

Caulerpa (Chlorophyta, Caulerpales) from the Kenyan coast

by

Eric Coppejans and Tom Beeckman

Laboratorium voor Morfologie, Systematiek en Ecologie van de Planten
R.U.G. Ledeganckstraat 35, 9000 Gent, Belgium

With 4 plates

Coppejans, E. & T. Beeckman (1990): *Caulerpa* (Chlorophyta, Caulerpales) from the Kenyan coast. - Nova Hedwigia 50: 111-125.

Abstract: In view of preparing a Flora of the Seaweeds from Kenya, material is collected yearly by the authors since 1985. Twelve species of *Caulerpa* have been collected so far, some including several varieties: *C. brachypus*, *C. cupressoides*, *C. elongata*, *C. fastigiata*, *C. lentillifera*, *C. mexicana*, *C. racemosa* (with several var.), *C. scalpelliformis*, *C. serrulata*, *C. sertularioides*, *C. taxifolia*, *C. verticillata*. An identification key is provided, the different species are described and illustrated (except *C. lentillifera* and *C. racemosa*); ecological and biogeographical data are added.

Introduction

This marine macrophytological research is carried out in the framework of different research projects: Kenyan-Belgian project in Marine Ecology and Management of the coastal zone (ABOS, 1984-1988), Floristics, Faunistics and Ecology of Kenyan coastal biotopes (FKFO, 1988-1991), Dynamics and assessment of Kenyan mangrove ecosystems (CEC, 1989-1991).

The final goal of our own research is to prepare a Marine Benthic Algal Flora for the Kenyan coast (partim Chlorophyta to start with) including identification keys, detailed original descriptions, taxonomic discussions and numerous illustrations of the morphology as well as anatomical details (drawn by camera lucida). In a later stage brown and red algae will be studied in the same way, but this surely is a long term project.

Material and methods

As stated in Coppejans & Beeckman (1989), but with a supplementary collecting period in December 1988 with emphasis on the Malindi area (Mambrui, Watamu, Mida Creek).

All the drawings are original and made by the authors (Pl. 1: T.B., Pl. 2-4: E.C.).

0029-5035/90/0050-0111 \$3.75

© 1990 J. Cramer in der Gebrüder Borntraeger
Verlagsbuchhandlung, D-1000 Berlin · D-7000 Stuttgart

Identification key of *Caulerpa* Lamouroux from Kenya

- 1a. No marked distinction between the filamentous prostrate (stoloniferous) and erect parts. *C. fastigiata*
- b. Prostrate and erect parts markedly different. 2
- 2a. Erect parts blade-like, unbranched, lanceolate, provided with small marginal teeth. *C. brachypus*
- b. Erect parts variously branched, divided or incised. 3
- 3a. Branchlets spherical or clavate or turbinate or peltate. 4
- b. Branchlets filiform or spiny or strap-like and marginally dentate or strongly compressed and disposed in one plane (pinnate aspect). 11
- 4a. Branchlets peltate (stalk-like lower portion abruptly expanded into a disciform structure). *C. racemosa* var. *peltata*
- b. Branchlets not peltate. 5
- 5a. Branchlets gradually enlarged from base to apex (clavate), with rounded or flattened apex. 6
- b. Branchlets (sub-)spherical and sessile on the erect shoots or abruptly expanded into a (sub-)spherical top from the stalk-like lower portion. 8
- 6a. Ends of branchlets flattened. *C. racemosa* var. *turbinata*
- b. Ends of branchlets rounded. 7
- 7a. Branchlets not crowded, mostly (sub-)opposite; erect shoots sometimes partly naked, then slightly compressed and constricted or of irregular width. *C. racemosa* var. *lamourouxii*
- b. Branchlets crowded, radially arranged. *C. racemosa* var. *laetevirens*
- 8a. (Sub-)sessile spherical branchlets either extremely rare and irregularly placed or more frequent and (sub-)opposite; erect shoots sometimes partly naked, then slightly compressed and constricted or of irregular width. *C. racemosa* var. *lamourouxii*
- b. Branchlets crowded, radially arranged, stipitate. 9
- 9a. Stalk-like portion markedly constricted; spherical branchlets very densely packed along the erect shoots. *C. lentillifera*
- b. No constriction in the stalk-like portion; spherical branchlets less dense. 10
- 10a. Erect shoots short (1-2 cm); spherical part of the branchlets 2-3 mm wide (or more), shortly stipitate *C. racemosa* var. *clavifera*
- b. Erect shoots long and slender (6-7(-14) cm); spherical part of the branchlets 1-2 mm wide, markedly stipitate. *C. racemosa* var. *occidentalis*
- 11a. Branchlets in whorls. 12
- b. Branchlets not in whorls but dichotomous or opposite in one plane. 13
- 12a. Verticils conspicuous, well separated; branchlets rather long and elegant with (2)3(4) terminal mucrons; stoloniferous part naked. *C. verticillata*
- b. Verticils small and crowded; branchlets short and stiff with a single mucron on each apex; stoloniferous part also (partly) covered by short branchlets. *C. elongata*
- 13a. Branchlets strap-like, (sub-)dichotomous, with dentate margin and frequently spirally twisted. *C. serrulata*
- b. Branchlets opposite or in more numerous rows. 14
- 14a. Branchlets filamentous or spiny. 15
- b. Branchlets strongly complanate. 17
- 15a. Branchlets usually short (1-2 mm), spiniform, generally on 2 opposite rows, sometimes on 3 rows (specimens from sheltered biotopes with somewhat longer branchlets). *C. cupressoides*
- b. Branchlets usually long (4-5 mm), elegant, in 2 opposite rows (specimens exposed to surf or heating with somewhat shorter branchlets). 16
- 16a. Branchlets cylindrical, of uniform diameter throughout. *C. sertularioides*
- b. Branchlets at least slightly compressed, slightly constricted at the base, gradually tapering into a spine at the apex. *C. taxifolia*

- 17a. Midrib broader than the length of the pinnately placed branchlets; apices of the branchlets roundish, smooth or denticulate. *C. scalpelliformis*
- b. Midrib markedly narrower than the length of the pinnately placed branchlets; apices of the branchlets acuminate and apiculate. 18
- 18a. Branchlets sickle-shaped, slightly constricted at the base, gradually tapering into a spine at the apex; branchlets never (or rarely) overlapping. *C. taxifolia*
- b. Branchlets markedly wider in the middle or subapical part, distinctly constricted at the base, rather abruptly tapering into a terminal spine, branchlets frequently overlapping in the widest part. *C. mexicana*

Descriptions

***Caulerpa brachypus* Harvey f. *parvifolia* (Harvey) Cribb** Figs. 1-2

Stolons very thin (0,5 mm in diameter), bearing erect, shortly stipitate, simple, elliptic to oval fronds, up to 10 mm long and 3 mm broad, with smooth or slightly toothed margin, teeth simple.

