Distribution ecology and the impact of human activities on some *gracilaria* species of the kenya coast

OYIEKE Helida A.
Kenya Marine & Fisheries Research Institute
P.O. Box 81651 Mombasa
KENYA

Abstract

The genus Gracilaria belongs to the group of seaweeds that are of commercial value and are being harvested worldwide for their active ingredient agar. A pre-requisite for the harvesting of these plants, which has often been ignored, is a study on their ecological requirements within an ecosystem which leads to better understanding of the plants and hence good management practices and conservation in cases where wild stocks are harvested. With this aim in mind a study on the distribution ecology of 8 different Gracilaria species; G. corticata, G. crassa, G. edulis, G. fergusonii, G. millardetii, G. salicornia, G. verrucosa and Gracilaria sp. was carried out along the Kenyan coast extending from the North-coast to the South-coast border. In the study rocky platforms with their reef edges exposed to the open sea had a wider variety of species than either rocky platforms in sheltered waters or sandy beaches (the mean number of species per site being 3.6 ± 0.8, 1.4 ± 0.5, 2.0 ± 0.7 respectively). With regard to the frequency of occurrence in all the 23 stations studied the most common species was G. salicornia followed by G. corticata and G. crassa. G. verrucosa, G. edulis and Gracilaria sp. were less common while G. millardetii and G. fergusonii were rare. The plants were observed to grow in varied types of habitats and microhabitats in the eulittoral zone which included rocky coral platforms with their associated lagoons, pools and fringing reefs, sandy beaches and mangrove swamps. G. salicornia tended to show no specific ecological niche as it was observed in all the habitats and microhabitats studied while the rest of the species were more specific in their niche requirements. The threat that human activities impose upon these plants is discussed.

Introduction

Seaweeds play an important ecological role such as primary production, nutrient storage and cycling, sediment formation and the provision of habitats which support enhanced secondary production (Lapointe, 1989). In Kenyan coastal waters there is a rich flora of over 300 species (Moorjani, 1977). Most of the Kenyan seaweed records are species lists and taxonom in studies with very little ecological work (Coppejans and Gallin, 1989; Isaac, 1967; 1968; 1971; Isaac and Isaac, 1968; Lawson 1969; Moorjani, 1977; 1980; Oyieke and Ruwa, 1987).

Apart from their ecological role seaweeds have also been known to serve as raw materials for several commercial products (Michanek, 1979). *Gracilaria* is one of the most important seaweeds for the commercial production of agar (Santos, 1980). Species of *Gracilaria* are common along the Kenyan coast and could provide a major source of agar. Hence there is need to manage and conserve wild stocks of *Gracilaria* species in order to maintain and enhance their productivity. The study reported herein, on the distribution of *Gracilaria* species of the Kenyan coast, was carried out in order to provide information relevant for future sustainable commercial exploitation of these plants, and to elucidate facts on the impact of human activities on their survival.

Materials and methods

Twenty three stations were chosen along the Kenya coast for study (Fig. 1). At each sampling station a straight 4m wide transect was laid out from the beach to the edge of the reef covering the whole length of the reef platform. All the pools and lagoons that the transects cut through were sampled for species of *Gracilaria* during low tide. Snorkeling was done wherever necessary. At the reef snorkeling was carried out along the edge of the outer reef, 50m on each side of the transect. A record of all the habitats and microhabitats was taken. In order to give a fair representation of each station, 3 such transects were studied 100m apart thus giving a continuous 300m section of the outer reef covered at each station. This study was carried out during the peak seaweed growing season (unpublished data) between the months of August and December. In order to find out the impact of development programmes along the coastal zone on these plants, the species diversity of study sites at Mckenzie station were compared for the years 1986, 1990 and 1993.

An attempt also was made to study the zonation pattern of the species and for this Hartnoll's (1976) and Lewis's (1964) universal zonation schemes were adapted. The height above datum of each beach sampled was determined during calm waters around neap tide days, using tidal predictions for 1990.

Results

The distribution of the various *Gracilaria* species along the Kenya coast is shown in Table 1, whilst profiles of some of the representative stations studied showing details of different habitats are shown in Figure 2 (a-c). The beaches studied can be divided into 3 cartegories based on their substrates. There were sandy beaches either with or without mangrove ecosystems, rocky platforms without a reef edge mainly found where there was sheltered waters, and rocky platforms with a reef edge exposed to the open sea.

