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The Morphology and Distribution Ecology of *Corynomorpha prismatica:* A Red Seaweed of Potential Economic Significance in Southeast Tanzania

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Abstract

Investigations have been conducted on the gross morphology and distribution ecology of *Corynomorpha prismatica* J. Agardh (Rhodophyta, Cryptonemiales) at Lindi, southeast Tanzania. The mean standing crop of the seaweed in the study locality was 518 ± 80.2 g/m^2 dry weight. Frond height varied as a function of habitat elevation, being 21.2 ± 1.3, 20.2 ± 2.0, 13.7 ± 2.5 and 4.3 ± 0.4 cm at -15, 5, 25 and 45 cm elevation above spring-tide low-water mark, respectively. Populations of *C. prismatica* were almost exclusively confined to west-facing vertical rocky surfaces sheltered from direct insolation during the morning hours. The fronds showed a wider variety of morphological appearance than reported in the literature. This was partly due to variations in the patterns of thallus regeneration after wounding. The economic implications of these findings are discussed.

Introduction

Corynomorpha prismatica J. Agardh (Rhodophyta, Cryptonemiales) was reported from the shores of Tanzania for the first time by Schmitz (1895). The seaweed has also been reported from India (Balakrishnan, 1962), and it probably also occurs on other tropical shores. Generally, however, *C. prismatica* is one of the lesser known frondose red algae. For example, very little is known about its gross morphology. Even less is known about its distribution ecology.

In Tanzania, the richest beds of *Corynomorpha prismatica* have been located at Likotwa village, Lindi (south-east Tanzania). In this locality populations of this species approach 100% cover. In the present paper the author attempts to advance our knowledge on the range of vegetative morphology and frond regeneration in *C. prismatica,* and on some aspects of its littoral distribution. These advances are based on studies recently conducted at Likotwa village referred to above.

As one of the larger cartilaginous frondose red seaweeds on the shores of Tanzania occurring in rich abundance, *Corynomorpha prismatica* attracts attention as a seaweed of potential economic significance in the production of the red seaweed commercial colloids agar and carrageenan. The information reported in this paper is thus likely to be applicable to possible exploitation of the seaweed.

Materials and Methods

The habitats to which *Corynomorpha prismatica* is adapted were studied by examining a wide range of localities on various shores of Tanzania. After locating Likotwa village, Lindi, as the area with the densest populations of the seaweeds, studies were planned and executed along a transect from highest high-water mark to lowest low-water mark of the spring tides and the upper sublittoral zone.

While studying the field distribution of *Corynomorpha prismatica,* it became evident that those plants at the uppermost end of its intertidal distribution were shortest. The tallest plants were in the permanently immersed habitats. This led to studies on frond height as a function of habitat elevation.

A random sample of 100 *Corynomorpha prismatica* plants was taken from various elevation levels (Fig. 1). The plants harvested from each zone were placed in numbered plastic bags and their heights subsequently measured. Mean heights with confidence limits of P = 0.05 were calculated according to Snedecor and Cochran (1967), and are shown in Fig. 1.

Standing crops of the seaweed were also determined. This was done using a 0.4 x 0.4 m wooden quadrat. The quadrat was laid on the ground, and all *Corynomorpha prismatica* plants growing within the quadrat were hand-picked and placed in a numbered collecting bag. Fifteen quadrat samples were taken.

The plants were subsequently sorted to remove impurities, and dry weights determined. The weights obtained were converted to g/m^2 by dividing by 0.16, the area in m^2 covered by the sampling quadrat. The mean standing crop value and its confidence limits ($P = 0.05$) were then calculated.

Variations in thallus morphology were recorded by examining over 200 freshly harvested specimens and photographing the growth forms observed.

Aspects of thallus regeneration were studied in the collected specimens. Regeneration patterns in the areas wounded through grazing, etc. were recorded photographically.

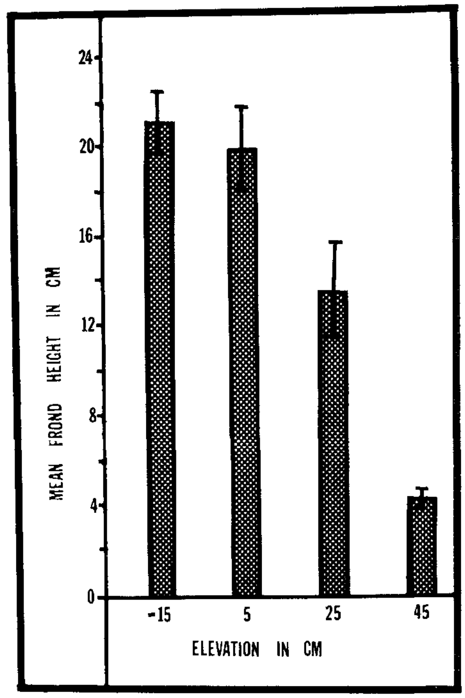

Fig. 1. *Corynomorpha prismatica*. Average frond height as function of elevation above lowest low-water mark of spring low tides

Results

Populations of *Corynomorpha prismatica* at Lindi are almost exclusively confined to vertical rocky surfaces around the lowest low-water mark of spring low-tides (-0.4 m to + 0.5 m about the tide datum). The habitat at Likotwa village has many stable rocky outcrops, with gulleys surrounded by vertical or overhanging walls (Fig. 2: *2*). *C. prismatica* grows attached to the vertical walls of the furrows and is usually found hanging downwards from the walls. There is a fairly strong wave action in the rocky habitats where *C. prismatica* thrives, and the plants are periodically covered with water which is frequently swept through the furrows by wave action.