Reference material. HEC 5549: 1-7-1985, Mombasa, Mc. Kenzie Pt., infralittoral, -4 m at low tide, on sand between *Halophila balfourii*, under larger seaweeds.

Distribution along the E. African coast. Somalia (Sartoni 1978); Tanzania (Jaasund 1976, 1977; Taylor 1967); Mozambique (Taylor 1967).

Discussion. Completely agreeing with Cribb's fig. 4 & 5 (1958: 209), Jaasund's fig. 39 (1976) and Sartoni's fig. 2a (1978: 403). None of the fronds from our collection have proliferations.

***Caulerpa cupressoides* (West) C. Agardh** Figs. 3-7

Well developed specimens growing in rather dense groups because of the frequently ramified smooth stolons, up to 2 mm in diameter in stout specimens; erect branches up to 16 cm high (fig. 3) in largest specimens, more generally 4-8 cm high, naked at the base (over a distance of 40 mm in the largest specimen, 5 mm in the smallest ones); branching mostly irregular, sometimes subdichotomous; each branch with 2-3(-4) rows of short [1-2(-3) mm] spiniform, terete branchlets; these upwardly curved, frequently constricted at the base, tapering towards the apex into a sharp point (fig. 6, 7).

Reference material. HEC 5661: 11-7-1985, HEC 6972: 24-7-1987, Mombasa, Mc. Kenzie Pt., infralittoral on steep slope of tidal channel, on silty sand, -4 m at low tide; HEC 6758: 12-7-1987, Mombasa, Nyali Reef, sandy bottom of backreef pool; HEC 6852: 15-7-1987, Diani Beach (in front of Robinson Baobab Club), on sand covered coral boulder in lagoon, -1 m at low tide; HEC 7057: 30-7-1981, Diani Beach (in front of Jadini Beach Hotel), backreef pool, vertical sandy walls, between rhizomes of seagrasses; HEC 7339: 15-3-1988, Mombasa, Nyali Reef, sand covered coral platform, where waves break at low tide; HEC 8197: 27-12-1988, Mambrui (10 km N of Malindi), sandy bottom of low midlittoral tidepool on reef.

Distribution along the E. African coast. Somalia (Sartoni 1978); Kenya (Isaac 1967; Kay 1969; Moorjani 1977); Tanzania (Jaasund 1976, 1977; Taylor 1967); Mozambique (Taylor 1967).

Discussion. As mentioned by Taylor (1960: 147) this is an extremely variable species of which numerous varieties and forms have been described.

Some of the Kenyan specimens are stout (HEC 5661, fig. 3), others middle-sized (HEC 6758a (fig. 5), HEC 6072, HEC 8197), others small and slender (HEC 6852, HEC 7057 (fig. 4), HEC 7339) with erect branches of only 1-2 cm high. Some have the branchlets arranged in a distichous manner (HEC 5661, HEC 6758b, HEC 6972, HEC 7057), others are tristichous (HEC 6852, HEC 7339), some are partly distichous and tristichous (HEC 8197).

No well defined correlation could be made between morphology and ecology of the specimens. Therefore we prefer to avoid the assignment to any variety or form.

