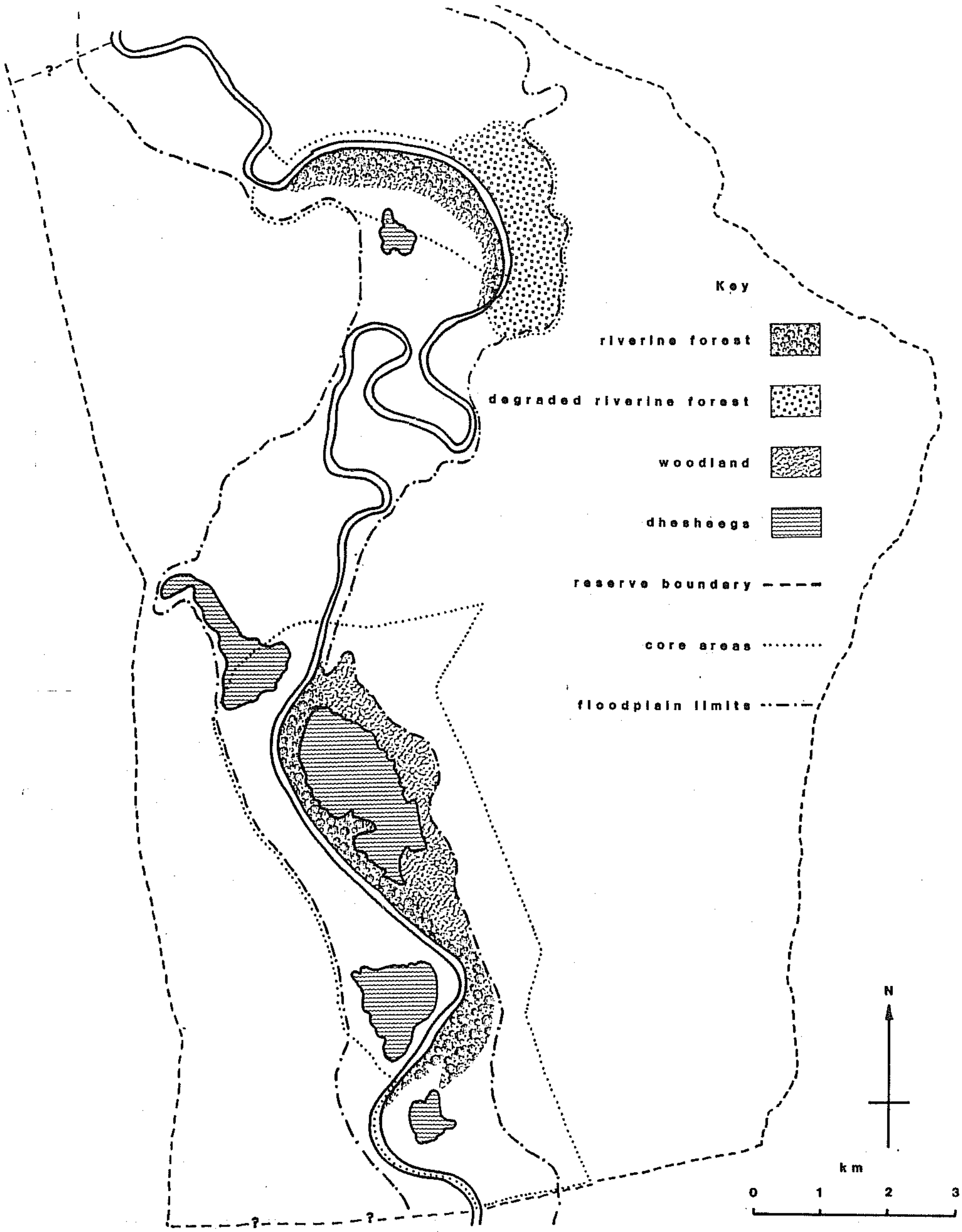


FIG. 2 - Map of study sites showing vegetation and physiographic features, the proposed wildness reserve boundary and the extent of core forest areas.

June-September, 1986. Only Shoonto and Barako Madow forests were considered intact. Some forest sites were found to have been felled or burnt by local villagers while others were severely degraded through small-scale clearance for timber, fuel, grazing and browse. Much of this clearance was in anticipation of irrigation schemes associated with the construction of a dam upstream at Baardheere, due for completion in 1993.

Vegetation studies carried out by the Somalia Research Project concentrated on the two main forest blocks at Shoonto and Barako Madow. Shoonto forest spans the width of the floodplain and borders a marsh and a large dhesheeg which does not normally dry out. Further from the river, the forest grades into dense woodland. There are only occasional signs of selective felling in the forest and woodland although the dhesheeg is frequently visited during the dry season by nomads with their stock. The forest is isolated from cultivation and is remote from villages, although the opposite bank is cultivated.

Barako Madow forest lies inside a sharp meander, just south of Bu'aale on the west side of the river. There is a sharp divide between the forest and woodland which is nested along the southern border of the forest, itself bordered by a partly cultivated, large, shallow dhesheeg. The river levees are cultivated close to the forest and the forest itself is more disturbed than at Shoonto, with frequent glades formed by the felling of large timber trees.

METHODS

Vegetation surveys were designed to record forest structure and composition and to provide insight into the frequency and regenerative powers of woody species and their site preferences. A preferential sampling system was used instead of a random or grid sampling method since movement within the forest was extremely difficult, and the vegetation composition and level of disturbance was hard to ascertain.

A total of seventeen, 20 m × 20 m plots were surveyed in three study areas. The plots were evenly distributed among the main community types. At Shoonto North, plots were taken at intervals along transects perpendicular to the river edge since broad changes in vegetation type were recognisable along this environmental gradient. These plots were then surveyed for their height above the river level.

Botanical composition

All species were collected in each sample plot for herbarium identification and the vernacular name provided by our local guide was noted. Presence of seedlings, fruits and flowers was recorded and notes were made on the form of different tree and shrub species. Additional species which did not occur in the sample plot but which occurred within a 20 metre zone surrounding the plot were recorded.

