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Utilized and potentially utilizable seaweeds on the Namibian coast: biogeography and accessibility

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Abstract

Of the 1500 km coast of Namibia, only 80 km is predominantly rocky, the remaining 1420 km being sandy with only minor rocky outcrops. At present two species are utilized, *Gracilaria verrucosa* for agar and *Laminaria schinzii* for human consumption. Other potentially utilizable seaweeds occurring on the coast are *Ecklonia maxima* for alginates, *Suhria vittata* for agar, *Gigartina radula*, *G. stiriata* and *Aeodes orbitosa* for carrageenans and *Porphyra capensis* for human consumption. *Laminaria schinzii* also can be used for alginate production. Due to the diamond-mining areas around the 80 km rocky area at Luderitz (26° 39′ S), only 20 km are accessible; hence, at present the seaweeds are being exploited almost to their full potential. The species currently not being utilized could be used, however, to support the industry that already exists at Luderitz. To increase production, access to the diamond areas would have to be gained or a cultivation program initiated.

Introduction

The 1500 km coast of Namibia stretches from the Kunene River, 17° 30′ S, which marks the border with Angola, to the Orange River, 28° 20′ S, marking the border with South Africa (Fig. 1). The coast is relatively straight, lacking indentation and is bisected by the Tropic of Capricorn. Historically the coast has been notoriously dangerous to shipping; large swells, high winds, fog and the isolation of the coast contribute to it being called the 'Skeleton Coast'.

To date, the seaweeds of Namibia have, to a large extent, escaped the attention of phycologists. Only the unpublished survey of parts of the coast by Simons *et al.* in 1957, a survey of the marine intertidal fauna of the coast (which included a few seaweed species) by Penrith & Kensley (1970a, 1970b) and Kensley & Penrith (1980) and the single seaweed collection at Swakopmund by Wynne (1986) provide records of seaweeds on the Namibian coast.

Namibia does not have a history or tradition of seaweed utilization. This new and previously untapped resource already is providing employment at an agar factory in Luderitz (Rotmann, 1987). This paper highlights the seaweeds that might be utilized in the future as well as those that already are used and the potential of each species.

Description of the coast

The only predominantly rocky area on the coast occurs from Luderitz (26° 39′ S) to Bogenfels (27° 25′ S), 80 km south of Luderitz (Fig. 1). The rest of the 1500 km coast is sandy with scattered rocky outcrops. In the north, from Swakopmund