***Caulerpa elongata* Weber-van Bosse**

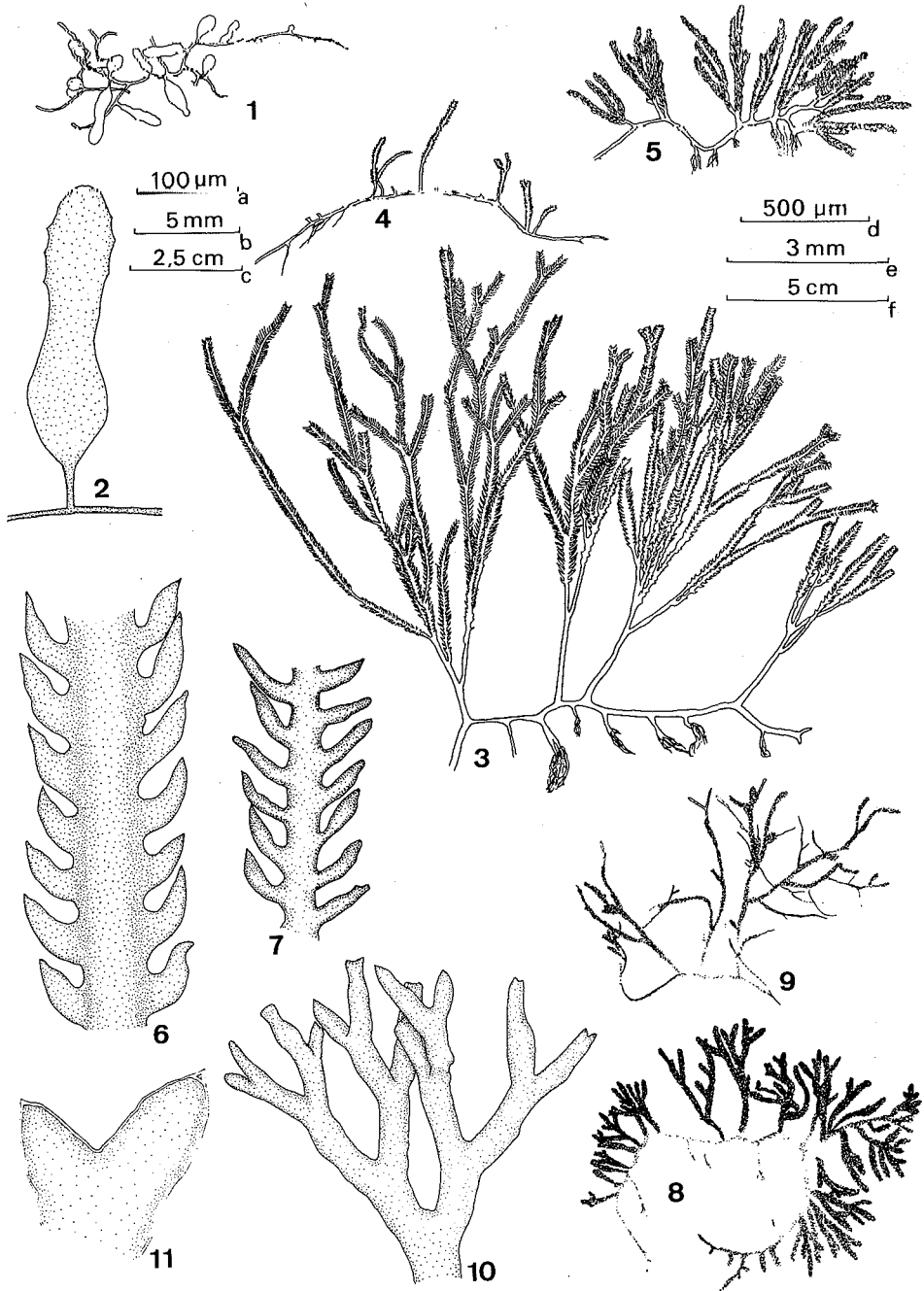
Figs. 8-11

Stolons as well as upright branches densely covered by whorls of stiff branchlets, giving a lycopod-like aspect. Ramified stolon more or less densely covered by short (0,5-1 mm) branchlets disposed in verticils and in some specimens (HEC 6033) provided with very numerous rhizoidal groups; upright branches in most cases very numerous, either richly branched (fig. 8) or unbranched, 0,5-3,5 cm high, very densely covered by verticils of 4 stiff, 1-2 mm long dichotomous branchlets dividing 3-4 times in alternate planes (fig. 10), 160-190 μ m in diameter at the base, each apex with a single sharp point (fig. 11).

Reference material. HEC 5597: 5-7-1985, HEC 6020: 27-1-1986, HEC 7223: 3-3-1988, Mombasa, Mc. Kenzie Pt., sand covered coral, just under low water mark, rather sheltered; HEC 6033: 28-1-1986, Mombasa, Nyali Reef, same ecology; HEC 7338: 15-3-1988; Mombasa, Nyali Reef, sand covered coral, just where the waves break at low tide (strange growth form, see discussion); HEC 7427: 21-3-1988, Malindi, National Park Casuarina Pt., sandy place at inner side of reef, under low water mark.

Distribution along the E. African coast. Somalia (Sartoni 1978); Tanzania (Jaasund 1976; Taylor 1967); Mozambique (Taylor 1967).

Pl. 1: (The letter between the parentheses refers to the scale bar). Figs. 1-2. *Caulerpa brachypus* Harv. f. *parvifolia* (Harv.) Cribb: 1. General morphology (c), 2. Detail of an erect frond (1, 2: HEC 5549) (b). - Figs. 3-7. *C. cupressoides* (West) C. Ag.: 3-5. General morphology. 3. Well developed specimen from sheltered habitat, branchlets on 2 rows (HEC 5661) (f), 4. Poorly developed specimen (HEC 7057) (f), 5. Specimen from a more exposed site with branchlets on 3 rows (HEC 6758) (f); 6-7. Details of the side branchlets (6, 7: HEC 5661) (e). - Figs. 8-11. *C. elongata* Web.-v. Bosse: 8, 9. General morphology, 8. Well developed specimen (HEC 5597) (f), 9. Partly sand covered specimen (HEC 7338) (f); 10 (d), 11 (a). Branchlet and mucronate apices (HEC 6020).



Discussion: *C. elongata* is closely related to *C. pickeringii* Harv. & Bail. and *C. webbiana* Montagne. *C. pickeringii* is differentiated from both other species by the branchlets on the stolons being as long and dense as on the upright branches "giving a *Codium* aspect to the thallus" (Weber-van Bosse 1898: 273). All our Kenyan specimens have smaller and less densely placed branchlets on the stolons than on the erect branches. *C. webbiana* is differentiated from *C. elongata* by the naked stolon apices devoid of branchlets and by the branchlets of the older parts of the stolon growing out as hyaline filaments attaching sand grains all over the stolon. None of our Kenyan specimens show these characters and we therefore identify them as *C. elongata*. Taylor (1967: 47) also exclusively collected *C. elongata* along the coast of Tanzania and Mozambique. Sartoni (1978: 407) apparently found both *C. elongata* and *C. webbiana* in Somalia. Jaasund (1976: 19) originally described *C. pickeringii* from Tanzania mentioning shorter branchlets on the stolons than on the upright branches; this character excludes *C. pickeringii*. The apices of the stolons are described as being naked, a character of *C. webbiana*. In 1977 he redescribed the same specimens, but mentioned crowded branchlets on the stolon apices, identifying them as *C. elongata*. Isaac (1967, 1968) mentions both *C. pickeringii* and *C. webbiana* but no *C. elongata* from the Kenyan coast, without giving any description. It is therefore impossible to confirm these identifications without seeing his reference specimens. Moorjani (1977) also mentions *C. pickeringii* from Kenya but not reference material has been preserved.