The vegetation was divided into vertical strata in order to assess the regeneration of particular species in each plot by noting the occurrence of the same species in different strata. The strata used were: over (>) 10 m, 3-10 m, 1-3 m and less than (<) 1 m in height.

Canopy depth and canopy width

The height of the first branch and the width of the canopy was measured for each tree and shrub over 3 metres in height, using tape measures. Two measurements were made for canopy width, at right angles to each other across the greatest width of the canopy. The average radius of each canopy was then calculated and used to determine the area of a circle of this radius centred on each tree. By summing these values, the canopy cover of each tree and shrub species within the plot was then calculated as a percentage. These figures were used in an ordination programme to identify forest types according to the relative cover of constituent species.

The size of trees and shrubs

Diameter at breast height and the height of all trees above 3 metres was measured in each plot. The number of stems was noted for shrubs and a ground level diameter was measured. Where trees reproduced by ramets, an individual tree was defined as a rooted stem which supported a separate canopy. Where large trees were strongly butressed, the diameter was measured immediately above the butresses. It was rarely possible to measure tree height using a clinometer due to the dense vegetation. In most cases height was estimated from visual comparison with trees of known height. Total volume of wood within each plot was then calculated using the formula $v = gh/2$, where v = total above-ground wood volume including branchwood, g = basal area of main stem at breast height, h = tree height. Since the analysis of this data is incomplete, it is not presented here but it should give an indication of the productivity of the forest and allow comparisons between the volume of wood in different parts of the floodplain and in different vegetation types.

The position of trees and shrubs

The position of trees and shrubs within the plot was determined by taking coordinates from a chain along the mid-line of each plot and a tape measure running at right angles to the chain. Using the canopy width and canopy depth measurements and information noted on the form of different tree species, we were able to draw diagrams for each plot which are a close representation of the forest structure.

Soils

Soil samples were collected from the centre of all plots at an approximate depth of 20 cm. Samples, collected in paper wallets, were analysed for pH (using litmus on-site and a pH meter in the UK), texture, organic content and nutrient levels. The analysis of organic content and nutrient levels is not presented here.

Plot position and height

The locations of all plots were determined within each study site using a magnetic compass and standard pacing from access tracks and paths. A dumpy level was used along transects to find the height of vegetation plots relative to the river, taking readings at intervals of 20 metres. The resulting profiles provide additional information on the distribution of vegetation types within the floodplain. Position of sample plots within the forest also provides a reference for the identification of vegetation types from aerial photographs.

RESULTS

Physical features

Profiles of the levees at Shoonto North show variation in the steepness of the riverbank to a height of approximately 4 m above the river level in July 1986. Bare sand banks were frequent, sometimes reaching out to the middle of the river course. The middle of the levees were up to a metre higher in places than the riverbank and were crossed by a series of gullies, giving the levees an irregular, undulating profile (see Figure 3).

At the time of study, the forest margin on the dhesheeg edge at Shoonto North was approximately at river level. There was evidence of flooding across the levees in all the study sites. Shells of river snails were found scattered on the forest floor. At Shoonto North many gullies ran transversely across the levee and short gullies occurred at the point where the levee descended to the dhesheeg. Near the gullies, tree roots were exposed and river debris was entangled in the vegetation up to 50 cm above the ground. The forest floor at the dhesheeg edge was damp below the immediate surface.

The undulating profile of the river levees probably reflects the irregular deposition of sediments through floods of varying size and duration. Consequently, the soil type and texture at the surface of the levee within each plot showed no consistent pattern although in general the finer clay particles are deposited further from the river edge than the loam or sand.

Classification of vegetation types

TWINSPAN and DECORANA computer programmes were used to distinguish different types of forest within the floodplain. A number of vegetation associations could be defined and a classification for the forest vegetation was constructed (Table 2).

