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Eucheuma (Rhodophyta, Gigartinales) in the W Indian Ocean region – notes on collections kept in Berlin-Dahlem and Hamburg

Abstract

Mshigeni, K. E. & Jahn, R.: *Eucheuma (Rhodophyta, Gigartinales)* in the W Indian Ocean region - notes on collections kept in Berlin-Dahlem and Hamburg. – Willdenowia 25: 399–407. 1995. – ISSN 0511–9618.

A survey on the *Eucheuma* collections from the W Indian Ocean region kept at B and HBG is given; notes on the distribution of *E. denticulatum, E. odontophorum* and *E. platycladum* are added and the characters distinguishing *E. odontophorum* from *E. platycladum* listed.

Introduction

The red algal genus *Eucheuma* J. Agardh *(Gigartinales, Solieriaceae)* is economically the most important seaweed in the western Indian Ocean region. Some of its species are exported by Tanzania (Anderson 1953; Mshigeni 1973, 1987) and Madagascar (Mollion, Andriantsiferana & Sekkal 1990; Rabesandratana & Rabesandratana 1992) for use as a source of carrageenan (Doty 1973, 1988; Mshigeni & Semesi 1977). The commercial importance of *Eucheuma* in the region is likely to increase in the near future with the introduction and successful assimilation of its cultivation technology in Tanzania's rural communities along the coast (Mshigeni 1992). This *Eucheuma* farming technology has been pioneered by M. Doty and V. Alvarez (Doty 1973) in the Indo-Pacific region.

However, the various species of *Eucheuma* in the W Indian Ocean region are still imperfectly known (Doty 1988; Mollion, Andriantsiferana & Sekkal 1990), and there is a need for a detailed study of their taxonomy and distribution. Most of the earlier authors, who validated the names of *Eucheuma* species from the region, based their descriptions on dead specimens or just fragments. Often the samples were collected by non-specialists or short-term visitors, who did not record field data and the morphological variability of the sampled plants in their natural habitats. Therefore, they could not know to what extent the morphological characters had been influenced by the environment (e.g. exposure to waves, intertidal stress, grazing) or by age phenomena. The current circumscription of the *Eucheuma* species of this region (Mshigeni 1984, 1987) were reached after extensive field studies of these taxa in East Africa

Tab. 1: *Eucheuma* specimens from the W Indian Ocean region in B and HBG.

Locality	Collector	Date	Voucher	Remarks
Eucheuma denticulatum				
Cape of Good Hope	[herb. Schiffner]	Not recorded	B: Algae 15 031	Non-compressed, spinulose, verticillate
Cape of Good Hope	Not recorded	Not recorded	B: Algae 23 778	Non-compressed, spinulose, verticillate
E. horridum				
Mauritius	Not recorded (fragments in envelope No. 29)	Not recorded	B: Algae 15 042	Spinulose, non-compressed, some of the spines elongated into branchlets, irregularly arranged
Madagascar	[herb. Wollny, herb. Th. Reinbold]	Not recorded	HBG: H.H. 10	Fronds slender, spinulose, non-compressed, spines not arranged in regular whorls
E. odontophorum				
Kiu Island Lagoon, Kenya	*P.J. Greenway 9388 & S.P. Rawlins*	13. 10. 1957	B: Algae 33 866, 34 190	Fronds clad with spines, semicompressed, with many constrictions along the axes
E. platycladum				
Dar es Salaam, Tanzania	*Holst 1340*	12. 1892	B: Algae 36 507	Type; single specimen, spinulose, axes dorsiventrally compressed, constrictions along the axes not distinct
Tamatave Riff, Madagascar	*Voeltzkow*	1903	B: Algae 37 362 (wet)	Fronds clad with spines, dorsiventrally compressed, constrictions along thallus axes not distinct
E. striatum				
Zanzibar	*Stuhlmann*	1889?	HBG: H.H. 21	Type (fragment)
Pemba Island	*Voeltzkow*	1903	B: Algae 29 068	Several specimens, non-spinulose, non-compressed, with acuminate branches

and Mauritius, and by comparing the collections with specimens from other herbaria (listed also in Doty 1988).