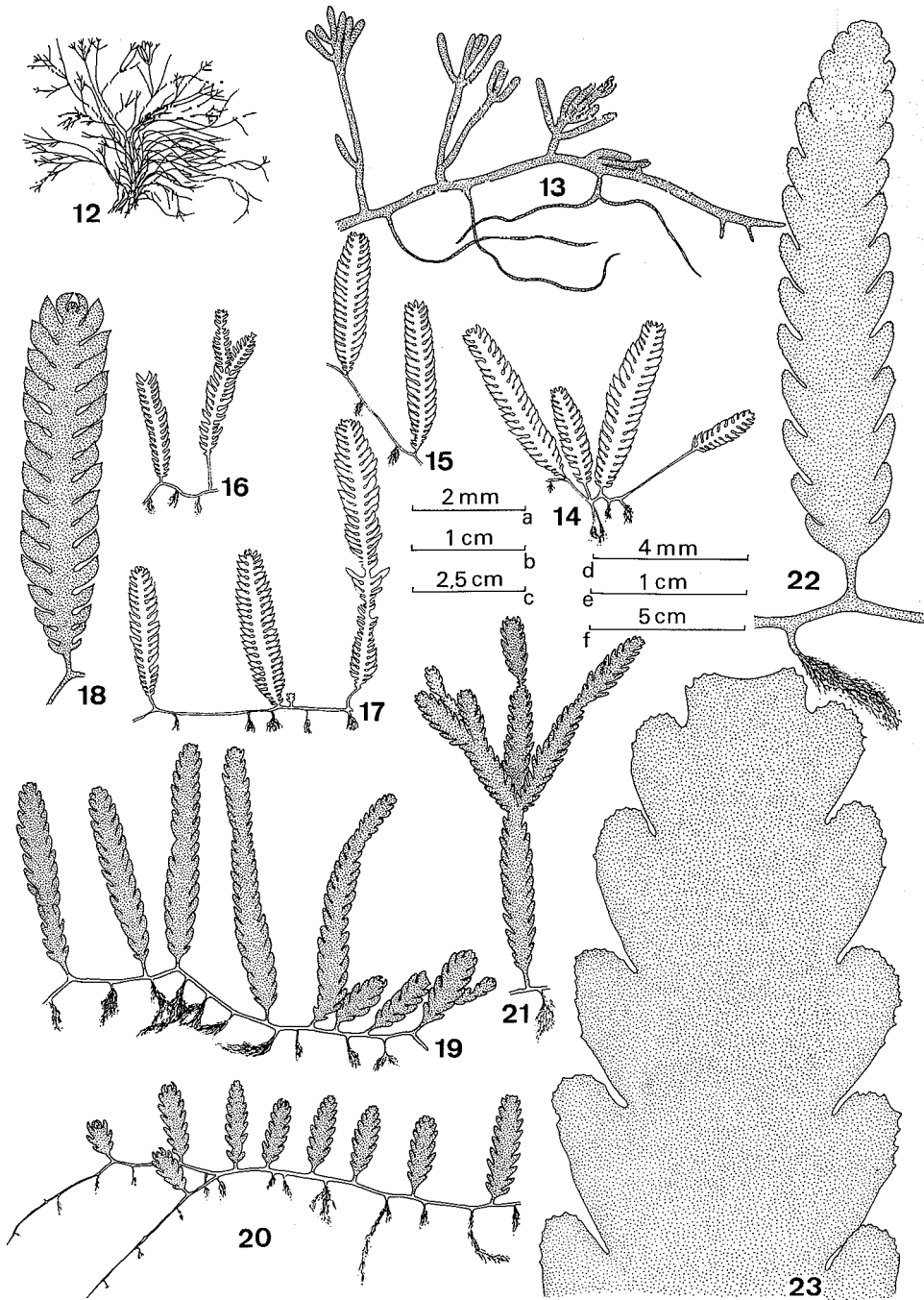
A single collection of ours (HEC 7338) (fig. 9) is aberrant because of the axes bearing alternatively short branchlets (stolonoid structure) and long branchlets (structure of upright shoot). Moreover some apices are naked, others are covered with short branchlets. This could be due to the fact that these specimens were growing in a sandy wavebreaking area at low tide; large parts of the thallus were submerged in the sand. Alternative periods of sand accumulation (axes submerged: stolonoid structure) and of stabilized sediment (axes emerging = upright shoot structure) could then induce the combined anatomy. The presence of both naked and branchlet covered apices should be stressed as it is generally a criteria used to differentiate *C. elongata* from *C. webbiana*.

Caulerpa fastigiata Montagne

Figs. 12-13

Filamentous plants forming mats on rocks and sand, in the high midlittoral or supralittoral zone, frequently well developed on shaded surfaces (vertical or overhanging walls). No morphological differentiation between the stoloniferous and

Pl. 2: (The letter between parentheses refers to the scale bar). Figs. 12-13. *Caulerpa fastigiata* Mont.: 12. General morphology (HEC 6692) (c), 13. Detail of stolonoid with erect branches (HEC 5842) (a). - Figs. 14-18. *C. mexicana* (Sond.) J. Ag.: 14-17. General morphology (HEC 8194) (c), 18. Detail of an erect frond (HEC 5563) (e). - Figs. 19-23. *C. scalpelliformis* (R. Braun) C. Ag.: 19. Well developed specimen from sheltered biotope (HEC 5547) (f), 20. Small specimen from an exposed site (HEC 5558) (f), 21. Specimen with proliferations (HEC 6757) (f), 22. Detail of an erect frond with denticulate pinnae (HEC 5547) (b), 23. Detail of the apex; denticulate margin of the pinnae (HEC 7225) (d).



erect branches except for the presence of rhizoidal holdfasts on the first ones. The diameter is slightly different, being up to 150 μm for the stolons, up to 110 μm for the erect filaments. Branching of the latter irregular, alternate, subdichotomous or opposite; filament apices originally somewhat clavate, becoming cylindrical or slightly tapering into blunt tips.

Reference material. HEC 5587: 3-7-1985, Mombasa, under KMFRI, high midlittoral, sloping rockwalls; HEC 5842: 14-1-1986, Mombasa, between KMFRI and Mc. Kenzie Pt., medium midlittoral, slopes and vertical walls, trapping large amounts of sand; HEC 6692: 2-7-1987, Gazi, on *Sonneratia*-pneumatophores, high midlittoral, inferior limit of mangrove; HEC 6836, 13-7-1987, Tiwi, horizontal substrate, between supra- and midlittoral.

Distribution along the E. African coast. Somalia (Sartoni 1978); Kenya (Isaac 1967, Moorjani 1977); Tanzania (Jaasund 1976, 1977); Mozambique (Taylor 1967).

Discussion. The Kenyan material fits well with earlier descriptions.

***Caulerpa lentillifera* J. Agardh**

See Coppejans & Beeckman (1989: 383-384).

***Caulerpa mexicana* (Sonder) J. Agardh**

Figs. 14-18, 34-35

Plants stoloniferous; stolons poorly branched, 0,5-1 mm thick, richly provided with slender descending rhizoid-bearing branchlets. Erect foliar branchlets (2,5-)4(-6) cm high, up to 9 mm wide, shortly stipitate [1-2(-3) mm], distichous, pinnate; all parts (except stipe) compressed: midrib 1-1,5 mm wide, pinnae (2,5-)3(-4) mm long, closely oppositely placed, up-curved, acuminate, contracted at the base, the widest part just below the apex, overlapping [the middle and/or subapical part of a pinna overlapping the middle part of the next pinna (fig. 34, 35), or not (fig. 18)]. A single erect branch (HEC 8194) with regrowth (longer pinnae after gradually shorter ones) and another one (HEC 8194) with a dichotomy of the midrib formed after grazing of the original apex.