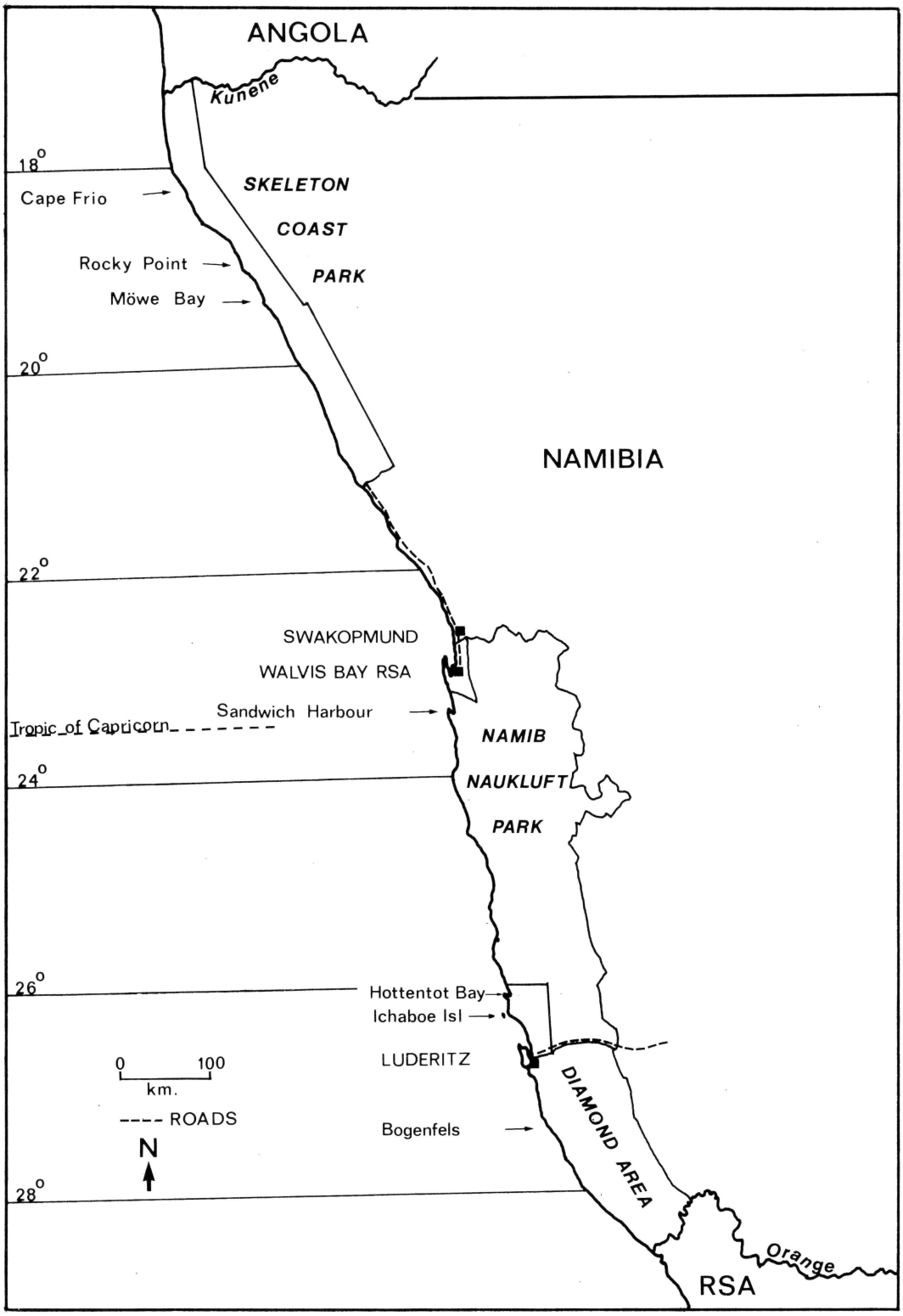

Fig. 1. The Namibian coast.

(22° 55′ S) to the Angolan border, there are few rocky outcrops along the predominantly sandy coast. Most of the rock in this area occurs in the low intertidal or subtidal and is often inundated with sand, resulting in a very low seaweed biomass. South of Swakopmund is the South African-owned Walvis Bay enclave, and immediately south of that is the Namib Naukluft Park with sand dunes reaching down to the water's edge. Closer to Luderitz, the rocky outcrops become larger and more frequent. The tidal range is small, with an absolute minimum of 0.42 m and an absolute maximum of 1.88 m.

Materials and methods

Surveys and collections were made along the coast at various sites. These sites were reached by land where possible, otherwise by sea. Transects were perpendicular to the shore with 0.25 m^2 quadrats. The surveys were carried out from June to December (winter to summer) 1988 at approximately bimonthly intervals. Four transects per site were taken and quadrats placed at every 0.15 m increase in elevation.

Trial harvesting of *Laminaria schinzii* Foslie was initiated at various sites in the Luderitz area to determine standing crop and re-growth after harvesting. The commercial harvesting method currently used was adopted, i.e. blades are cut 2 cm above the meristem, and all blades are removed from a harvested plant. In various kelp beds, sites were marked with concrete blocks and corks. Sites were chosen by dropping the concrete blocks into the kelp beds. All *Laminaria* plants within a radius of 1 m of a block were harvested. Wet weights were determined because the industry uses this system, and quotas are allocated in terms of wet weight.

Results

The following utilized or potentially utilizable seaweeds were identified on the coast of Namibia:

Alginate producers: *Laminaria schinzii* and *Ecklonia maxima* (Osbeck) Papenf.

Agarophytes: *Gracilaria verrucosa* (Hudson) Papenf. and *Suhria vittata* (L.) J. Ag. (*Gelidium pteridifolium* R. E. Norris, M. H. Hommersand et S. Fredericq sp. nov. also occurs on the coast but not in sufficient quantity to be considered here).

Carrageenophytes: *Gigartina radula* C. Ag., *Gigartina stiriata* (Turner) Aresch. and *Aeodes orbitosa* (Suhr) Schmitz.

Human or animal consumption: *Laminaria schinzii*, *Ecklonia maxiam* and *Porphyra capensis* Kuetz.

Laminaria schinzii

Laminaria schinzii, a digitate form, occurs along the entire Namibian coast as far as Rocky Point (Fig. 1) (Penrith & Kensley, 1970). It grows from mean low water spring (MLWS) to ~16 m, distribution being dictated by substratum. The largest *Laminaria* beds occur around and south of Luderitz.