The present study focusses on the historical *Eucheuma* material from the W Indian Ocean region in the herbaria of Berlin-Dahlem (B) and Hamburg (HBG).

Results and discussion

Our results are summarized in two tables. Tab. 1 contains the details of all *Eucheuma* specimens of African origin that were found in the herbaria investigated.Tab. 2 lists published records of distribution of *Eucheuma* species from the western Indian Ocean region; in addition to the cited species, Doty (1988) recognises the occurrence of *Eucheuma serra* J. Agardh in Mauritius.

Tab. 2: Published records of *Eucheuma* species in the W Indian Ocean region (see Dixon (1962) and Mshigeni (1987) for synonymy and re-identifications), * = records need confirmation.

Locality	Reference	Name recorded	Collector	Date
Eucheuma cottonii				
Mascarene Ridge	Weber-van Bosse (1913)	*E. cottonii*	*J. S. Gardiner*	Sealark Expedition
Tanzania	Mshigeni (1973, 1979)	*E. okamurai*	*K.E. Mshigeni*	1969
Tanzania	Mshigeni & Semesi (1977)	*E. okamurai*	*K.E. Mshigeni*	1969
Tanzania	Jaasund (1976, 1977)	*E. okamurai*	*E. Jaasund*	1966-69
Kenya*	Yarish & Wamukoya (1990)	*E. cottonii*		
E. denticulatum				
Mauritius	Dickie (1875)	*E. spinosum*	*Pike*	1869?
Zanzibar	Sonder (1879)	*E. spinosum*	*A. Roscher*	1859
Zanzibar	Schmitz (1895)	*E. spinosum*		1885
Tanzania	Schmitz (1895)	*E. spinosum*	*C. Holst*	1892
Tanzania	Mshigeni (1973, 1979)	*E. spinosum*	*K.E. Mshigeni*	1969
Tanzania	Mshigeni & Semesi (1977)	*E. spinosum*	*K.E. Mshigeni*	1969
Tanzania	Jaasund (1976, 1977)	*E. spinosum*	*E. Jaasund*	1966-69
E. horridum				
Mauritius	Harvey (1834)	*Sphaerococcus horrida*	*Ch. Telfair*	18??
Mauritius	Dickie (1875)	*E. horridum*	*Pike*	1869?
Mauritius	J. Agardh (1892)	*E. jugatum*		
Mauritius	Børgesen (1943)	*E. serra*	*Th. Mortensen*	1929
Mauritius	Børgesen (1943, 1950)	*E. jugatum*	*Th. Mortensen*	1929
Mauritius	Børgesen (1943, 1950)	*E. horridum*	*Th. Mortensen*	1929
Tanzania	Mshigeni (1987)	*E. horridum*	*K.E. Mshigeni*	1969
Kenya	Yarish & Wamukoya (1990)	*E. horridum*		
Madagascar*	Mollion, Andriantsiferana & Sekkal (1990)	*E. denticulatum*		
Madagascar*	Rabesandratana & Rabesandratana (1992)	*E. denticulatum*		
E. odontophorum				
Mauritius	Dickie (1875)	*E. spinosum*	*Pike*	1869?
Mauritius	Børgesen (1943)	*E. odontophorum*	*Th. Mortensen*	1929
Mauritius	Børgesen (1943)	*E. speciosum* var. *mauritiana*	*Th. Mortensen*	1929
Tanzania	Mshigeni (1973, 1979)	*E. speciosum* var. *mauritiana*	*K.E. Mshigeni*	1969
Tanzania	Mshigeni & Semesi (1977)	*E. speciosum* var. *mauritiana*	*K.E. Mshigeni*	1969
Tanzania	Jaasund (1976, 1977)	*E. speciosum* var. *mauritiana*	*E. Jaasund*	1966-69
Tanzania	Mshigeni (1987)	*E. odontophorum*	*K.E. Mshigeni*	1969
Mauritius	Doty (1988)	*E. odontophorum*	*M. Doty*	