The most common of all the *Gracilaria* species studied was *G. salicornia*. It was recorded virtually at all sampling stations and in every habitat and microhabitat. The species was mainly eulittoral though a small percentage was recorded from the sublittoral. Individuals of this species ranged from those which were completely exposed to desiccation during low tide to those which were permanently covered by water in pools. On the basis of their substrates four ecotypes were recorded; one type was observed growing in shallow intertidal pools of up to about 10 cm deep while the other type grew directly on rocky surfaces as cushions and these were completely exposed during low water. The third type was observed in intertidal rocky-muddy substrates where the algae grew in big bundles up to 15 cm in diameter, while the fourth type was recorded in the sublittoral with erect long thalli.

G. corticata and *G. crassa* were the next most common species. The former had two ecotypes; the first one grew as an epiphyte on seagrasses either in the sublittoral or in eulittoral pools while the second type grew directly on rocky surfaces at the edge of the reef. *G. crassa* on the other hand grew in rocky pools at the reef edge where they were hidden in crevices. The pools were either sublittoral or in the lower eulittoral zones.

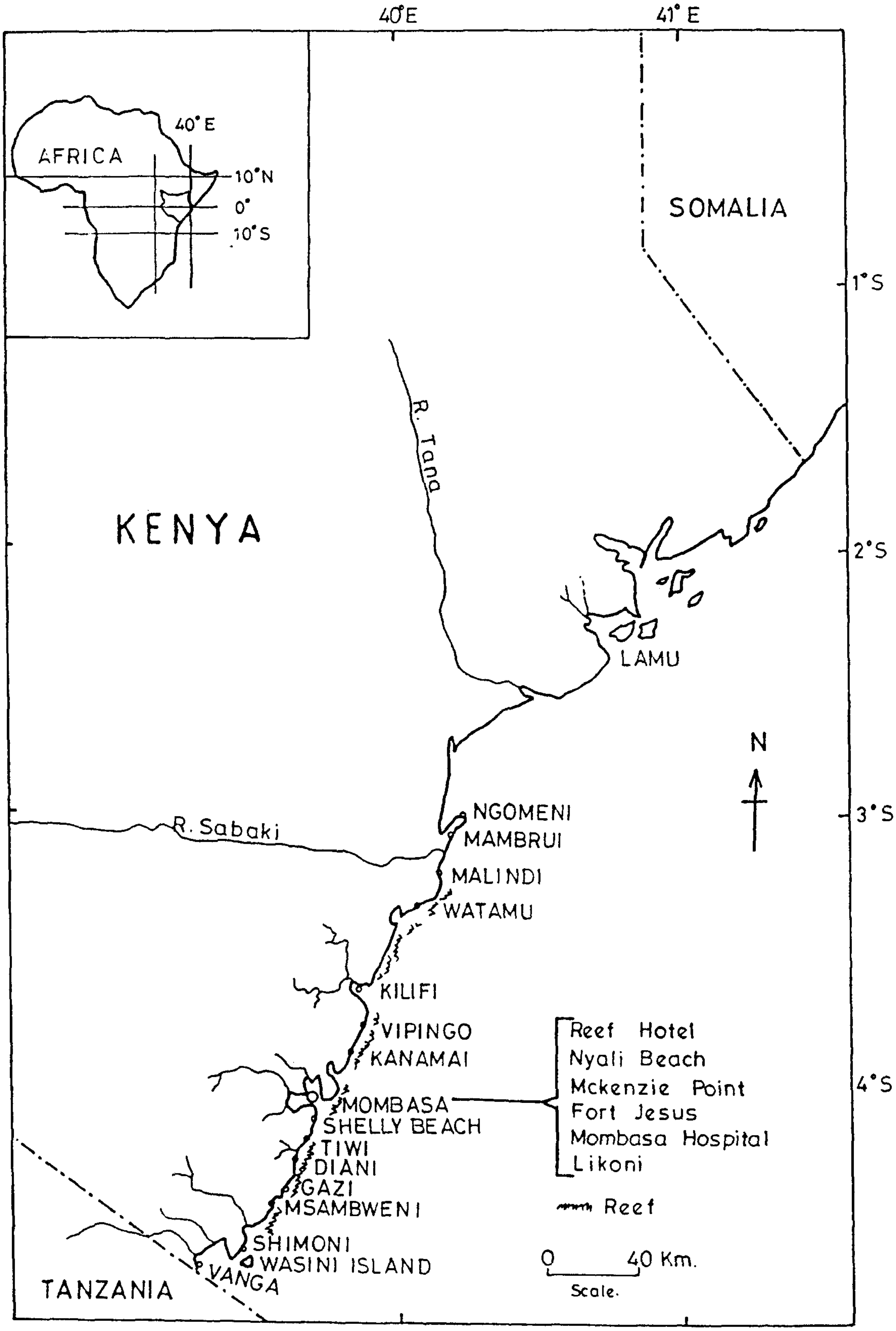

Fig. 1. Kenya coast showing stations of study. Inset: regional location.