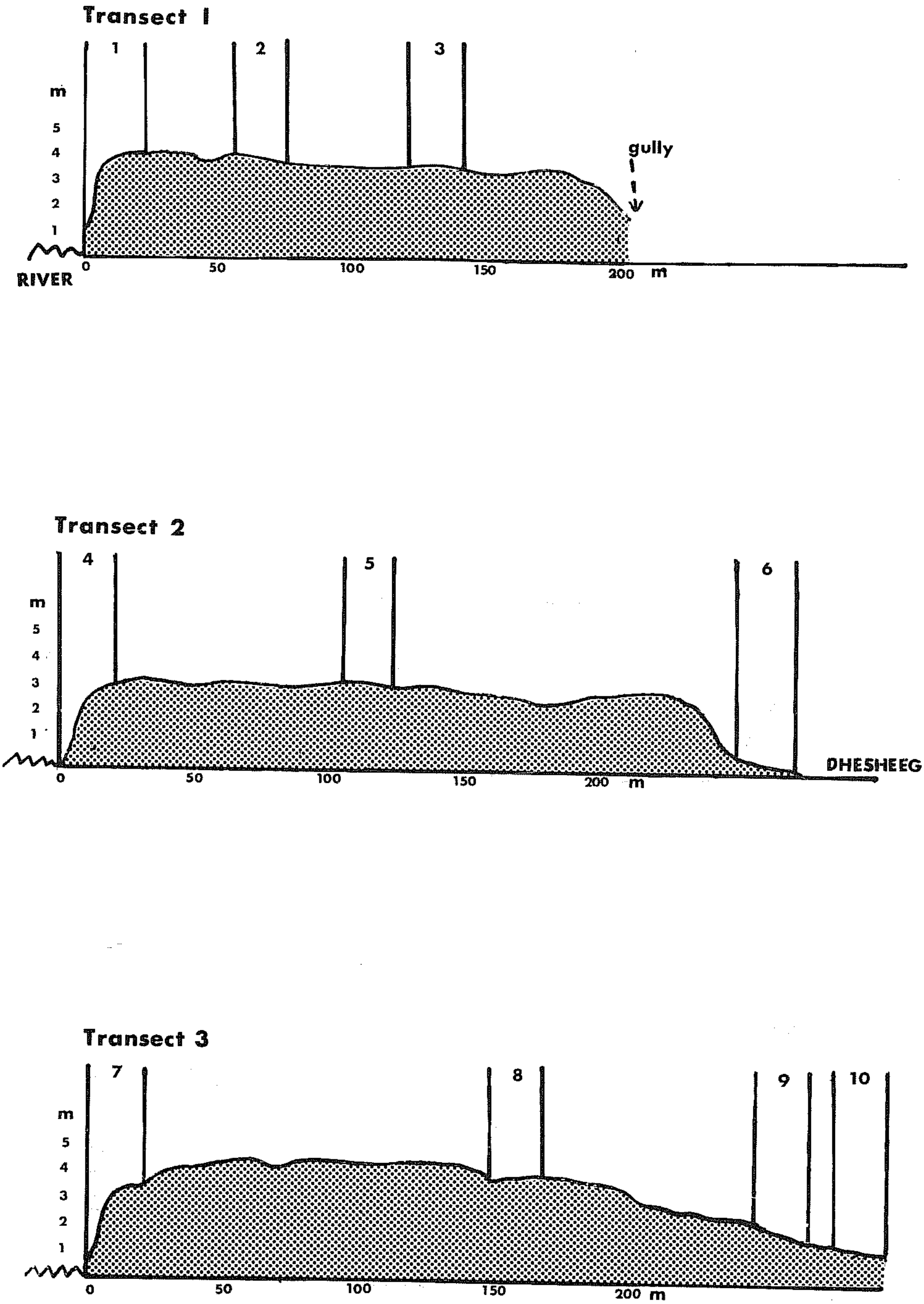


FIG. 3 - Profiles of the levee at Shoonto North study site from the river to the dhesteeg edge, showing the position of vegetation plots.

TABLE 2 - Classification for levee forest vegetation.

PLOTS	POSITION IN FLOODPLAIN + TWINSPAN NO.	INDICATOR SPECIES & CHARACTERISTIC SPP. OF FOREST TYPE	DESCRIPTION OF FOREST IN VICINITY OF PLOTS
7,11	river edge (010)	*Ficus sycomorus* *Hunteria zeylanica* *Camptolepis ramiflora* *Ficus scassellatii* *Thespesia danis* *Diospyros cornii* *Kigelia africana*	Large crowned overstorey with trees overhanging river, notably *Ficus, Mimusops, Diospyros, Thespesia* and *Garcinia.* Dense understorey of *Hunteria* and *Camptolepis.* Dense liana thickets near the river. Seedlings abundant. Fine, sandy soil with thin, complete litter layer.
1,2, 15	river edge (0011)	*Lecaniodiscus fraxinifolius* *Lawsonia inermis* *Ficus scassellati* (Maunder 171 «khandol»)	Higher areas of active levees. Overstorey more varied than in lower areas (010) and more open canopy. *Ficus, Afzelia, Thespesia* and *Hunteria* from the bulk of the understorey. *Acridocarpus* common in the shrub layer with abundant tree seedlings. Complete litter layer, deeper than in 010.
3,5 8,12	mid-levee (0010)	*Acacia sp* *Afzelia quanzensis* *Mimusops fruticosa* (Maunder 169 «majebe»)	Large-crowned *Acacias, Thespesia & Afzelia* dominate the overstorey. Dense understorey of *Hunteria* and *Thespesia.* Seedlings frequent. Herbaceous vegetation limited to open glades, often edged by thickets of *Acridocarpus* and *Sansevieria.*
16,17	mid-levee (000)	*Harrisonia abyssinica* *Afzelia quanzensis* (Maunder 124, 120, 122)	Broken canopy due to selective felling of tall trees. *Acacia, Afzelia* and «khandol» (Maunder 171) frequent. Dense midstorey layer of shrubs. Liana thickets common. Herbs and grasses dense in numerous glades.
6,9 10	dhesheeg edge (0111)	*Garcinia livingstonei* *Lawsonia inermis* *Camptolepis ramiflora* *Exoecaria* sp. *Trichilia emetica* *Antidesma venosum*	Forest edge bordering a dhesheeg. Fringe of dense saplings - mostly *Camptolepis* with *Trichilia* and «khandol». Sparse midstorey of *Lawsonia, Thespesia* and *Exoecaria* with few tall trees, increasing away from the edge: *Garcinia, Lawsonia, Mimusops* and *Acacia.* Herbs dense in glades. Seedlings abundant. Dark, thin, loamy soil.
4,13	river edge/ pediplain (0110)	no true indicators	Intermediate or transitional forest type. Dense understorey of *Camptolepis* and *Hunteria* in common with river edge and dhesheeg edge groups. Overstorey trees characteristic of both riverbank and mid levee plots but *Thespesia, Acacia* and *Sorindeia* most frequent. Seedlings abundant, including some woodland species in pediplain plot and *Hyphaene* and *Phoenix* palms. Lianas abundant through all layers. Pediplain soil clayey.
14	edge of pediplain forest; adjacent to flood channel([1])	*Hyphaene* sp. *Newtonia erlangeri* *Lecaniodiscus fraxinifolius* (Maunder 105 «anyo goled») (Maunder 107 «pogade») (Maunder 90 «geed gamun») *Balanites aegyptica* (Maunder 108 «elan»)	Forest/woodland edge. Composition distinct from other forest plots although *Thespesia, Mimusops* and *Lecaniodiscus* also occurred here. Overstorey dominated by *Hyphaene* and *Newtonia* with dense understorey of small trees and undershrubs, notably «geed gamun». Very few woody climbers. Loamy soil. Leaf litter sparse.

1. Collection numbers refer to specimens held at the Royal Botanic Gardens, Kew, UK.
2. Names in « » are local vernacular names, used here in the absence of a definitive identifications.

A strong relationship exists between the vegetation types and the position on the floodplain, suggesting that edaphic factors such as soil type and frequency of flooding may affect vegetation development, as found for floodplain forests along the Tana river (Hughes 1984).

River edge, mid-levee and dhesheeg edge forest types could be easily distinguished on the ground. Dense forest growth was limited to the river and dhesheeg edges, where seedlings were abundant and the midstorey and understorey were dominated by one or two shrub species. Liana thickets were chiefly confined to the river edge and the greatest variety of canopy tree species could be seen along the crest of the levee. A more open forest structure with occasional glades was apparent across the bulk of the levee. Here, one or two major tree species were dominant and dense undergrowth occurred in open glades.