(continuation Tab. 2)

Locality	Reference	Name recorded	Collector	Date
Eucheuma platycladum				
Tanzania	Schmitz (1895)	*E. platycladum*	*C. Holst*	10. 1892
Tanzania	Mshigeni (1973, 1979)	*E. platycladum*	*K.E. Mshigeni*	1969
Tanzania	Mshigeni & Semesi (1977)	*E. platycladum*	*K.E. Mshigeni*	1969
Tanzania	Jaasund (1976, 1977)	*E. platycladum*	*E. Jaasund*	1966-69
Tanzania	Mshigeni (1987)	*E. platycladum*	*K.E. Mshigeni*	1969
Tanzania	Doty (1988)	*E. platycladum*	*G.F. Papenfuss & R.F. Scagel*	1962
Tanzania	Doty (1988)	*E. platycladum*	*K.E. Mshigeni*	1969
Madagascar	Mollion, Andriantsiferana & Sekkal (1990)	*E. platycladum*		
Madagascar	Rabesandratana & Rabesandratana (1992)	*E. platycladum*		
E. striatum				
Zanzibar	Schmitz (1895)	*E. inerme*		1885
Tanzania	Schmitz (1895)	*E. inerme*	*C. Holst*	1892
Zanzibar	Schmitz (1895)	*E. striatum*	*F. Stuhlmann*	1888-90
Tanzania	Mshigeni (1973, 1979)	*E. striatum*	*K.E. Mshigeni*	1969
Tanzania	Mshigeni & Semesi (1977)	*E. striatum*	*K.E. Mshigeni*	1969
Tanzania	Jaasund (1976, 1977)	*E. striatum*	*E. Jaasund*	1966-69
Madagascar	Mollion, Andriantsiferana & Sekkal (1990)	*E. striatum*		
Madagascar	Rabesandratana & Rabesandratana (1992)	*E. striatum*		

The various species of *Eucheuma* were arranged by Weber-van Bosse (1928) into two sections: section *Axifera* encompasses species with a central axis of relatively small and densely packed cells (e.g. *E. denticulatum*, *E. serra*, *E. horridum*); section *Anaxifera* embraces taxa (e.g. *E. cottonii*, *E. platycladum*) whose fronds lack a definite central axis. But Doty (1988: 204-205) has cautioned that transverse sections of the same thallus may appear anaxiferous if cut at a distance and axiferous when cut close to the apex. He has revised the sectional arrangement of the various species of *Eucheuma* and separated some of the taxa into the new genus *Kappaphycus* Doty, which encompasses species characterised by the presence of kappa carrageenan (e.g. *K. cottonii*, *K. inerme*). But he does not place *Eucheuma platycladum* under *Kappaphycus*, even though the species produces kappa carrageenan preponderantly (see also Doty & Santos 1978; Mshigeni & Semesi 1977, Doty 1988: 204). Since the precise chemical analysis of the carrageenan types in the majority of the *Eucheuma* species reported in the region is still to be done, and since some findings are not adequately conclusive, we have retained the old genus name.

Eucheuma denticulatum (Burman) Collins & Hervey

The locality of the two specimens kept at B, i.e. Cape of Good Hope or just Cap., is doubtful, since the southern tip of Africa is believed to be too cold for *Eucheuma*. As shown