Table 1. The distribution of *Gracilaria* species along the Kenya coast.

SPECIES	STATIONS																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
G. Corticata J. Agardh	x		x	x	x	x		x	x		x		x		x			x			x		x
G. Crassa Harvey			x	x				x		x	x		x		x	x	x				x		
G. edulis (J. Ag;) Silva								x			x										x		
G. fergusonii J. Agardh										x												x	
G. millardetti J. Agardh												x											
G.salicornia (J. Ag;) Dawsoon	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
G. verrucosa (Huds.) Papenfus				x														x					x
Gracilaria sp			x								x		x										
Total No. of spp.	2	1	4	4	2	2	1	4	2	3	5	2	4	1	3	2	2	3	1	1	4	2	3
Substrate	S	S	RR	RR	S	S	S	RR	R	RR	RR	RR	RR	R	RR	S	S	S	R	R	RR	R	S

Key: **RR** rocky platform with reef edge, **R** rocky platform without reef edge, **S** sandy beaches

G. verrucosa, G. edulis and Gracilaria sp. were less commonly observed, each species being found at only 3 of the 23 stations. *G. verrucosa* was recorded in sandy channels where it grew directly from the sand with part of its based parts being partly buried in the soft sediments in the sublittoral.

G. edulis was basically eulittoral growing in shallow sandy or rocky pools either in association with seagrass or in isolation. *Gracilaria* sp. on the other hand was observed basically in the eulittoral with a small percentage in the sublittoral zone. These eulittoral plants grow in small rocky pools on the reef platforms.

They are cartilagenous, flat, 3-6 cm high with a blade diameter of 2.4 mm broad. The branching pattern is dichotomous with a distinguishable main axis. Blade margins are smooth with bi-lobed rounded tips. Fresh specimens are brownish yellow and when pressed they turn pinkish red. Thallus has rhizoidal structures for attaching onto the rocks.

Judging from this study, *G. millardetii* and *G. fergusonii* would be classified as rare in their distribution along the Kenya coast. The former was recorded only in shallow rocky eulittoral pools at one site, while the latter was recorded in the sublittoral among hard substrates such as dead coral rocks at two widely separated sites.