These differences in composition and structure of the forest types were separated by the ordination (see Figure 4). Its first two axes explain 80% of the variation between sample plots. The axes probably represent a combination of factors including distance from the river and soil properties. They may also reflect the regeneration characteristics of different species. Plots were loosely grouped according to position on the floodplain although there was some overlap between river edge and midlevee plots and the division of forest types was not as fine as that shown by the TWINSPAN classification (see Figures 4 and 5).

The TWINSPAN classification divided the plots into six groups. Figure 5 shows the indicator species upon which the main subdivisions are based. Table 2 also shows characteristic species, typical of each group of plots and gives a broad description of the vegetation types.

The first sample division separated the forest edge plot from other forest types due to its distinct botanical composition. Many species that were frequent in this plot such as *Balanites aegyptica* and *Cadaba spinosa* were characteristic of woodland elsewhere in the floodplain. Riverine and dhesheeg edge plots with a dense understorey were then separated from plots with a high overstorey cover at the second division. The third and fourth sample divisions divided each of these into three further groups, picking out indicator species which are limited to particular areas of the floodplain, for instance *Ficus sycomorus* at the rivers edge, *Acacia sp.* in mid-levee positions and dense stands of *Garcinia livingstonei* at the dhesheeg edge. It is of interest to note that the mid-levee plots taken from Barako Madow were separated from other mid-levee plots by both the classification and ordination analyses. This probably reflects the presence of a tall, dense shrub layer which has developed as a response to selective felling of timber trees.

The distribution and regeneration of forest trees and shrubs

In order to assess whether the remaining forest areas are viable, detailed information on the distribution of individual species and the age structure of

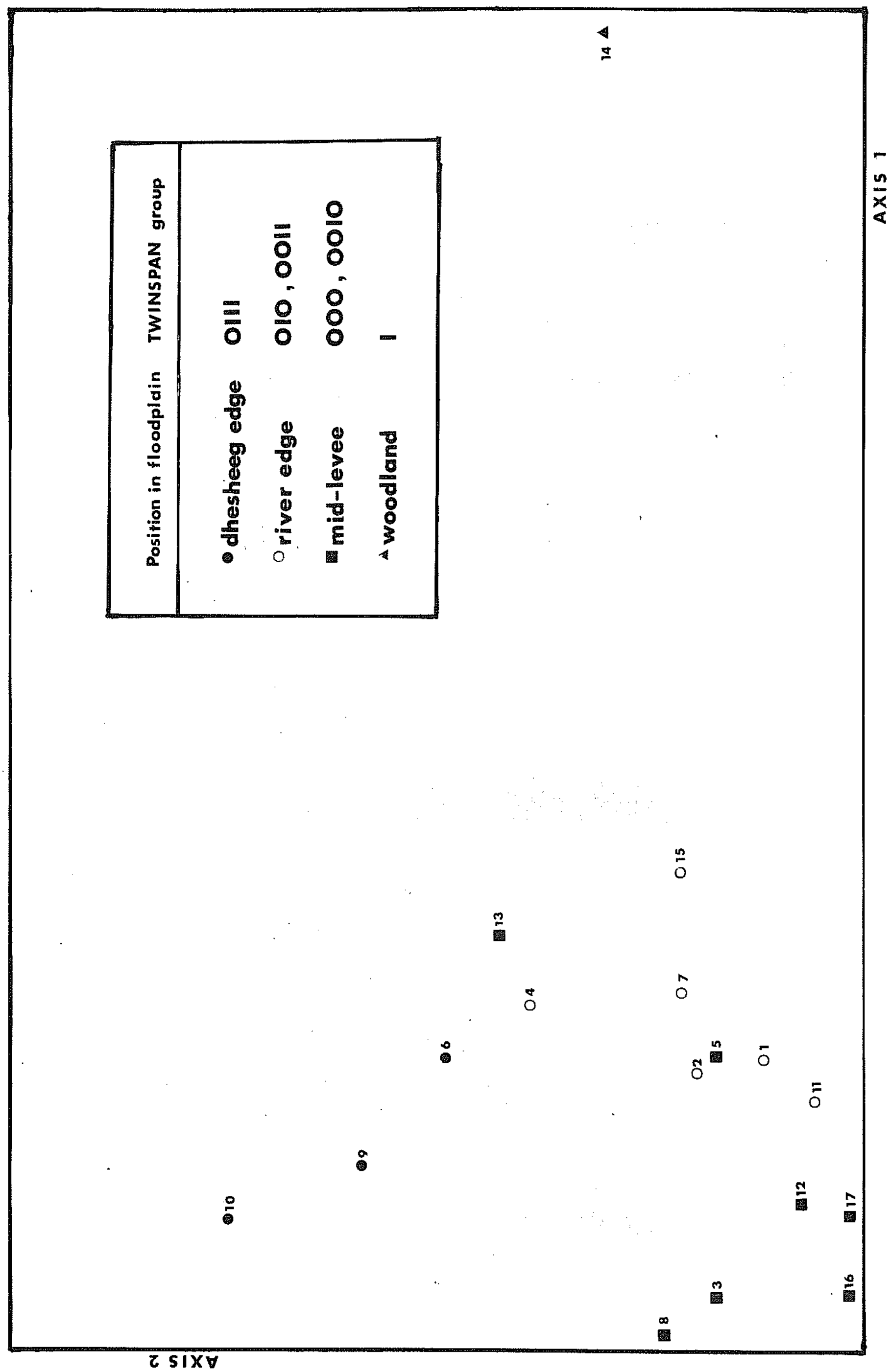


FIG. 4 - DECORANA ordination of the vegetation data, showing plot no's, the position of plots on the floodplain and the corresponding TWINSPAN groups.

