Some New Records of Marine Algae from the Mediterranean Sea.

With reference to their geographical distribution.

By

A. A. Aleem.[1]

(Contributions from the Marine Botanical Institute, Göteborg, No. 3).

During October 1944, I made a collection of marine algae from the south east coast of the Mediterranean (Peninsula of Sinai, Egypt) from localities both near and far from the region where the Suez Canal joins that sea. The study of this collection revealed the presence of a number of interesting species described below. The species in question are known to occur in the Indian Ocean and their discovery in the Mediterranean is of interest from the point of view of geographical distribution. With the exception of *Caulerpa racemosa*, these species may be considered as new additions to the list of algae already recorded from the Mediterranean.

The identification of the species was carried out at the Marine Botanical Institute, Gothenburg, with the kind assistance of Dr. T. Levring. Drawings were made from material preserved in formalin.

Notes on the Species.

Caulerpa racemosa (Forssk.) J. Ag.; Hamel 1930 a p. 421 fig. 31.

This species was found cast ashore between Port Said and El Arish on the Mediterranean (Fig. 1). The coast line between these two places is, for the most part, sandy and shallow; tides are insignificant. I have also collected it during the summer, 1946 both from Ghardaqa and from Suez on the Red Sea, where it was attached to dead corals.

---

[1]) Permanent address: University of Alexandria, Egypt.

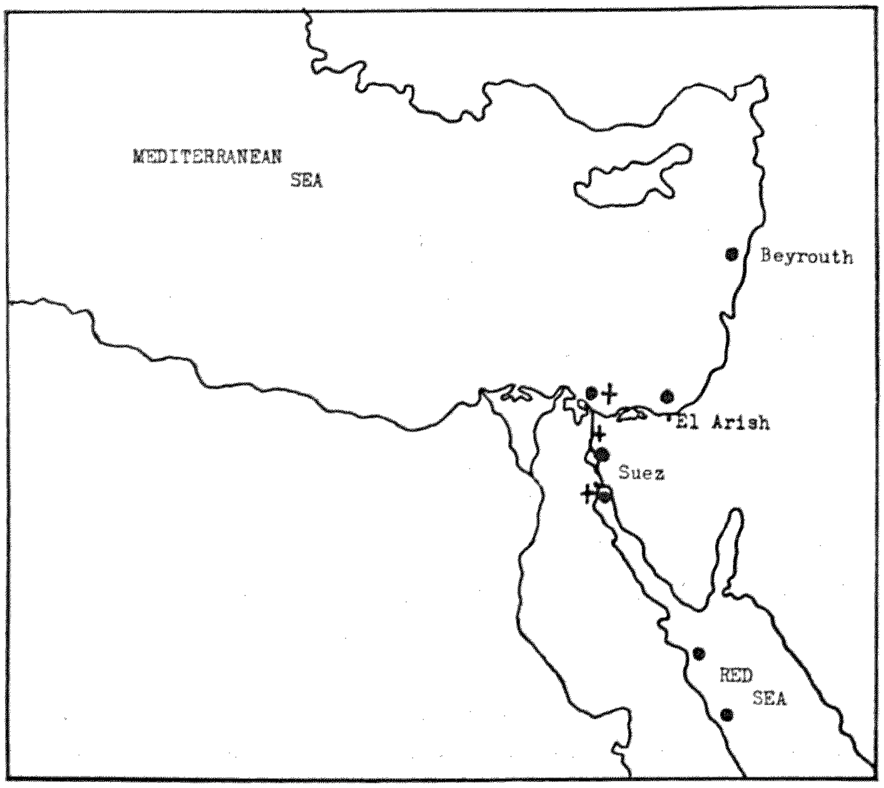

Fig. 1. Distribution of *Caulerpa recemosa* (●) and *Solieria dura* (+) in the Eastern Mediterranean.

This species can be fairly described as pantropical, *i. e.* has a wide distribution in most warm seas. Its presence in the Mediterranean had already been reported from two localities, *viz.* from the port of Sousse (Tunis) (*cf.* Hamel 1926 and 1930 b) and from Beyrouth, on the Syrian shore (*cf.* Lami 1932 p. 355). According to Hamel, the plant forms a dark green mat and reaches up to 10 cm high on the walls protecting the port at Sousse.