Laminaria morphology varies considerably with wave exposure. Total blade surface area in the most exposed sites was 1.0 ± 0.2 m^2. This increased with decreasing wave exposure to a surface area of 2.0 ± 0.3 m^2 in the most sheltered sites. Blade width was responsible for the change in surface area, as the difference in blade length was negligible. At a depth of 1.5 m below MLWS, stipe length did not vary at 1.7 ± 0.15 m^2. In the most wave-exposed and most sheltered kelp beds, the sole component was *Laminaria schinzii*, but in semi-exposed sites *L. schinzii* competed with *Ecklonia maxima*. In the most exposed sites, *L. schinzii* density was approximately 12 plants m^{-2} and in sheltered sites, seven plants m^{-2}. The ratio of *L. schinzii* to *Ecklonia maxima* in the semi-exposed sites was 3:1, resulting in a *Laminaria* density of approximately seven plants m^{-2} for these sites. *Laminaria schinzii* plants at present are harvested commercially in the Luderitz area. The results of the trial harvesting indicated that regrowth after harvesting occurred in 3-4 months at a rate of 12 mm per day. On a 20 km section of coast in the Luderitz area, it was estimated that 300 tons of *Laminaria* blades are available per

annum, using the harvesting method outlined above.

Ecklonia maxima (Fig. 2A)

This species is not collected or harvested in Namibia. Luderitz marks the northern extent of its distribution, although drift plants have been found as far as 60 km to the north. It occurs as an onshore kelp from MLWS to 7 m depth only in semi-exposed sites.

Gracilaria verrucosa

Gracilaria verrucosa grows in the sand and muddy bottom of Luderitz lagoon, Sandwich Harbor, Walvis Bay and the Swakopmund area. The seaweed is not harvested, but is collected from beach cast at Luderitz, approximately 10–15,000 tons (wet weight) taken per annum. At other sites, natural stocks are insufficient to warrant collection. In the Luderitz area, propagation was found to be vegetative as no sexually reproductive material was found; however, cystocarpic material was found in the Swakopmund area.

Suhria vittata (Fig. 2B)

On the Namibian coast *Suhria vittata* grows epiphytically on the stipes of *Laminaria schinzii* and *Ecklonia maxima*, on limpet shells and occasionally on rock. *Suhria vittata* was found 60 km north of Swakopmund and is reported (Anderson & Bolton, 1985) to occur as far north as Mowe Bay (Fig. 1).

Gigartina radula and *Gigartina stiriata (Fig. 2C, E)*

These species were found to grow in the intertidal zone from MLWS to about 0.4 m above MLWS, this point varying with the degree of wave exposure. Both of these species tend to grow best in relatively sheltered habitats. In exposed sites, the '*Gigartina* zone' was dominated by *Champia lumbricalis* (Roth) Desvaux and *Plocamium rigidum* Bory. Although the *Gigartina* species grow prolifically as far noth as the Hottentot Bay area (Fig. 1), *G. stiriata* and, to a lesser extent, *G. radula* are scarce, and from the Swakopmund area north, *G. radula* and *G. stiriata* are totally replaced by *Nothogenia erinacea* (Turner) Parkinson.

Aeodes orbitosa (Fig. 2D)

Aeodes orbitosa grows prolifically around and south of Luderitz, but north of Ichaboe Island (Fig. 1) the species was very scarce. In and north of the Swakopmund area, *A. orbitosa* was not found, although it has been reported (Simons *et al.*, unpub.) as far north as Cape Frio (Fig. 1). *Aeodes orbitosa* grows in an intertidal zone that largely overlaps the '*Gigartina* zone', but its lower limit occurs above MLWS and its upper limit also occurs above that of the '*Gigartina* zone'. *Aeodes orbitosa* was found to grow better in sheltered habitats where it can attain a frond surface area of over 1 m^2. Under exposed conditions, thalli were small and stunted.

Porphyra capensis

Porphyra capensis is morphologically variable (Isaac, 1945) and probably accounts for more than one species. It is found along the entire coast wherever rocks occur in the splash zone.