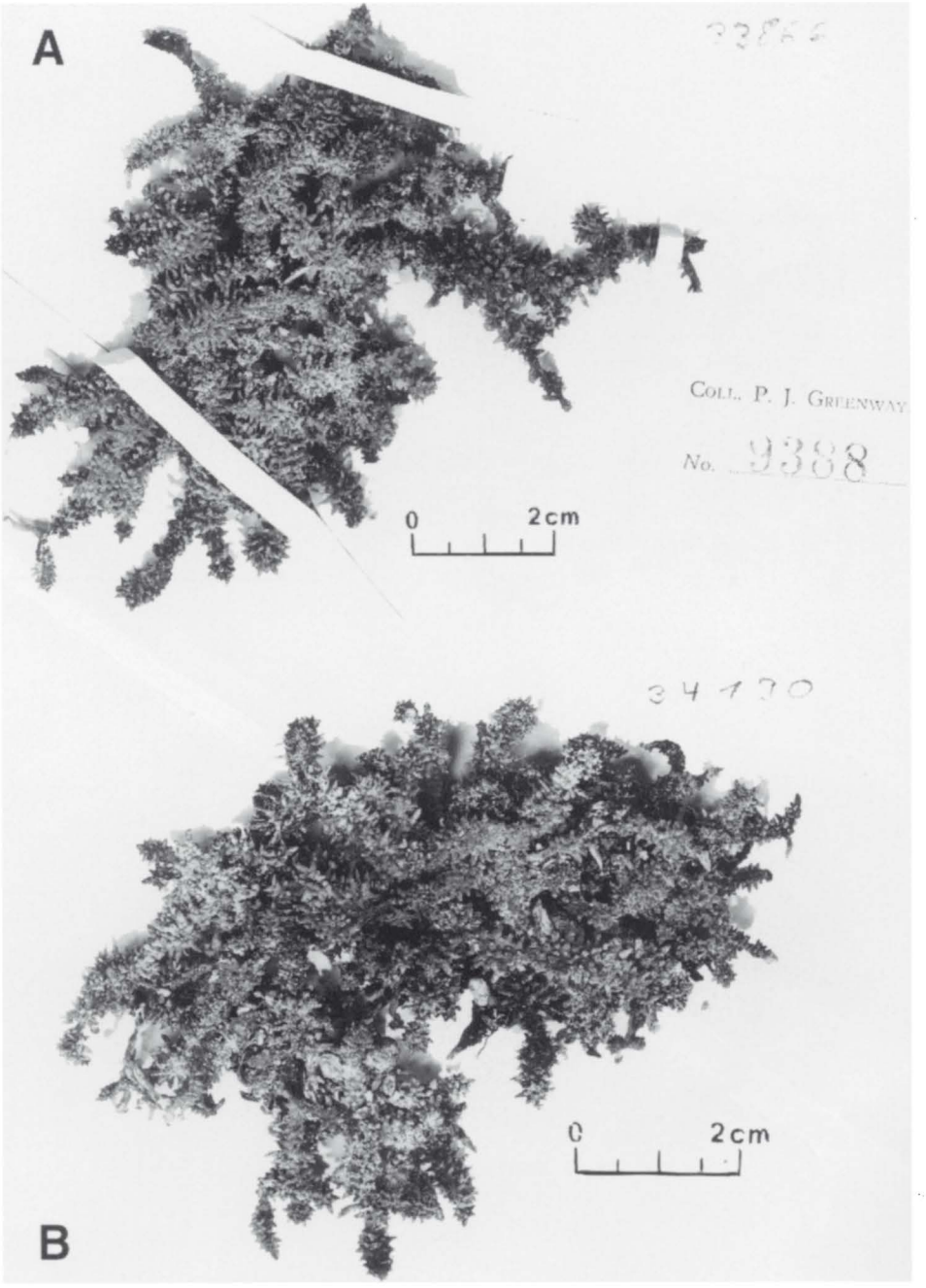

Fig. 1. *Eucheuma odontophorum*, specimens at B – A: Algae No. 33 866, B: Algae No. 34 190.