Its distribution in the Eastern Mediterranean seems to be more frequent than in localities further west. The continuous distribution of this species (together with that of *Solieria dura,* to be described below) between the Mediterranean and the Indian Ocean has now been established (see Fig. 1), especially after its discovery in 1932 from the Suez Canal watercourse by Gruvel at Lake Mourrah (often incorrectly referred to as L. Amer) which is one of the big lakes through which the Canal passes; Gruvel's material was determined by Lami (1932). I have, however, not found it near Alexandria

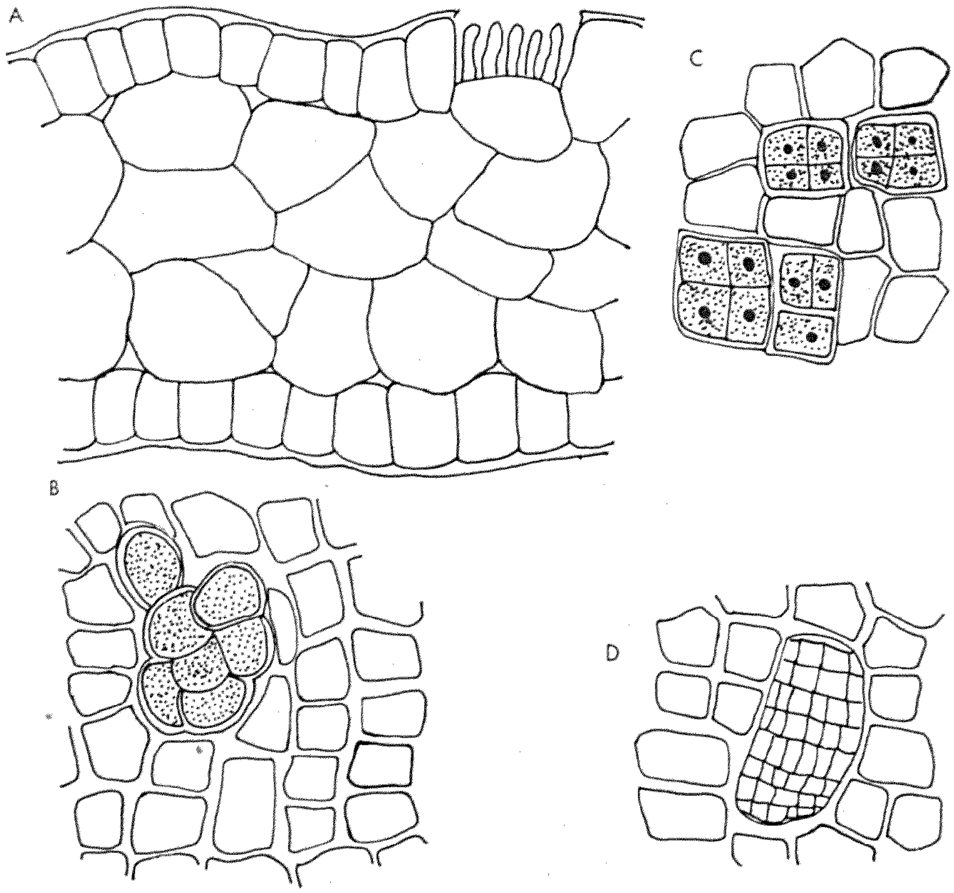

Fig. 2. *Spathoglossum variabile*, A transverse tangential section of the frond showing a group of young hairs; B a group of sporangia; C differentiation of sporangia from epidermal cells; D differentiation of hairs. B, C and D in surface view. — ×160.

where, on the other hand, *Caulerpa prolifera* forms a luxuriant association both in the lower littoral and in the upper sublittoral regions.

Geographical distribution: most warm seas.

Spathoglossum variabile Fig. et De Not.; Zanardini 1858 p. 246; De Toni, 1895 p. 247; *S. lubricum* Fig. et De Not. in Kütz. 1859 p. 48 pl. 1. — Fig. 2—3.

This species which is recorded for the first time from the Mediterranean can be easily distinguished from *S. solierii*, whose presence in the western shores of this sea has been described by Hamel (1931-39 p. 325), mainly by the anatomical structure of the thallus. In cross section *S. variabile* (Fig. 2 A) shows a medulla of 3—5 (rarely more) rows of cells with their tangential walls