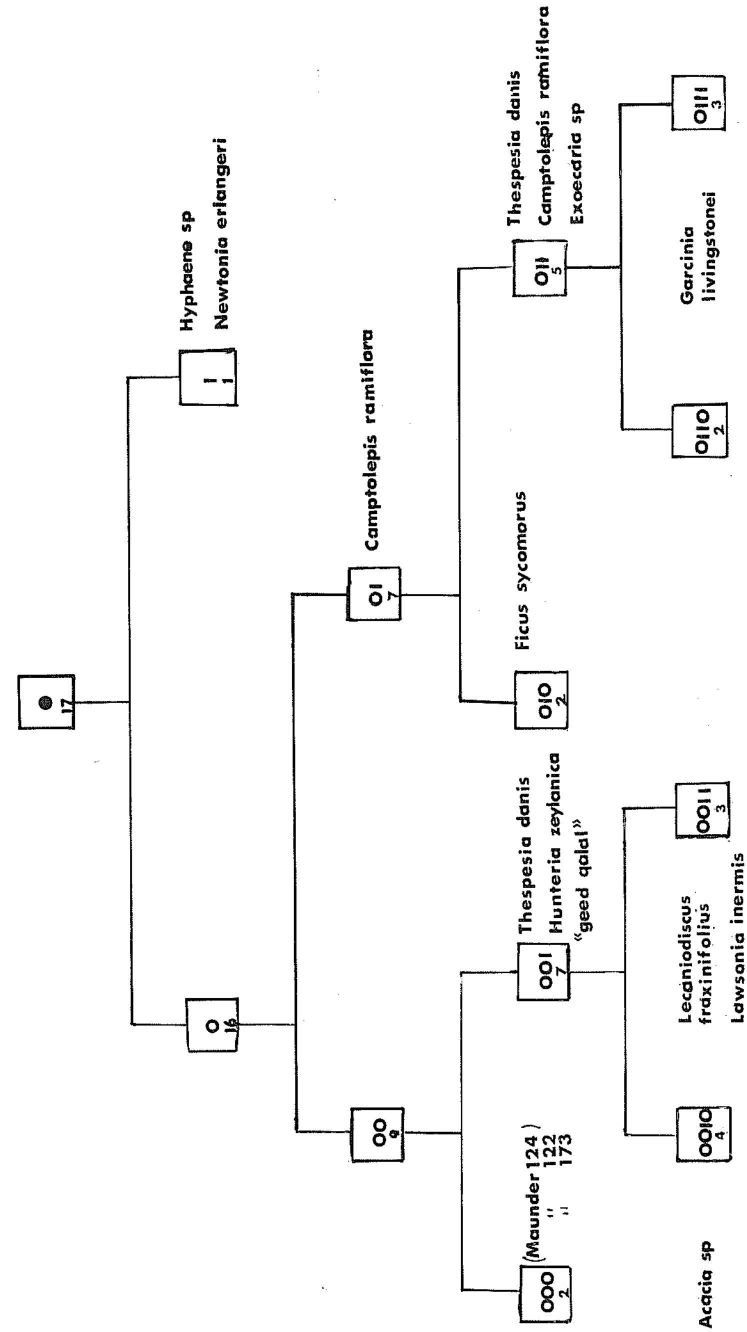


FIG. 5 - TWINSPAN Indicator Species Analysis for 17, 20m × 20m sample plots in levee forest. Group notations are shown in the centre of each box. The other figures in the boxes give the number of sites in each group. The most important division species are shown at each separation.

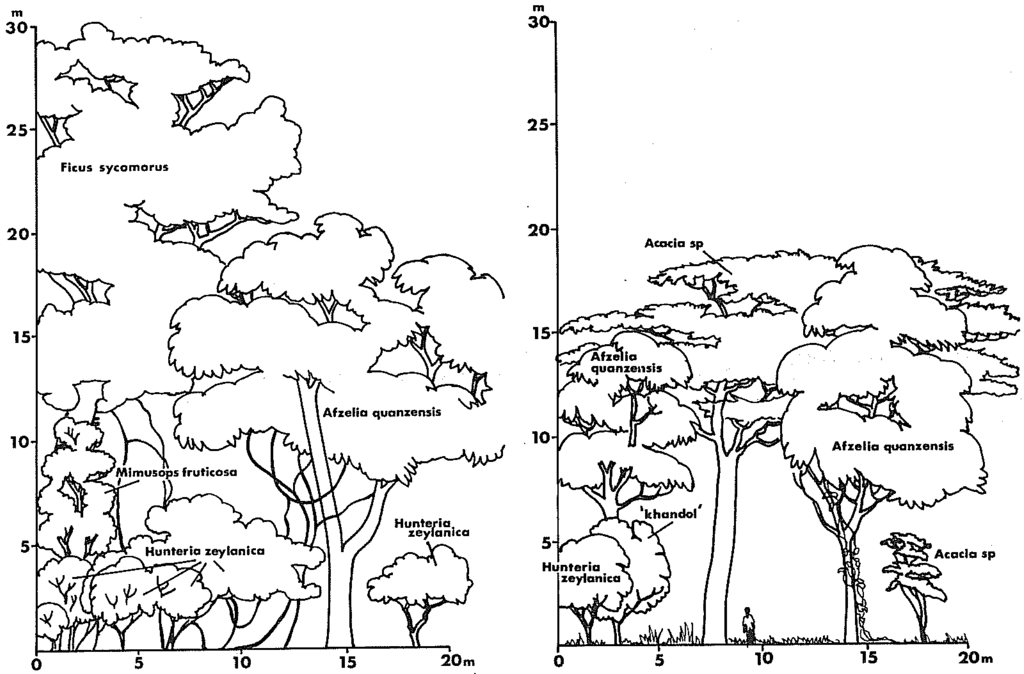
the vegetation is required. Although no systematic survey was made of entire study sites to determine the status and distribution of individual species of trees and shrubs, detailed information was collected within sample plots which represented the main vegetation types of each forest area, at varying distances from the river. Together with more general information noted on the occurrence of each species elsewhere in the levee forests, this data provides some insight into the habitat requirements of individual species.

Most major tree species show some preference for position within the forests. For example, *Ficus sycomorus* and *Diospyros cornii* only occurred within 30 m of the river edge while *Exoecaria sp.* and *Lawsonia inermis* were limited to the extreme dhesheeg edge. None of the major tree species was restricted to the mid-levee plots but *Afzelia quanzensis* and *Mimusops fruticosa* were more frequent there than in other plots.