In this study it was observed that *Corynomorpha prismatica* populations were particularly rich on west-facing rocky surfaces (Fig. 2: *2*), whereas almost no fronds grew on east-facing slopes (except where the plants were well shaded by over-hanging walls).

It was also found that the plants at the uppermost end of *Corynomorpha prismatica's* distribution were significantly shorter than those at about the spring low-tide water mark or in permanently immersed habitats (Fig. 1). In the infralittoral fringe and upper sublittoral habitats plants of 20 to 27 cm were common, whereas at 45 cm elevation most plants ranged from 3 to 6 cm in height.

The average standing crop of *Corynomorpha prismatica* in the study transect during the sampling month (August 28, 1976) was 518.0 ± 80.2 g/m^2, dry weight.

A very large proportion of *Corynomorpha prismatica* plants grow singly (Fig. 2: *3*) without any branching. When branched, the branching pattern is mainly dichotomous (Fig. 2: *4*).

The fronds are attached to the rocky substrata by small disc-like holdfasts. From the holdfasts, secondary shoots are normally produced, giving rise to shoots of different ages and sizes (Fig. 2: *5*).

Some fronds display "wounds" (Fig. 3: *6*, *7*). These seem to represent areas grazed by marine animals. From some of the wounded areas the apices had been completely removed (Fig. 3: *7*). In this study it was observed that wounded plants do not die, but regenerate new shoots.

The regeneration of a new shoot begins as a "bud" emerging from the wounded area (Fig. 3: *7*). These buds continue to enlarge, and develop as new lateral shoots when only a small wound is present on the side of a shoot axis, or as terminal shoots when the entire shoot apex has been destroyed (Fig. 3: *8*, *9*). In the latter case, a whorl of 3 to 8 or more buds may develop terminally (Fig. 3: *8*, *9*).

The buds from which new shoots are regenerated (when the shoot apex is wounded) may all start developing at the same time so that all the secondary

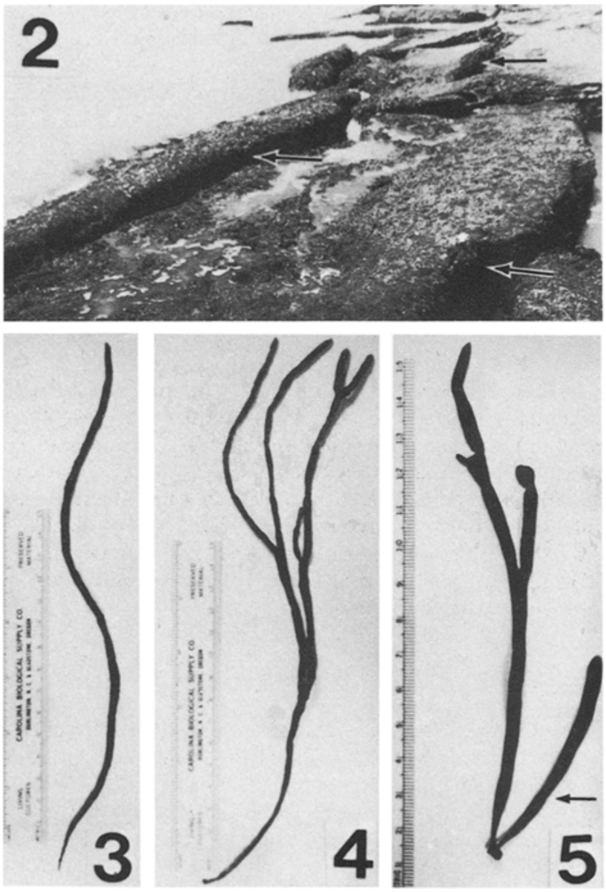

Fig. 2. *2*: *Corynomorpha prismatica* habitat at Likotwa village, Lindi, Tanzania; note vertical west-facing walls (arrowed) of natural "furrows" near low-water mark. *3-5*: *Corynomorpha prismatica*; *3*: specimen with no branching; *4*: main axis with typical branching; *5*: secondary shoot (arrowed) arising from basal portion of primary axis