Reference material. HEC 5563: 2-7-1985, Mombasa, Mc. Kenzie Pt., infralittoral, -2 m at low tide, sand covered coral substrate; HEC 8194: 27-12-1988, Mamburi (10 km N of Malindi), low midlittoral tidepool on reef; on sand.

Distribution along the E. African coast. Somalia (Sartoni 1978), Kenya (Isaac 1967), Tanzania (Jaasund 1976, 1977, Taylor 1967), Mozambique (Isaac 1957, Taylor 1967).

Discussion. It is not always easy to distinguish *C. mexicana* from *C. taxifolia* in the Kenyan collections. The first is more flattened than the second, its pinnae are wider in relation to their length and more markedly spiny at the top; in *C. taxifolia* the branchlets more gradually taper into an apical point, being more "boat" or sickle-shaped. Papenfuss (1956) regards both names and *C. crassifolia* (J. Ag.) J. Ag. as synonyms.

Caulerpa racemosa (Forsskål) J. Agardh

var. **clavifera** (Turner) Weber-van Bosse f. **macrophysa** (Kützting) Weber-van Bosse

var. **laetevirens** (Montagne) Weber-van Bosse

var. **occidentalis** (J. Agardh) Børgesen

var. **peltata** (Lamouroux) Eubank

var. **turbinata** (J. Agardh) Eubank

see Coppejans & Beeckman (1989: 384-388).

Caulerpa scalpelliformis (R. Braun) C. Agardh

Figs. 19-23, 33

Plants stoloniferous, generally poorly branched, 1-1,5 mm thick, provided with generally well developed rhizoid-bearing branchlets (depending on the depth of the soft substratum). Erect foliar branches up to 9 cm long in sheltered habitat (fig. 19), 2 cm high in more exposed places (fig. 20), 1 cm wide, shortly stipitate [2-3(-10) mm], pinnate; all parts (except stipe) compressed: midrib 6 mm wide (wider than the length of the pinnae), markedly veined, pinnae 3-4 mm long, closely oppositely placed, up-curved, with rounded apex, smooth (fig. 33) or with denticulate upper and outer margin (fig. 22, 23), not contracted at the base, overlapping (the apex of a pinna overlapping the base of the next pinna, fig. 33) or not (fig. 22, 23); the erect shoots of some collections (HEC 6757) with regrowth and regeneration shoots (fig. 21).

Reference material. HEC 5547: 1-7-1985, HEC 5558: 2-7-1985, HEC 5973: 21-1-1986, Mombasa, Mc. Kenzie Pt., sand covered coral, low midlittoral pools and subtidal (-2, -4 m at low tide); HEC 6690: 2-7-1987, Gazi, on sand, between seagrasses, subtidal; HEC 6757: 12-7-1987, Mombasa, Nyali Reef, backreef pool (specimens with proliferations); HEC 7225: 7-3-1988, Shimoni (in front of Marine Park Office), on sand, subtidal, very densely placed foliar branchlets.

Distribution along the E. African coast. Somalia (Sartoni 1978), Kenya (Isaac 1967, Taylor 1967, Moorjani 1977), Tanzania (Jaasund 1976, Taylor 1967), Mozambique (Taylor 1967).

Discussion. The typical variety apparently only occurs in Australia (Weber-van Bosse 1898, Svedelius 1906, Womersley 1984) and is characterized by the alternate-pinnately placed, pointed pinnae. The Kenyan material agrees with var. *intermedia* Weber-van Bosse (with smooth margin of the pinnae) and with var. *denticulata* (Decaisne) Weber-van Bosse (with dentate margin). Some stolons bear foliar branches with smooth margin, others with denticulate margin; sometimes some pinnae of the same branch have a dentate, others a smooth margin. Therefore we do not assign a varietal identification to our collections.

Caulerpa serrulata (Forsskål) J. Agardh emend. Børghesen

Figs. 24-25

Stolons stout (2-3 mm thick), from sparsely to richly branched, generally with numerous well developed rhizoid-bearing branchlets. Erect foliar branchlets in typical (spirally twisted) form (fig. 25), (1-)2-3(-4) cm high, shortly stipitate (2-5 mm), stipe terete; blade narrow, flattened, dichotomous, spirally twisted, stiff, with serrate margins, dark green. Another form, reaching 6 cm height is markedly stipitate (6-22 mm, fig. 24), with strap-like frond, dichotomous in one plane, less stiff, serrate margins, bright green.

Reference material. HEC 6851: 15-7-1987, Diani, in front of Robinson Baohab Club, lagoon, on sand covered coral boulder (tiny specimen: fronds 1 cm high); HEC 6989: 27-7-1987, Tiwi, medium midlittoral sandy pool (extremely dense); HEC 7056: 30-7-1987, Diani, in front of Jadini Beach, main reef, bottom of sand covered infralittoral pool; HEC 7228, HEC 7268: 7-3-1988, Shimoni, HEC 7228 in front of Marine Park Office, infralittoral, -3 m on sand (frond in one plane), HEC 7268, S. point of Wasini Isld., -1 m at low tide, between *Cymodocea serrulata*; HEC 7403: 19-3-1988, Malinidi, Casuarina National Park, low midlittoral sandy pool; HEC 8198: 27-12-1988, Mambrui (10 km N of Malindi), sandy bottom of infralittoral pool on reef.

Distribution along the E. African coast. Somalia (Sartoni 1978), Kenya (Isaac 1967, Moorjani 1977), Tanzania (Jaasund 1976, Taylor 1967).

Discussion. The form with long stipes, ramified in one plane and provided with short teeth (HEC 7228), is called var. *boryana* (J. Ag.) Gilbert f. *occidentalis* (Weber-van Bosse) Gilbert by some authors (Taylor 1960: 146, Menez & Calumpang 1982: 9).