Discussion

Although the coast of Namibia is approximately bisected by the Tropic of Capricorn, the marine climate is far from tropical or even sub-tropical. The cold Benguela current flows northward along the coast, which, coupled with wind-driven upwelling of cold water, contributes to a temperate marine climate. The average annual temperature range for Luderitz is 12 to 14.8 °C, run-

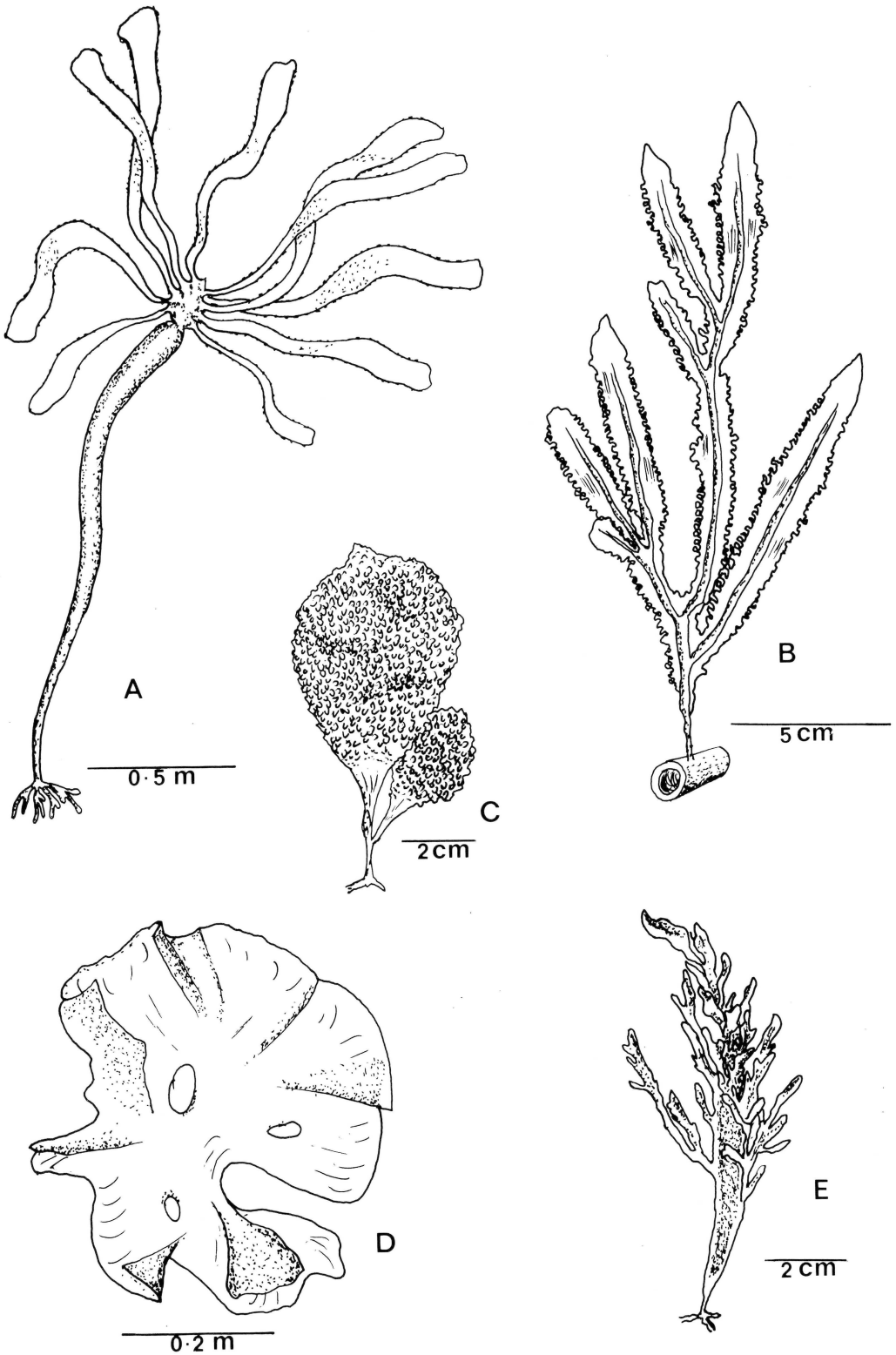

Fig. 2. Potentially utilizable seaweeds: A = *Ecklonia maxima*, B = *Suhria vittata*, C = *Gigartina radula*, D = *Aeodes orbitosa*, E = *Gigartina stiriata*.

ning average 23 days over 10 years (Sea Fisheries data, Roux, pers. com.), which is the lowest for the Namibian coast. The reason for this is that a large upwelling cell exists in the Luderitz region. Water temperature increases slightly south of Luderitz and gradually north of Luderitz, the average annual temperature range for Swakopmund ranging from 12 to 18.4 °C, running average 23 days over 10 years (Sea Fisheries data). The temperature continues to increase northward until, in the vicinity of the Angolan border, there is a rapid rise in temperature to tropical conditions (Lawson *et al.*, 1975).