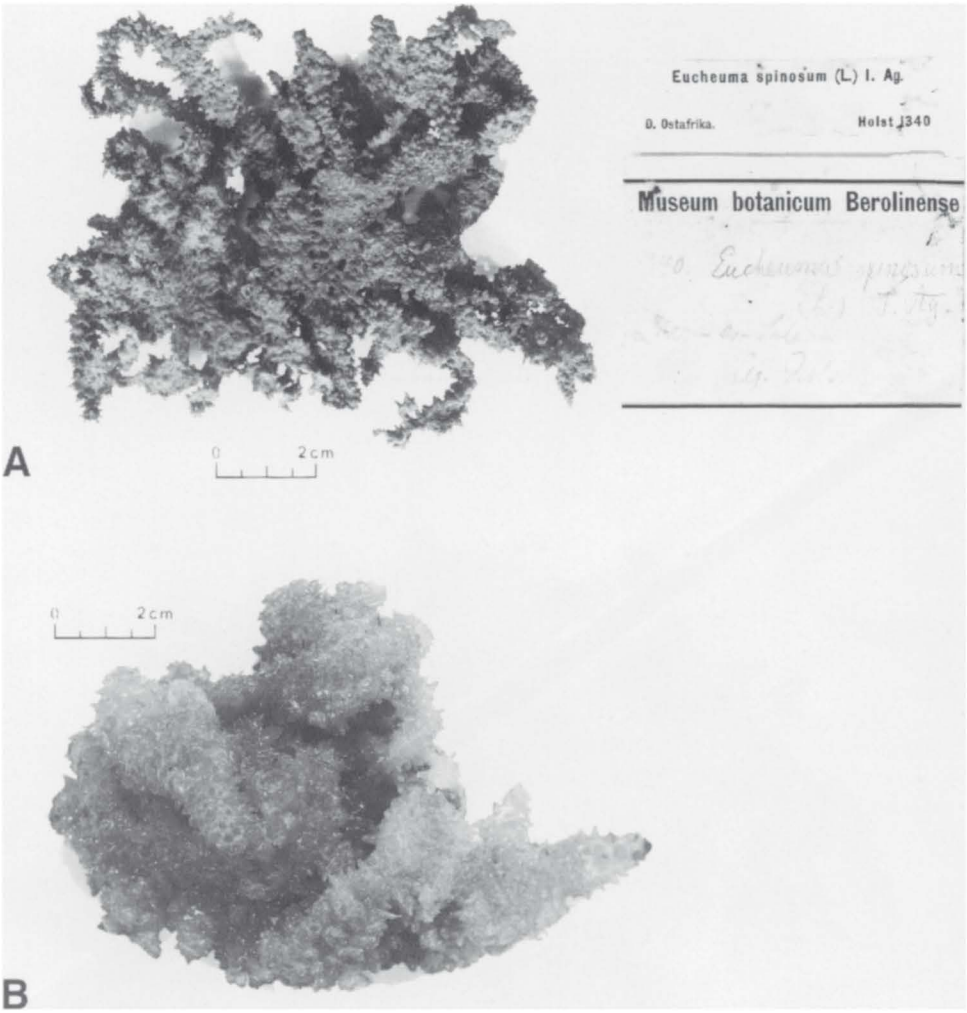

Fig. 2. *Eucheuma platycladum*, specimens at B – A: Algae No. 36 507 (type), B: Algae No. 37 362.

in Tab. 2, and pointed out by Mshigeni (1979, 1984, 1987) and Jaasund (1976, 1977), the species is widely distributed in East Africa. Its range has recently been extended to Madagascar (Mollion, Andriantsiferana & Sekkal 1990; Rabesandratana & Rabesandratana 1992). In addition we found a box with dried specimens of *E. denticulatum* which lacked a label; this might be some of the material which Schmitz (1895: 139) referred to as *E. spinosum*.

E. odontophorum Børgesen

The record from Lamu in Kenya (Fig. 1) represents the northernmost locality of this species. Doty (1988) has also documented its occurrence in Mauritius but writes: "... Not enough is known about *E. odontophorum* to circumscribe it in detail. The type specimen ... and the only other collection seen ... is of thin axiferous, strap-shaped fragmentary blades, ornamented only by lateral teeth, so as to look like a juvenile form of *E. platycladum*". He points out that the placement of *E. platycladum* in the sections is unsatisfactory, since there are mixed reports of their axes being anaxiferous as well as axiferous. Earlier Weber-van Bosse (1928: 417) was not sure of the placement of this species in the section *Anaxifera* since she was unable to locate the type specimen in Berlin.