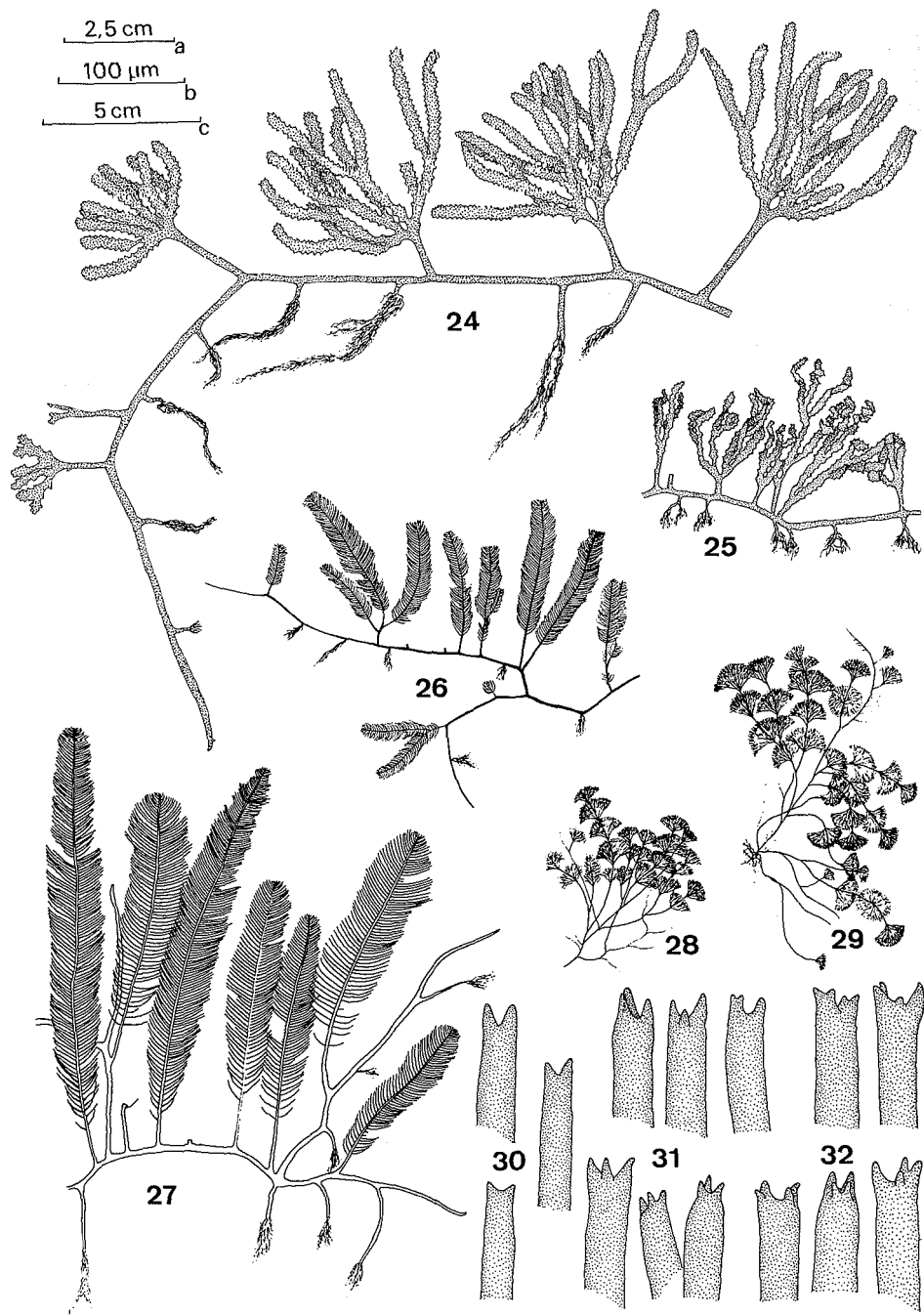
Caulerpa sertularioides (Gmelin) Howe

Figs. 26-27

Two extreme forms occur along the Kenyan coast: a smaller, more slender one (form 1), a longer, stout one (form 2). But intermediates can also be found.

Form 1. (fig. 26). Stolons thin (0,25-0,5 mm), richly branched, forming rather dense vegetations; upright branches 2 cm (HEC 7379) -5 cm (HEC 9548) high, 4-10 mm wide, main axis rather frequently (sub-) dichotomously branched, naked at the base (3-10 mm), provided with pinnately disposed branchlets; pinnae cylindrical or slightly compressed, not contracted at the base, elegantly upcurved, with mucronate tips. Growing in well insolated (mostly shallow) low midlittoral reef pools.

Pl. 3: (The letter between parentheses refers to the scale bar). Figs. 24-25 (a). *Caulerpa serrulata* (Forssk.) J. Ag. emend. Børghs.: 24. General morphology of a "var. *boryana* (J. Ag.) Gilb. f. *occidentalis* (Web.-v. Bosse) Gilb." with flat frond (HEC 7228), 25. Typical form with spirally twisted frond segments (HEC 7403). - Figs. 26-27 (c). *C. sertularioides* (Gmel.) Howe: 26. General morphology of the large form (HEC 7365), 27. Habit of the small form from shallow midlittoral pools (HEC 5548). - Figs. 28-32. *C. verticillata* J. Ag.: 28, 29. General morphology of well developed specimens (HEC 7366) (a), 30-32 (b). Details of apices of determinate branchlets with 2 (fig. 30), 3 (fig. 31), 4 (fig. 32) terminal mucrons (HEC 6065).



Form 2. (fig. 27). General aspect as form one, but stolons 1-1,5 mm thick, sparsely branched; upright branches up to 14 cm high and 20 mm wide, main axis rarely branched. Growing in infralittoral zone or in larger intertidal pools or tide channels, more or less shaded by seagrasses.

Regrowth (longer pinnae being formed after gradually shorter ones) occurring in both forms.

Reference material. Mc. Kenzie Pt.: HEC 5548, 1-7-1985 (form 1), HEC 6973, 24-7-1987 (form 1), sand covered coral, tide channel slope, -4 m; Gazi (form 2): HEC 6076, 30-1-1986, HEC 6694, 2-7-1987, HEC 6730, 8-7-1987, HEC 7170, 25-2-1988, HEC 7365, 16-3-1988, large tide pools on intertidal seagrass flat and tide channel of mangrove; HEC 6756: 12-7-1987, Mombasa, Nyali Reef, backreef pool (form 1); HEC 7227: 7-3-1988, Shimoni, in front of Marine Park Office, infralittoral, -3 m at low tide (form 2); HEC 7277: 9-3-1988, Shimoni, Kisite Isld. National Park, shallow reef pools, low midlittoral (form 1); HEC 7399: 19-3-1988, Malindi, Casuarina National Park, medium midlittoral pools (form 1).

Distribution along the E. African coast. Somalia (Sartoni 1978), Kenya (Isaac 1967, 1968, Moorjani 1977), Tanzania (Jaasund 1976, Taylor 1967), Mozambique (Taylor 1967).