There was evidence for the regeneration of most forest trees and shrubs of the levee forests. Seedlings or saplings were recorded for nearly all the woody species within the study sites. The forest appeared to have a very diverse age structure and individuals of a wide variety of ages occurred throughout the study sites. Data from the sample plots showed that the composition of each stratum varied greatly i.e. the understorey did not usually reflect the overstorey (see Figure 6). This situation is common in tropical forests that experience drastic environmental fluctuations (Longman and Jenik 1987).

The establishment of seedlings and saplings of some forest trees was apparently restricted to certain positions on the river levees (Table 3). Most seedlings were found in the seasonally-inundated zones. For example, *Garcinia* saplings only occurred along the *dhesheeg* edge at Shoonto, although mature trees and seedlings were present in the pediplain forest and forest/woodland edge plots. These observations are consistent with those of Hughes in the Tana floodplain (1984), where *Garcinia* seedlings were abundant throughout the floodplain after the rains but all except those at the rivers edge dried out and died. Conversely, *Afzelia* seedlings were restricted to mid-levee positions. The levee is often up to a metre higher here than at the river's edge and the canopy is more open so that the soil may be better-drained and relatively dry. Many of the other major tree species such as *Thespesia, Acacia* and *Hunteria* show signs of regeneration across the entire levee profile and can thus be considered to be «generalists» within the levee forests.

Most shrub species were recorded across the levee profile. Almost all were frequent in surrounding woodland. These shrubs were most common in glades within the forest and may be regarded as pioneers or «sun species» (Hubbell and Foster 1986). Many have specialised growth forms or have an ability to climb other forest trees. Light may be more important for the regeneration of these species than edaphic factors, so they are quick to colonise gaps in the canopy. This may explain why there was a predominance of dense undershrubs at Barako Madow, where many of the large timber trees had been felled, leaving huge, densely vegetated glades.



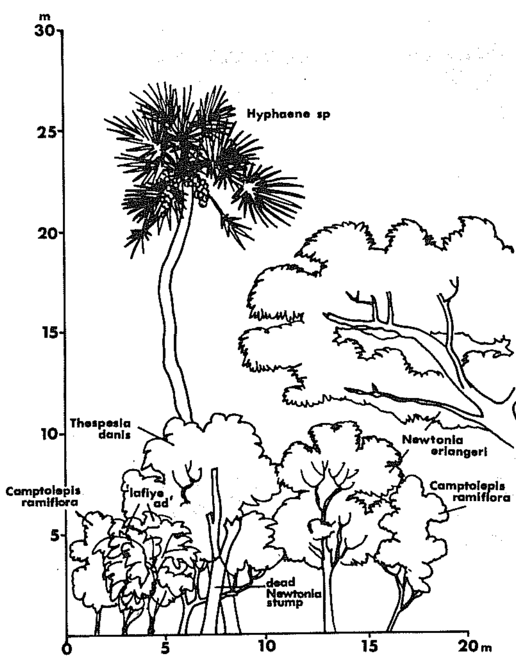
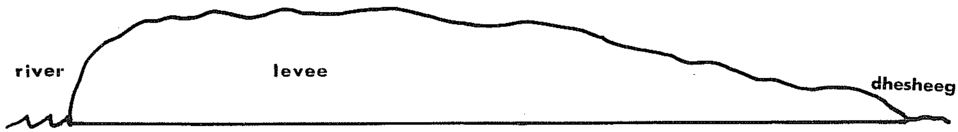


FIG. 6 - Section diagrams showing forest structure within 20m × 20m sample plots at different positions on the floodplain (from top to bottom: river edge; mid-levee; forest/ woodland edge).

TABLE 3 - Schematic diagram showing location of seedling establishment of trees and shrubs across the levee profile



← *Mimusops fruticosa* →
Hunteria zeylanica
Acacia sp.
Thespesia danis
«lafiye ad»
«khandol»
«majebe»

← *Ficus spp.* →
Sorindeia madagascariensis
Lawsonia inermis

← →
Camtolepis ramiflora
Garcinia livingstonei
Trichilia emetica
Exoecaria spp.
Lawsonia inermis

← *Afzelia quanzensis* →
«geed galal»
«Maunder 124»

No seedlings/saplings were found for *Diospyros cornii*
Terminalia spp.
«gabal»
Kigelia africana
Cordia goetzei

Examination of many of the large glades formed by the felling of canopy trees revealed that seedlings of forest trees were usually absent. Similarly, the site of the Shoonto village, abandoned at least thirty years ago, was vegetated with perennial grass and occasional patches of dense woodland shrubs. Although this area is still surrounded by intact forest, it did not support seedling forest trees. Spontaneous recovery of severely disturbed forest areas therefore seems unlikely. It is possible that forest vegetation would eventually colonise any newly-formed levees but is most likely that such areas would be farmed.

No seedlings or saplings were found for some of the scarce forest tree species such as «gabal» and *Diospyros cornii.* These trees may be rare because their habitat is only a small proportion of the study site. Alternatively, it may be that conditions necessary for regeneration, such as a major inundation, occur too infrequently in the forests. The status of some of the large trees may also have been affected by logging. Anecdotal information recorded by Luchini in 1945 allows a comparison of records for the largest forest trees to be made. He noted 13 species of timber trees as widespread in the Middle Jubba at that time. All these species were recorded in this study although some, such as *Trichilia emetica* and *Diospyros cornii* are now very scarce in the remaining forest areas, presumably due to selective logging for their highly valued timber. The drastic reduction of forest area in the valley and the decline in many of the large mammal species will also have reduced the seed distribution within the valley.

Comparison of floristic composition between the Jubba and Tana forests

The riverine forests which have been studied in Africa include communities associated with perennial and seasonal watercourses in a wide range of physical and climatic conditions (Hughes in press). Although the Jubba forests have some species in common with other riverine forests in Africa and lowland coastal forests in East Africa, they are most similar in structure and composition to the Tana forests in Kenya. These forests are more accurately described as «floodplain forests» since they are limited to the lower reaches of perennial rivers where they depend on groundwater and inundation from the river for growth and regeneration (Hughes in press). Hence, unlike other riverine forests in the Sahel zone, dense, evergreen vegetation persists along the river courses. These formations are sufficiently distinct in physiognomic and floristic features to constitute a major vegetation type in East Africa.