E. platycladum Schmitz

In our search for *Eucheuma* specimens in Berlin, we detected a small cardboard box containing a dried specimen (Fig. 2A) with spinulose and compressed, anastomosed axes, which perfectly fitted our conception of *E. platycladum* Schmitz. The handwritten label bears the collectors name, the number and type locality indicated by Schmitz (1895: 152) for *E. platycladum*: *Holst 1340*, Dar es Salaam. But the species is labelled *Eucheuma spinosum* (L.) J. Agardh as Schmitz (1895: 152) explains: "This *Eucheuma* species is quite a big plant of peculiar habit. I have already seen several specimens of it, and I am astonished that nobody has described it as a separate species. I found it [the type specimen] named *E. spinosum*, but it has no similarity to this species; it rather resembles the Southwest-Australian *E. speciosum* (Sond.) J. Ag., but differs also slightly from this species". Since Schmitz died unexpectedly (see footnote in Schmitz 1895: 137), the label on the specimen was apparently not changed. The cardboard box as well as the printed label with the locality "D.[eutsch] Ostafrika" (German East Africa) indicates that this specimen was used as exhibition material, some of which survived the 1943 bombing of the Botanical Museum Berlin-Dahlem. This would also explain why Weber-van Bosse (1928: 417) was unable to locate the type. If duplicates mounted on herbarium sheets with correct labels had existed, she would have seen them; but they would have been destroyed together with those of *E. inerme*. What a coincidence that the re-discovery date, December 1992, was exactly a century after Holst had collected the material in December 1892 (Schmitz 1895: 138)!

Besides material used for exhibition purposes in the Botanical Museum Berlin-Dahlem before the Second World War most of the wet collections remained extent; among them we found another specimen of *E. platycladum* collected by A. Voeltzkow in 1903 from the "Tamatave Riff", Madagascar (Fig. 2B, Tab. 1) which confirms the recent report by Mollion, Andriantsiferana & Sekkal (1990) on the existence of *E. platycladum* in Madagascar, thus extending its geographical range beyond East Africa.

Not a single specimen of this species was found pressed onto herbarium sheets. This might be due partly to the inherent difficulties with drying its thalli, because of the cartilaginous nature of its fronds, the anastomosing habit, and the high phycocolloid content. The coastal inhabitants in Tanzania refer to the seaweed as mwani-mkate, meaning bread-like seaweed, or mwani-kisahani, referring to its plate-like appearance. Fronds of the alga form

expansive cake-like masses over the substrata, sometimes forming cushions which weigh several kilogrammes.

We do not share the view that the morphological differences of *E. odontophorum* and *E. platycladum* are not clear-cut (Doty 1988: 198). Both species have dorsiventrally compressed fronds and are spinulose, but there are differeces: the axes of *E. odontophorum* are axiferous, those of *E. platycladum* anaxiferous; the fronds of *E. odontophorum* show distinct segmentation (Fig. 1) those of *E. platycladum* lack constrictions along the axes; the younger axes of *E. odontophorum* are almost cyclindrical and the older sub-cylindrical, the axes of *E. platycladum* exhibit a stronger tendency of flattening and anastomosing, even on the relatively young branchlets; the axes of *E. odontophorum* are terminally downwardly arched (Mshigeni 1979, fig. 11; Mshigeni & Semesi 1977, fig. 5), this is not so distinct in the fronds of *E. platycladum.*

Acknowledgements

Thanks are due to the Institut für Allgemeine Botanik, University of Hamburg, for the use of the research facilities; to Dr. B. Zimmer for useful suggestions, and to B. Schreiber for assisting with the photographic work. The senior author is most grateful to the German Academic Exchange Service (DAAD) for financial support.

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