Discussion. Many varieties and forms have been described. Both forms mentioned here seem to be ecads of the type variety, the first one of well insolated shallow pools, heating up at low tide, the second one of more shaded biotopes, with stable temperature.

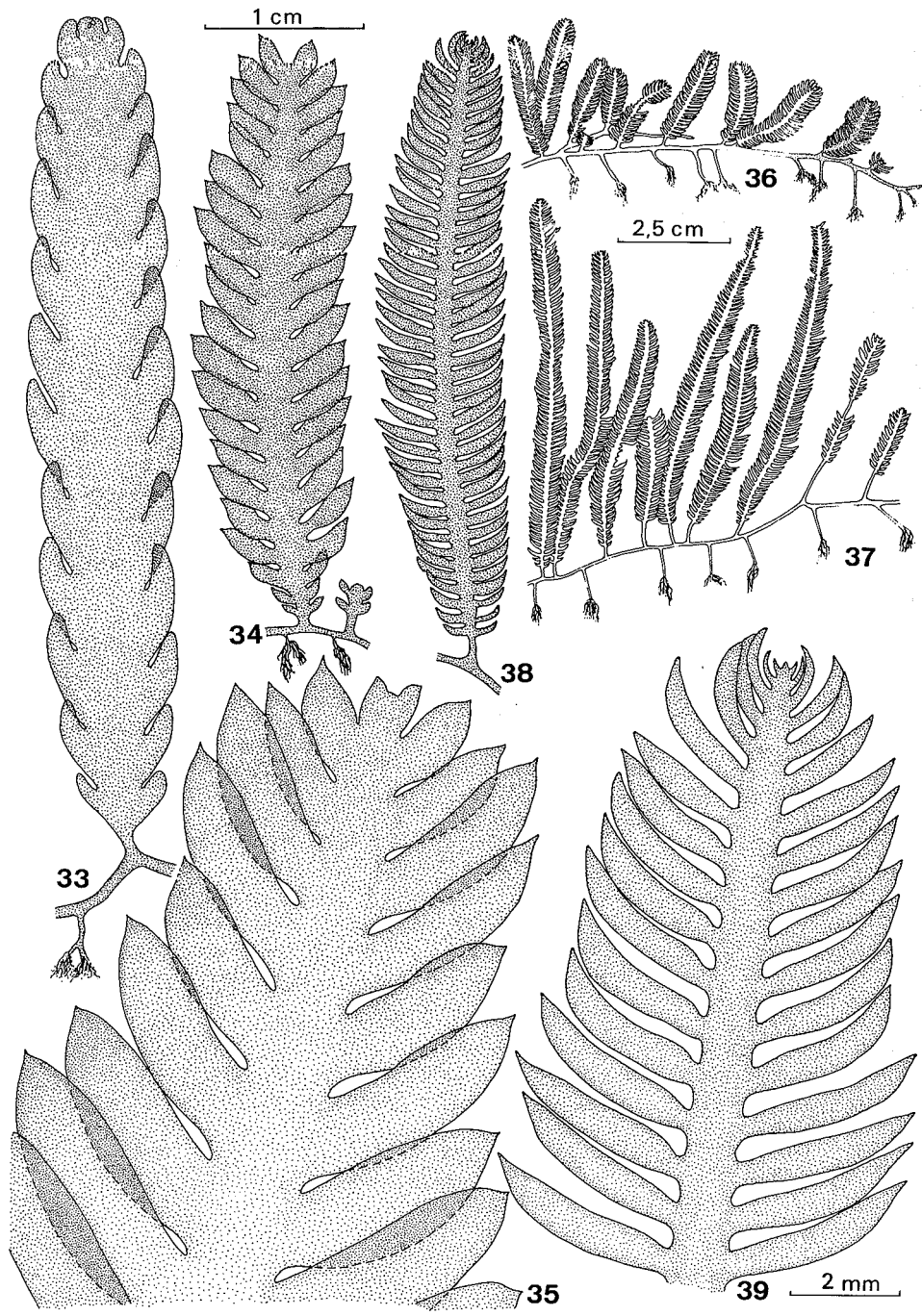
***Caulerpa taxifolia* (Vahl) C. Agardh**

Figs. 36-39

Plants stoloniferous, stolons richly branched, bearing numerous downward growing branchlets with groups of rhizoids and closely packed erect foliar branchlets. These (2,5-)4-5(-7) cm long, 5-7 mm wide, shortly stipitate [1-5(-8) mm], pinnate; midrib and pinnae compressed, midrib 0,5-1 mm wide, branched in HEC 7174 and HEC 7364, pinnae 2-3 mm long, closely placed, up-curved, gradually tapering to the acuminate apex, not or only slightly contracted at the base, generally not overlapping (fig. 38, 39). Regrowth (longer pinnae after gradually shorter ones) occurring regularly.

Reference material. Gazi Bay: HEC 6750, 10-7-1987, HEC 7174, 25-2-1988, HEC 7364, 16-3-1988, on sand, coral boulders and dead tree trunks in large midlittoral pools (between mangrove and seagrass beds) and in mangrove tide channel; HEC 6970: 24-7-1987, Mombasa, Mc. Kenzie Pt. sand covered coral, -3 m at low tide.

Pl. 4: Fig. 33. *Caulerpa scalpelliformis* (R. Braun) C. Ag.: Detail of an erect frond with smooth margins of the pinnae (HEC 5973) (a). - Figs. 34-35. *C. mexicana* (Sond.) J. Ag.: 34. Detail of an erect frond (HEC 8194) (a), 35. Detail of the apex of an erect frond (HEC 8194) (c). - Figs. 36-39. *C. taxifolia* (Vahl) C. Ag.: 36, 37 (b). General morphology (HEC 6970), 37. (HEC 7174); 38. Detail of an erect frond (HEC 6750) (a); 39. Detail of the apex of an erect frond (HEC 6750) (c).



Distribution along the E. African coast. Somalia (Sartoni 1978), Kenya (Isaac 1967, Moorjani 1977), Tanzania (Jaasund 1976, Taylor 1967).

Discussion. See *C. mexicana*.