Although Moomaw (1960) and UCL/TDRI (1984) refer to forest in the Holowajir and Boni reserves, in the extreme south-east of Somalia, quantitative studies carried out by Kuchar and Mwendwa in the Boni reserve (1982) concluded that the vegetation of this area was predominantly bushland and woodland-bushland. There has been no systematic survey of the Holowajir area but it is unlikely that any true gallery forest occurs there, since the watercourses have only a seasonal flow.

A comparison of floodplain forest in East Africa is therefore limited to the Tana and Jubba forests, both of which have been studied in detail. Direct comparison is limited by the fact that 50-60,000 hectares of riverine forest remain along the Tana (Hughes 1984) while only about 900 hectares remain in the Jubba valley (Deshmukh 1987). In both cases, the forest is restricted to narrow strips along the river course, often fragmented by cultivation.

The dynamics of floodplain vegetation was studied in far greater detail by Hughes (1984) than was possible in this study where quantitative work was restricted to intact blocks of mature forest. Despite the paucity of information on intermediate habitats along the Jubba, it is possible to compare the pattern of occurrence of mature forest, woodland and scrub vegetation in the two valleys, from vegetation maps and aerial photograph mosaics (Hughes 1984, AHT 1984). These broad classifications show that the Tana floodplain supports a far greater diversity of vegetation assemblages than the Jubba floodplain, although the more comprehensive vegetation survey carried out by Hemming and Deshmukh (Deshmukh 1989) along the Jubba revealed other vegetation types not described here.

Along the Jubba, the remaining evergreen forest covers the levees, which rise from the river bank to form a plateau stretching several hundred metres before reaching a dhesheeg. Cleared areas along the levees could be seen to have been derived from previously forested areas. Along the Tana, forest of similar structure and composition formed very narrow strips only 20-30m wide along the highest parts of the river levees, closest to the river. Scrub, bush and early successional vegetation were scarce along the Jubba. There was no equivalent to the point-bar or scrub vegetation dominated by *Populus illicifolia* and *Pluchea dioscoridis* or the early stages of colonisation of ox-bows, dominated along the Tana by *Spirostachys venenifera* and *Harrisonia abyssinica.* Indeed, only one ox-bow forest area was identified within the whole Middle Jubba region.

Along the Tana, tall forest of the «dry floodplain» areas is dominated by *Acacia elatior* with a dense understorey including *Dobera loranthifolia*, *Lecaniodiscus fraxinifolius* and *Terminalia brevipes.* This vegetation type was typical of the edge of the floodplain between the levee forests and the open bushland and accounted for over 40% of the floodplain vegetation along the Tana (Hughes 1984). The equivalent vegetation type along the Jubba was open woodland with an understorey of perennial grass, which abutted the evergreen levee forest and gave way suddenly to bushland at the edge of the floodplain. The overstorey was diverse; trees and shrubs included *Boscia coriaceae, Acacia nilotica, Dobera loranthifolia* and *Balanites aegyptica.*

The areas of evergreen levee forest which occupied most of the study sites along the Jubba are most similar to the «active levee evergreen» forests described for the Tana, although they have elements in common with the «inactive levee evergreen» and «clay evergreen» forests (Hughes 1984). The «active levee evergreen» forests were the most species rich forest areas along the Tana and were considered to be more mature than other forest types. Marsh (1976) suggested that mature riverine forest takes at least 50 years to develop along the Tana levees. Shoonto and Barako Madow were recorded by Luchini in 1945 and the extent of forest has remained virtually unchanged since the 1960 aerial photographs, suggesting that the forest described by this study is mature.

The greater diversity of vegetation assemblages in the Tana floodplain indicate a more frequently shifting river course with sediment eroded in one place and deposited in another, forming meander cut-offs and point bars. The levees along the Jubba river are relatively broad and dhesheegs, which are absent along the Tana, dominate the area between the levees and the edge of the floodplain. Meander cut-offs are rare, suggesting that the river banks have been intact for a relatively long period of time. Consequently, mature forest covers the Jubba levees and recent deposits and early successional vegetation are relatively scarce.

Table 4 shows the tall tree species in the evergreen forests of the Tana and Jubba rivers. The forests share many common elements but there are some notable differences. *Sterculia appendiculata* is found in most levee forests of the Tana (Hughes 1984) but is absent from the Jubba forests. The absence of *Aporrhiza paniculata* and *Blighia unijugata* the Jubba forests is of

TABLE 4 - Tall trees (> 10m), typical of the evergreen levee forests of the Tana and Jubba rivers.

FAMILY	SPECIES	TANA	JUBBA
GUTTIFERAE	*Garcinia livingstonei*	*	*
STERCIMOACEAE	*Sterculia appendiculata*	*	
MALVACEAE	*Thespesia danis*	*	*
CAESALPINACEAE	*Tamarindus indica*	*	
LEGUMUNOSAE	*Acacia* species	*	*
	Newtonia erlangeri	*	*
	Afzelia quanzensis		*
	Exoecaria sp.		*
MORACEAE	*Ficus sycomorus*	*	*
MELIACEAE	*Trichilia emetica*	*	*
SAPINDACEAE	*Aporrhiza paniculata*	*	
	Blighia unijugata	*	
ANACARDIACEAE	*Sorindeia madagascariensis*	*	*
EBENACEAE	*Diospyros* species	* *(mespiliformis)*	* *(cornii)*
SAPOTACEAE	*Pachystela brevipes*	*	*
	Mimusops fruticosa	*	*
BORGAGINACEAE	*Cordia goetzei*	*	*
PALMAE	*Hyphaene* sp.	*	*

less significance since these species were only recorded from one forest section in the Primate Reserve along the Tana river (Hughes 1984). *Tamarindus indica* is not indigenous to the Jubba forests but is grown as a crop near many villages in the valley. *Afzelia quanzensis* is absent from the Tana forests but is widespread in the Jubba forests and in the Holowajir (Kuchar and Mwendwa 1982). Luchini (1945) mentions that this large tree was «particularly abundant in the Jubba region», although «its distribution is uneven and this species was absent from the Manane forest». *Exoecaria sp.* was also common in our study sites, near the dhesheeg edges but was not recorded from the Tana forests.