On the Namibian coast there are two very important considerations for a successful seaweed harvesting or collecting program. Firstly there must be an adequate seaweed biomass available and secondly the area must be accessible to harvesters or collectors. In the Luderitz area both of these criteria are satisfied, but Luderitz is unique. South of Luderitz is the diamond-mining area, which is closed to the public, as is the area north of Luderitz. There is also no road, of any description, along the coast between Luderitz and Walvis Bay. North of Swakopmund, where a road does exist, the seaweed biomass is not great enough to be considered for harvesting.

Luderitz has a factory for the extraction of agar from *Gracilaria verrucosa*, and the same process can be used to extract agar from *Suhria vittata*. However, due to the availability and difficulty of collection, *Suhria vittata* could play only a very minor role in supplementing the agar production of the factory.

The carrageenophytes *Gigartina radula*, *G. stiriata* and *Aeodes orbitosa* all grow abundantly in the Luderitz area. Only 20 km of coast is accessible to the public at Luderitz so access to the diamond-mining area would be needed to support a small industry. The Luderitz agar factory quite easily could be converted to production of carrageenan.

The alginate producers, *Laminaria schinzii* and *Ecklonia maxima*, do not grow in sufficient quantity in the 20 km Luderitz area to warrant building an alginate extraction plant.

Seaweeds for human consumption (*Porphyra capensis* and *Laminaria schinzii*) and for animal feed (*Laminaria schinzii* and *Ecklonia maxima*) require very little processing, and *L. schinzii* already is harvested for this use. Removal of epiphytes from *Laminaria* blades tends to be quite labor-intensive, but, on the other hand, drying the seaweed costs nothing as Luderitz has a desert climate.

To extend the seaweed stocks in the accessible areas, cultivation needs to be considered. The Luderitz lagoon is the only suitable marine aquaculture site in Namibia that is open to the public. Sandwich Harbor and Hottentot Bay also would be suitable, but the former is virtually inaccessible and, despite its name, is not a harbor, whereas the latter is in a restricted area.

The seaweeds on the Namibian coast are being utilized almost to their full potential, considering that, of the 80 km of the entire coast with sufficient biomass to support a harvesting program, only 20 km is accessible for harvesting. Apart from the currently utilized *Gracilaria verrucosa* and *Laminaria schinzii*, the other potentially utilizable species can be seen as a source to supplement activities already in progress in the Luderitz area.

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References

Anderson, R. J. & J. J. Bolton, 1985. Suitability of the agarophyte Suhria vittata (L.) J. Ag. (Rhodophyta: Gelidiaceae) for mariculture: Geographical distribution, reproductive phenology and growth of sporelings in culture in relation to light and temperature. S. afr. J. mar. Sci. 3: 169–178.

Isaac, W. E., 1945. Seaweeds of possible economic importance in the Union of South Africa. J. S. afr. Bot. 8: 225–236.

Kensley, B. & M.-L. Penrith, 1980. The constitution of the

fauna of rocky intertidal shores of South West Africa. Part III. The north coast from False Cape Frio to the Kunene river. Cimbebasia 5: 201–204.

Lawson, G. W., D. M. John & J. H. Price, 1975. The marine algal flora of Angola: its distribution and affinities. Bot. J. linn. Soc. 70: 307–324.

Penrith, M.-L. & B. Kensley, 1970a. The constitution of the intertidal fauna of rocky shores of South West Africa. Part I. Luderitzbucht. Cimbebasia 1: 191–239.

Penrith, M.-L. & B. Kensley, 1970b. The constitution of the intertidal fauna of rocky shores of South West Africa. Part II. Rocky Point. Cimbebasia 1: 241–268.

Rotmann, K. W. G., 1987. The collection, utilization and potential farming of red seaweeds in Namibia. Proc. int. Seaweed Symp. 12: 301–305.

Wynne, M. J., 1986. Report on a collection of benthic marine algae from the Namibian coast (southwestern Africa). Nova Hedwigia 43: 311–355.