***Caulerpa verticillata* J. Agardh**

Figs. 28 32

Growing in dense, extremely soft and slender tufts. Stolons up to 250 μm in diameter, very densely branched, provided with very numerous groups of rhizoids; upright branches densely packed, up to 250 μm in diameter at the base, 10-30 mm high, more or less naked below, bearing conspicuous whorls of determinate branchlets, 5-10 mm in diameter, 3-8 mm apart; determinate branchlets 80 μm in diameter at the base, branching dichotomously 5-7-times, not constricted at the dichotomies, tapering to 27 μm at the apices; apices with (2-)3-4 terminal mucrons (fig. 29-31).

Reference material. Gazi Bay, HEC 6965: 30-1-1986, HEC 6693: 2-7-1987, HEC 6731: 8-7-1987, HEC 7171: 25-2-1988, HEC 7366: 16-3-1988, on dead tree trunks, mangrove roots, coral boulders in the mangrove tide channel and in midlittoral pools along the channel as described in Coppejans & Gallin (1989).

Distribution along the E. African coast. Kenya (Isaac 1967, 1968; Moorjani 1977); Tanzania (Lawson unpublished in Lawson 1980).

Discussion. In the Kenyan material we could observe the characteristic growth pattern which "reminds us to some extent of many dune grasses, which when covered with sand form their regenerating shoots from axes higher up the stem, by which means the plant continues to keep on the surface of the sand" (Svedelius 1906: 109). Specimens very similar to those from Papua-New Guinea (Coppejans & Meinesz 1988: 194).

General discussion

All the taxa described here and in Coppejans & Beeckman (1989) are present in previous check-lists for Kenya (Gerloff 1960; Isaac 1967, 1968, 1971; Isaac W. & F. 1968; Lawson 1980; Moorjani 1977) except for *Caulerpa racemosa* var. *lamourouxii* which had been wrongly identified as *C. fergusonii*. Other species which have been reported from the Kenyan coast previously by several of these authors are: *C. pickerlingii*, *C. webbiana*, *C. lanuginosa* J. Agardh and *C. vickersiae* Børgesen. In July 1989 we had the opportunity to check Isaac's specimens of these species in the East African Herbarium (Nairobi). They undoubtedly all belong to *C. elongata* (small, elegant or distichous forms of this species).

Acknowledgements

We are grateful to Professor P. Polk for giving us the opportunity to do phycological research in Kenya within the framework of the Kenyan Belgian Research Project, to Mr. Allela for putting the infrastructure of the Kenya Marine & Fisheries Research Institute at our disposal. Our gratitude also goes to I. Wolfs and E. Martens for the local organisation of the field work and laboratory research. This study was sponsored by ABOS and NFWO.

References

- COPPEJANS, E. & T. BEECKMAN (1989): *Caulerpa* section Sedoideae (Chlorophyta, Caulerpales) from the Kenyan coast. *Nova Hedwigia* **49**(3-4): 381-393.
- COPPEJANS, E. & E. GAILLON (1989): Macroalgae associated with the mangrove vegetation of Gazi Bay (Kenya). - *Bull. Soc. Roy. Bot. Belg.* **122**: 47-60.
- COPPEJANS, E. & A. MEINESZ (1988): Marine algae of Papua New Guinea (Madang Prov.) 1. Caulerpales (Chlorophyta-Caulerpales). - *Blumea* **33**: 181-196.
- CRIBB, A.B. (1958): Records of marine algae from South-Eastern Queensland. IV. *Caulerpa*. - *Rep. Dep. Bot. Univ. Qd.* **3**: 209-220.
- GERLOFF, J. (1960): Meeresalgen aus Kenya. 1. Cyanophyta und Chlorophyta. - *Willdenowia* **2**: 604-627.
- ISAAC, W.E. (1967): Marine Botany of the Kenya coast. 1. A first list of Kenya marine algae. - *J.E. African Nat. Hist. Soc.* **26**(2): 75-83.
- ISAAC, W.E. (1968): Marine Botany of the Kenya coast. 2. A second list of Kenya marine algae. - *J. E. African Nat. Hist. Soc.* **27**(1): 1-6.
- ISAAC, W.E. (1971): Marine Botany of the Kenya coast. 5. A third list of Kenya marine algae. - *J.E. African Nat. Hist. Soc.* **28**(2): 1-23.
- ISAAC, W.E. & F.M. ISAAC (1968): Marine Botany of the Kenya coast. 3. General account of the environment, flora and vegetation. - *J.E. African Nat. Hist. Soc.* **27**(1): 7-28.
- JAASUND, E. (1976): Intertidal seaweeds in Tanzania. - *Univ. Tromsø*.
- JAASUND, E. (1977): Marine algae in Tanzania. 8. - *Bot. Mar.* **20**: 509-520.
- KAY, Q. (1969): Marine botany of the Watamu district. - In JONES, D.A., Bangor-Watamu Expedition, preliminary report: 19-26. *Univ. Coll. North Wales*.
- LAWSON, G.W. (1980): A check-list of East African seaweeds (Djibouti to Tanzania). - *Univ. Lagos (Nigeria)*. 65 f.
- MENEZ, E. & H. CALUMPONG (1982): The genus *Caulerpa* from Central Visayas, Philippines. - *Smiths. Contrib. Mar. Sci.* **17**: 1-21.
- MOORJANI, S.A. (1977): The ecology of marine algae of the Kenya coast. - *Ph. D. thesis. Univ. Nairobi*. 285 f.
- PAPENFUSS, G.F. (1956): Notes on South African marine algae IV. - *J.S. African Bot.* **22**: 65-77.
- SARTONI, G. (1978): Ricerche sulla flora algale della Somalia centromeridionale. 1. Il genere *Caulerpa*. - *Webbia* **43**: 397-416.
- SVEDELIUS, N. (1906): Ecological and systematic studies of the Ceylon species of *Caulerpa*. - *Rep. Ceylon Mar. Biol. Lab.* **4**: 81-144.
- TAYLOR, WM. R. (1960): Marine algae of the Eastern tropical and subtropical coasts of the Americas. - *Ann Arbor Univ. Michigan Press*. 870 f.
- TAYLOR, WM. R. (1967): Species of *Caulerpa* (Chlorophyceae) collected on the International Indian Ocean Expedition. - *Blumea* **15**: 45-53.
- WEBER-VAN BOSSE, A. (1898): Monographie des *Caulerpa*. - *Ann. Jard. Buitenzorg* **4**(2): 243-401 + 15 pl.
- WOMERSLEY, H.B.S. (1984): The marine benthic flora of Southern Australia. Part 1. - *Woolman S. Australia*.