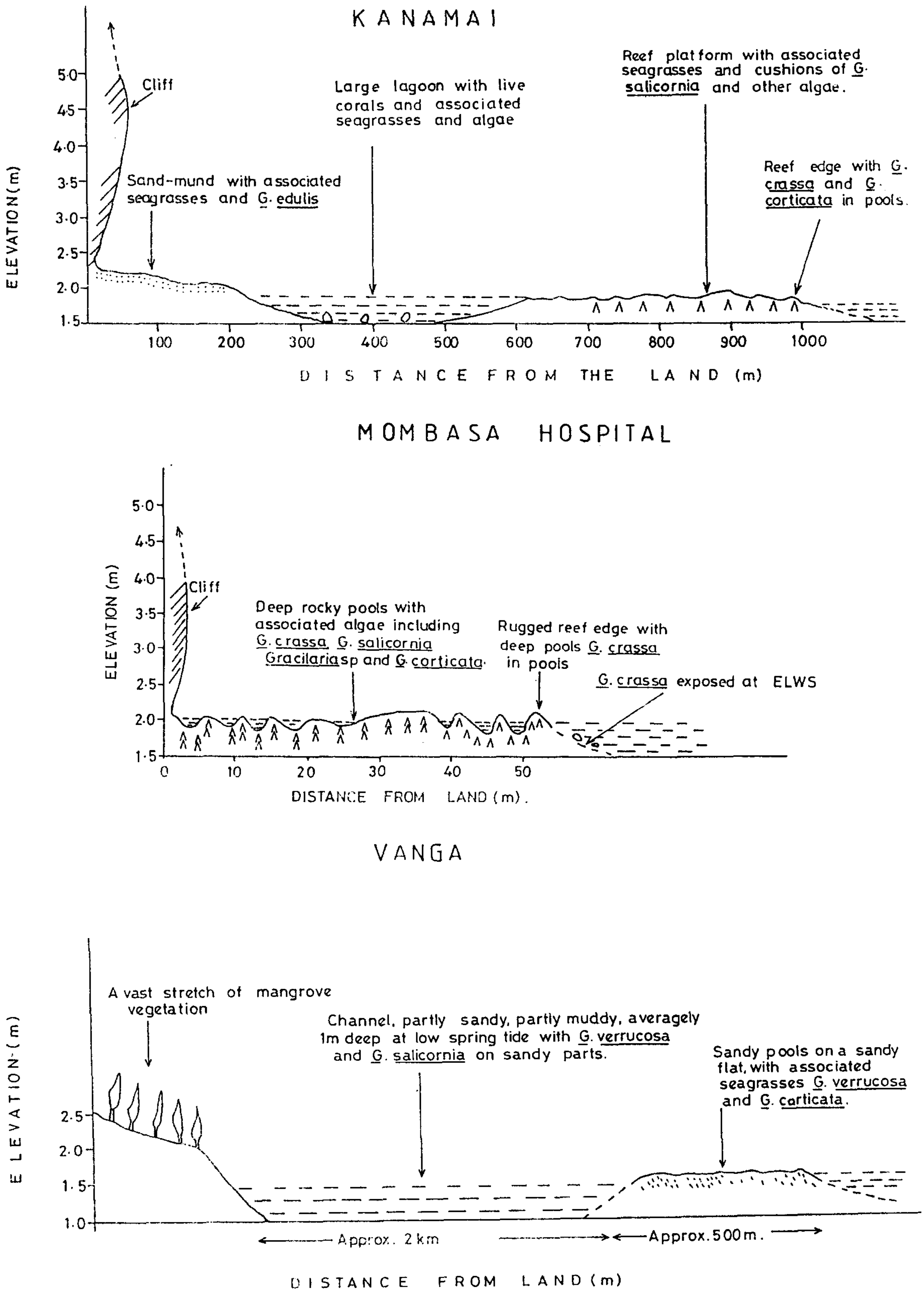

Fig. 2 (a-c). **Profiles of some representative stations studied indicating details of habitats and microhabitats.**

Discussion

The north-south distribution of the *Gracilaria* species along the Kenya coast did not show any specific trend. However, stations with rocky platforms having their reef edges exposed to the open sea had a wider variety of species than rocky platforms in sheltered waters or sandy beaches (mean number of species per site were 3.6 ± 0.8, 1.4 ± 0.5, 2.0 ± 0.7 respectively). Though no quantitative studies were carried out on standing crops of the different species, it is apparent from field surveys that *G. salicornia* is the most abundant followed by *G. corticata* in terms of biomass. The survey has shown a lack of large expanses of *Gracilaria* beds as reported from the temperate zones. Most of the populations grow in discrete patches. This observation could be attributed to the high temperatures experienced in the tropics which could possibly limit the maximum growth and productivity of the plants as well as the grazing activities of animals (Chapman & Chapman, 1973; McLachlan & Bird, 1986).

According to the Hartnoll (1976) shore zonation scheme adapted for the study it is apparent that *G. millardetii,* and *G. edulis* are the only species that are found only in the eulittoral whereas *G. verrucosa* is the only species that is found only in the sublittoral. The remaining species grow partly in the eulittoral zone and partly in the sublittoral (Fig. 3). It therefore follows that a larger percentage of the species grow in the eulittoral zone and particularly so in the lower eulittoral zone.

G. salicornia has been observed to grow in all types of microhabitats including those that subject it to complete desiccation stress at low tide. Those ecotypes which are characterized by cushion forms of growth appear to be better suited for survival in the harsh physiological conditions (Taylor & Hay, 1984). Upright elongated growth forms of this species are found where there is constant water cover, either in the form of pools, lagoons, wave splash or when in the sublittoral.

Of the coastal ecosystems the eulittoral zone, reported in this study as the main zone for the growth of *Gracilaria* species, experiences a great deal of disturbances from human activities through the hotel and other industries. The construction of hotels in some cases extend to this zone thus literally destroying the habitat. For instance, a transect at Mckenzie station in 1986 had 4 species of *Gracilaria* while the same transect in (1993) had relics of only one species *G. salicornia* which has been observed to be able to withstand very harsh conditions. Along this transect a hotel jetty has been constructed thus altering the environment by creating extra shade while the pillars of the jetty alter the flow of water in the area. Another transect in the same station was observed to cover one of the largest *G. corticata* beds during this study in 1990. The same area is currently being reclaimed for the purpose of jetty construction for a fish processing factory. The whole *G. corticata* bed has been totally wiped out. The eulittoral zone as a habitat is further affected by pollution effects which result from human activities. Apart from untreated seawage and factory effluents which are discharged directly onto this part of the coastal zone, waves and currents concentrate other pollutants such as hydrocarbons from the high seas and urban areas, in this zone.