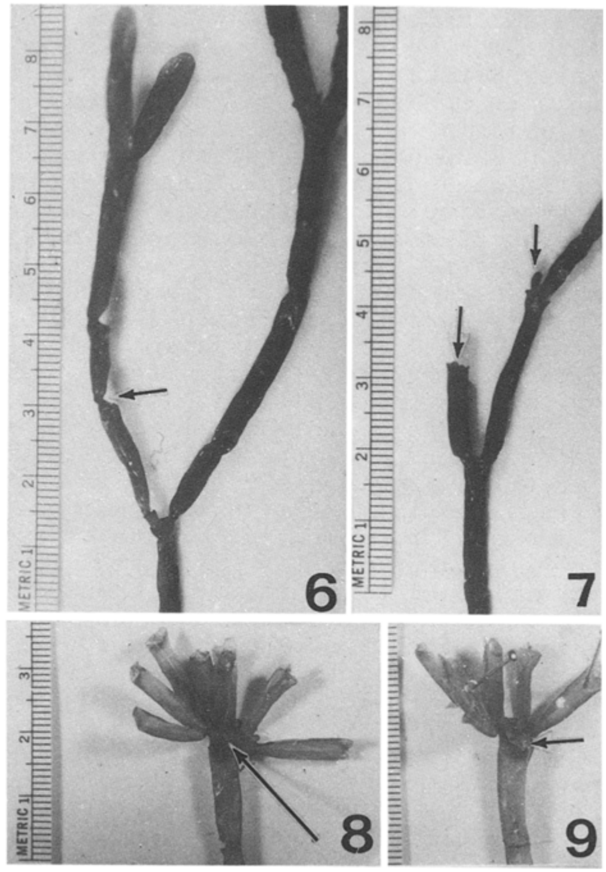

Fig. 3. *6-9*: *Corynomorpha prismatica 6*: specimen with freshly wounded frond (arrowed); *7*: specimen with one branch completely removed by grazers (left arrow) and another partially damaged (right arrow), note regenerating bud (right arrow); *8* and *9*: specimens with terminal scars (arrowed) where amputated apices have been replaced by whorls of new shoots

shoots in a whorl are of the same size (Fig. 3: *9*), or they may develop at different times giving secondary shoots of dissimilar size (Fig. 3: *8*).

Discussion

The observations that *Corynomorpha prismatica* plants mainly grow in the lowermost intertidal and upper subtidal habitats suggest that the seaweed is not well adapted for withstanding the adverse conditions of tide-induced exposure to direct insolation, nor the salinity and temperature fluctuations characteristic of the upper intertidal belts. This is further supported by the fact that those fronds occurring at an elevation of only 45 cm above low-water mark (mean tidal range between low-water mark and high-water mark of spring tides in the study site was 3.4 m) had an average frond height of 4.3 ± 0.4 cm, whereas fronds from permanently immersed habitats had a mean height of 21.2 ± 1.3 cm. Thus, should the seaweed be found to be a rich source of phycocolloid, the habitat from which to harvest large-sized plants is along the infralittoral fringe and upper sublittoral zones.

Another interesting feature on the distribution of *Corynomorpha prismatica* at Lindi is that populations of the seaweed are almost exclusively confined to the west-facing slopes, where the fronds are shaded from direct insolation at low tide during the morning hours. Where the seaweed also occurs on the east-facing slopes, this is mainly where the walls of the "furrows" overhang and shade the plants, or where the fronds are permanently immersed. This observation further supports the suggestion that *C. prismatica* has a low tolerance to direct insolation. Thus, although in the afternoons the west-facing slopes would also be expected to be subjected to direct insolation, afternoons are often cloudy and insolation is less intense than in the mornings. Populations of *C. prismatica* on west-facing slopes are therefore less adversely affected by insolation.

This study reveals that there is a wider range of morphological variation in the fronds of *Corynomorpha prismatica* than has been so far reported in the literature (Kylin, 1956; Balakrishnan, 1962; Jaasund, 1976): normal unwounded plants may arise singly, or gregariously from a basal disc; the erect axes may be unbranched or branched; when branched the branching may be dichotomous, or where wounding has resulted in the elimination of a shoot apex several axes may arise from the wounded apex giving rise to whorls of branches.

The observation that *Corynomorpha prismatica* has considerable powers of regeneration seems to be an important finding, since it suggests that should the fronds of this seaweed be harvested for commercial agar or carrageenan production, many new axes will be regenerated for subsequent crops. In fact, cutting the apical meristem (Fig. 3: *8*, *9*) seems to stimulate the budding of new shoots, a phenomenon akin to apical dominance in higher vascular plants.

The high standing crops of *Corynomorpha prismatica* at Lindi (518.0 ± 80.2 g/m^2, dry weight), the relatively large size of its fronds (mostly 20 to 27 cm tall), and its high powers of regeneration suggest this seaweed to be of potential economic significance in south-east Tanzania. It therefore seems desirable for further studies to be conducted on this seaweed to reveal the nature of its phycocolloid, i.e., whether agar or carrageenan, to determine the quantitative yields of its phycocolloid, whether its standing crops and its phycocolloid are stable or whether they vary seasonally, and the growth rate of regenerating shoots since this will reveal how frequently the fronds of the alga should be harvested during commercial exploitation.

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