Some species that were widespread within the Jubba levee forests such as *Mimusops fruticosa, Garcinia livingstonei* and *Hunteria zeylanica* are considered to be more typical of areas dominated by clay soils in the Tana forests and other East African coastal and riverine sites (Hughes 1984). Other species such as *Newtonia erlangeri, Hyphaene sp.* and *Phoenix reclinata* that were characteristic of the Tana «active levee evergreen forests» were more typical of the forest/woodland edge in the Jubba floodplain.

Deshmukh (in litt.) reports that three species (*Cola sp. nov., Pavetta tranjubensis* and *Acacia maculusoi*) may be confined to the Jubba floodplain. Collections of other common woody plants in forest areas along the Jubba show many more species not recorded by Hughes (1984) along the Tana (Madgwick et al 1988, Deshmukh 1989). Further comparison between the two areas is limited here since this study only recorded mature forest areas in any detail.

Effects of the dam on forest regeneration

Studies of regeneration in the Tana forests, suggest that flooding of the levees is crucial for the regeneration of the major forest trees and that the lack of seedlings and saplings in the forest areas was partly due to the decrease in extent and duration of flooding following the installation of dams upstream (Hughes 1984). Because of the construction of the dam at Baardheere along the Jubba river, it is important to evaluate the probable effects on the forest of a reduction in flooding due to controls on the river flow.

It can be seen that the forest depends on water from the river for its survival since, above the floodplain level, rainfall is insufficient to maintain closed, multi-layered evergreen forest although dense woodland sometimes occurs. Water reaches the forest vegetation by lateral seepage from the main river channel and by floodwater overflowing from the river. There is probably also some surface flow along seasonal water-courses from woodland areas. Synott (1988) concludes that lateral seepage is probably the most important source of water to the forest throughout the year. Not all riverine forest areas are washed over even in major floods and the water from annual floods does not remain available to the vegetation for a whole year. In addition, some *dhesheegs* fill with water annually without surface flow from the river giving firm evidence for lateral seepage.

Hughes (1984) suggests that a reduction in flooding may lead to a decrease in habitat diversity along the Tana since regeneration succession appears to be initiated on newly deposited sediments. The vegetation analysis presented here suggests that variation in the forest composition and structure may be more related to distance from the river than age or successional status. If the balance between forest and woodland is determined by soil moisture, controlled by the river freshwater table, then changes in the river levels after the dam is constructed may alter the vegetation communities. It would be expected that marginal forest areas would develop into partly-deciduous woodland as woodland species colonise the area and forest trees fail to regenerate. Studies in the floodplain forests of the Tana river (Hughes 1984) indicate that *Acacia forest* or deciduous woodland is likely to occupy these areas if they remain protected from clearance.

DISCUSSION

This preliminary comparison of the Tana and Jubba forests show that they share many common elements and the mature levee forests are similar in structure and composition. The Tana floodplain supports a greater area and greater diversity of natural vegetation types, although most are at an early successional stage. Riverine vegetation remaining along the Jubba includes examples of formerly more extensive, mature levee forests and riverine woodland in a relatively undisturbed state. The forest vegetation is extremely variable in composition and structure but this variation seems to be strongly related to distance from the river.

Although most forest trees and shrubs are regenerating within the Jubba forests, several tree species are extremely scarce. It is likely that some are rare because of the reduced seed distribution following the drastic reduction of forest area. Other trees and shrubs have very specific requirements for regeneration which occur only in a limited area of the floodplain. Many fruits produced by Jubba forest trees are designed to be dispersed by animals, some of which have large are a requirements. Consequently, any further reduction of forest area is likely to lessen the viability of the forest ecosystem.

This study revealed that seedling and sapling establishment of many forest trees was limited to seasonally inundated areas of the floodplain. When completed, the dam at Baardheere will reduce the incidence and duration of flooding, affecting the levee forests. In the long-term, the composition and structure of the forests will gradually change. Changes in flow of the Jubba river and loss of riverside vegetation are also likely to have profound effects on the cultivation of dhesheegs in the valley (Brunken and Haupt 1986).

At present rates of forest loss the remaining forests along the Jubba will be destroyed within the next few years. They are further threatened by planned agricultural development schemes within the Jubba valley (LDRC 1985). Spraying with insecticide to eradicate tsetse-fly will encourage forest clearance for agriculture and browse (Douthwaite 1985). Over 200,000 hectares of the Jubba valley will be irrigated for agriculture. This will accelerate the clearance of natural vegetation for crops and settlements. Pressures on the natural resources of the area, such as fuelwood and game, will also increase. Selective logging of timber species from the forests for structural timbers, doors and canoes is no longer sustainable since so little forest remains. In addition, Madany (1987) reports that twelve of the nineteen species of riverine forest and woodland species regularly used in hut construction are now uncommon or rare. Although there is currently ample supplies of fuelwood from bushland in most of the valley, there are already shortages around the densely populated areas (Synnott 1988). It is therefore essential that the remaining areas of forest are given effective protection from further degradation and clearance.

Shoonto and Barakö Madow reserves are the largest, most intact riverine forest blocks remaining along the Jubba (Deshmukh 1987) and should be conserved as a national monument and a natural resource (Madgwick and Wood 1988). This study and those of the Tana forests provide some insight into the ecology of floodplain forests but further detailed studies are required to determine the most effective methods for the reestablishment of forest and woodland cover along the river levees.

The Jubba forests have the potential to serve many interest groups and supply many benefits both locally and nationally. Future management policies in the Jubba valley should therefore ensure the protection of intact forest from further clearance or degradation while sustainable use of natural resources is developed in surrounding «buffer zones».

FOOTNOTE

The Somali Ecological Society, a voluntary conservation body in Somalia, is currently seeking funds towards the future protection and management of the Jubba forests. The Society has established a reserve at Balcad near Mogadishu to conserve the last area of riverine forest along the Shabeelle river.

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