The above cited interferences apply to all other eulittoral zone organisms and hence it is a threat to the whole ecosystem within this zone. There is, therefore, a serious need for policy-makers and coastal zone planners and managers to work in a more co-ordinated manner so as to come up with plans that would conserve the survival of organisms within the eulittoral zone. Otherwise, the present un co-ordinated development programmes along the coastal zone would lead to the extinction of some rare species sooner than expected.

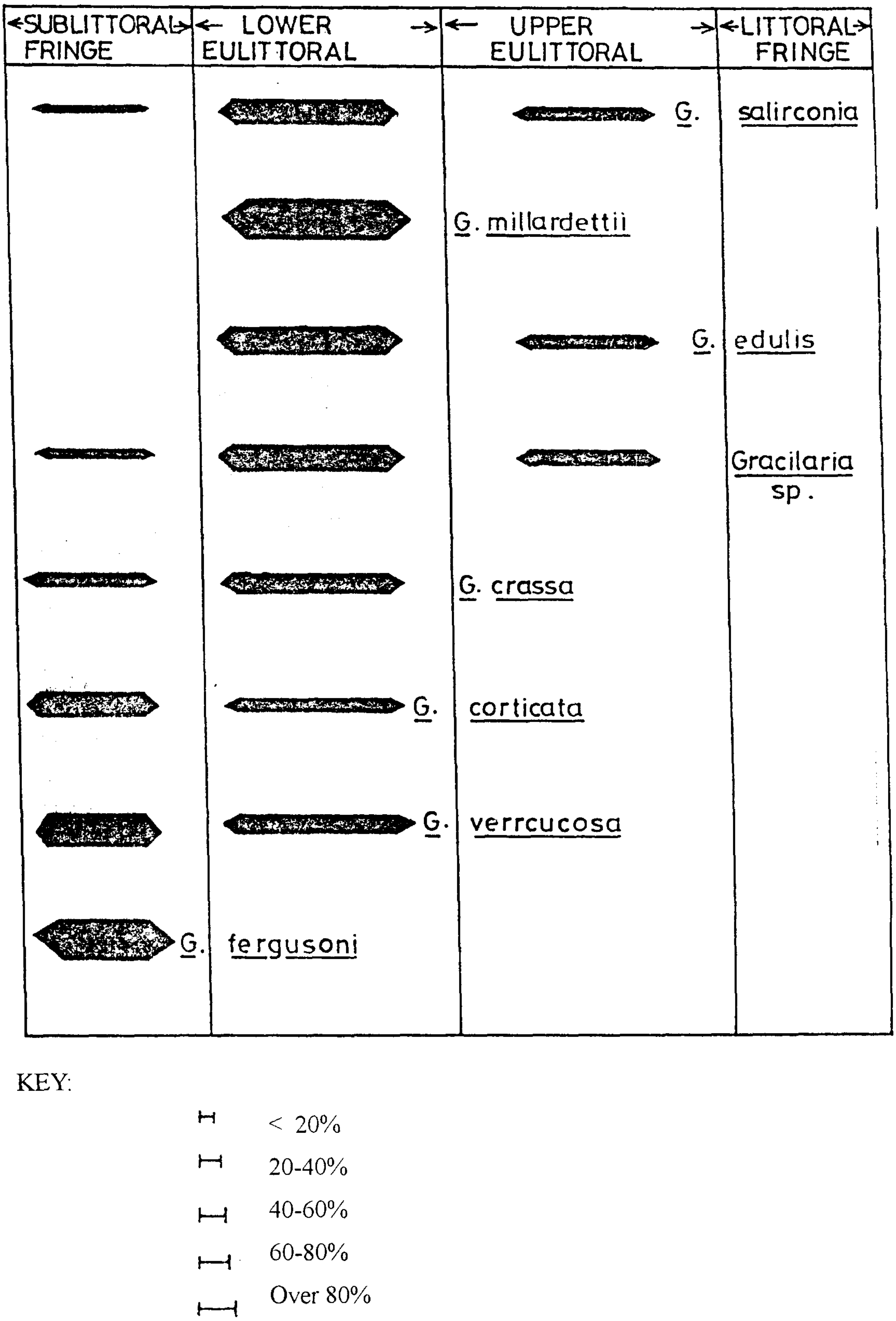

Fig.3. Relative zonation of different *Gracilaria* species showing percentage of number of times each species is found at each zone.

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