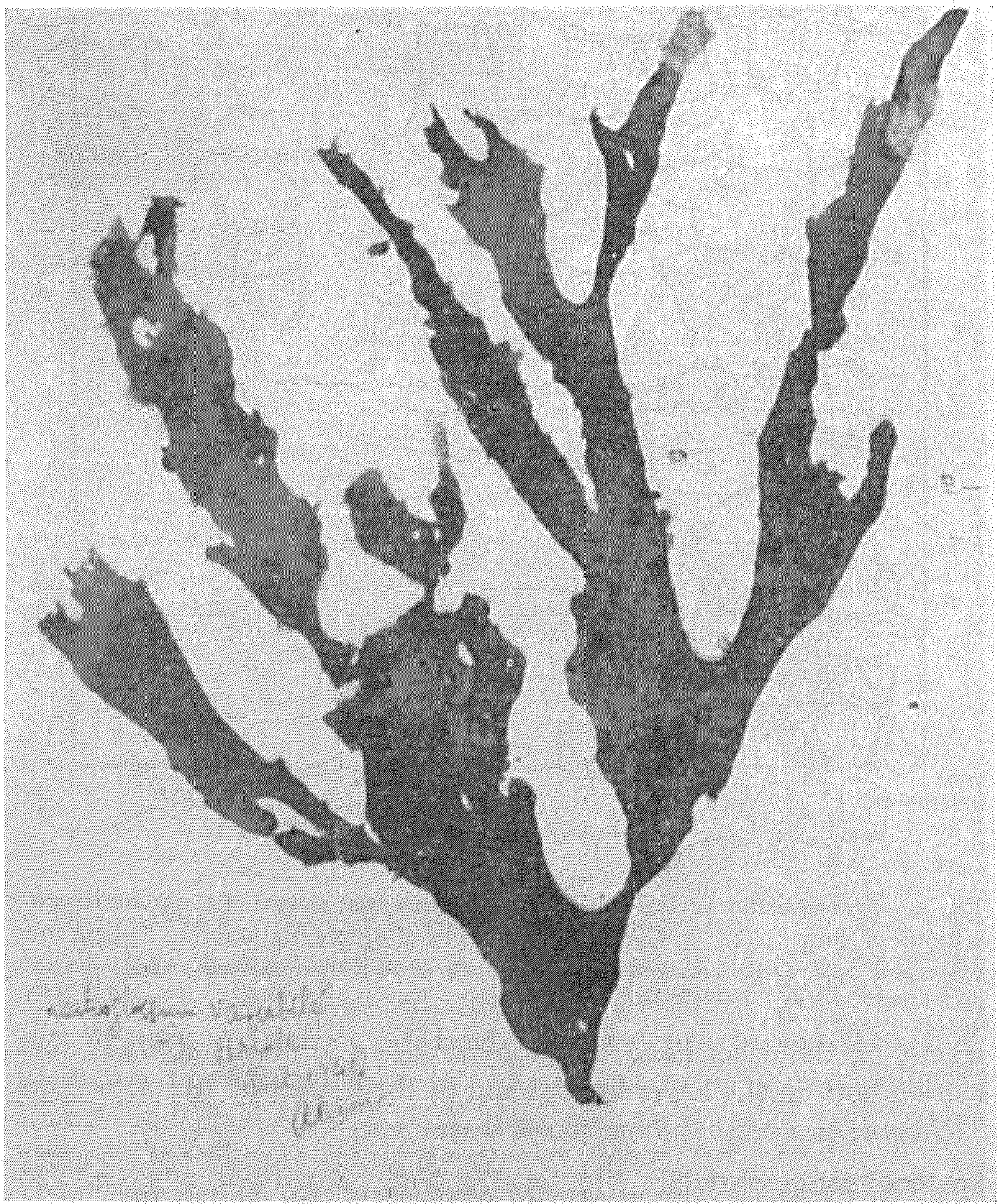

Fig. 3. *Spathoglossum variabile* Fig. et De Not. — ×0.7.

not forming longitudinal lines perpendicular to the surface; this in contrast to *S. solierii* in which such cells are arranged in regular longitudinal and horizontal lines. On the other hand, it is distinguished from *S. asperum* which occurs in the Indian Ocean and in the Indo-Pacific region, by the absence of the teath-like emergences from its margin.

Whole plants (fig. 3), most of which were in good condition, reaching up to 20 cm or more in length, were collected along the shore between Port Said and El Arish. The plant attaches itself to the substratum with an attenuated base. Basal segments are broadly cuneate; those higher up are more or less narrow and long with obtuse apices; margin entire. The plant is many times subdichotomously branched and the incisions between the lobes are roundish.

Surface cells (Fig. 2 B) are oblong to angular, usually 30—40 μ wide and 1.5 up to 2 times as long as broad. They are arranged in regular lines, especially in the young plants. Sporangia are differentiated from epidermal cells (Fig. 2 C) which become dense in contents. They arise singly or in groups and occur on either surface of the thallus. Usually they measure about $40 \times 50\ \mu$. The hairs, likewise, are differentiated from ordinary epidermal cells which divide by transverse and longitudinal lines into a large number of smaller cells (Fig. 2 D) with brown contents. They arise near the sporangia or occur separately. In transverse section they appear sunken below the epidermis.

Sporangia grow in situ (on the mother plant) and, as a rule, a large number of them is seen on the mother plant, but usually one sporangium is developed at a time from one point; sexual plants were not found.

The plant was cast ashore, it probably lives in deep water.

Geographical distribution: Indian Ocean (Red Sea, Arabian Sea, India, Malayan Archipelago), East Mediterranean (Port Said, El Arish).

Kylinia spathoglossi (Børg.) Aleem nov. comb.; *Acrochaetium spathoglossi* Børg. 1937 p. 30 fig. 14. — Fig. 4.

This species which Børgesen described for the first time from India is of interest to discover in the Mediterranean. The plant grows densely on both surfaces of the fronds of *Spathoglossum variabile* described in this paper. Young as well as old fronds of *Spathoglossum* were scarcely free from this *Kylinia*. The Indian plants were, however, growing on *S. asperum*.

My plants agree well with the original description of the species as far as the main characteristics are concerned. These are notably the habit of the plant, mode of branching and the shape of the basal attachment. Nevertheless, the size of the cells shows variation from the type, which may be due to the different habitat under

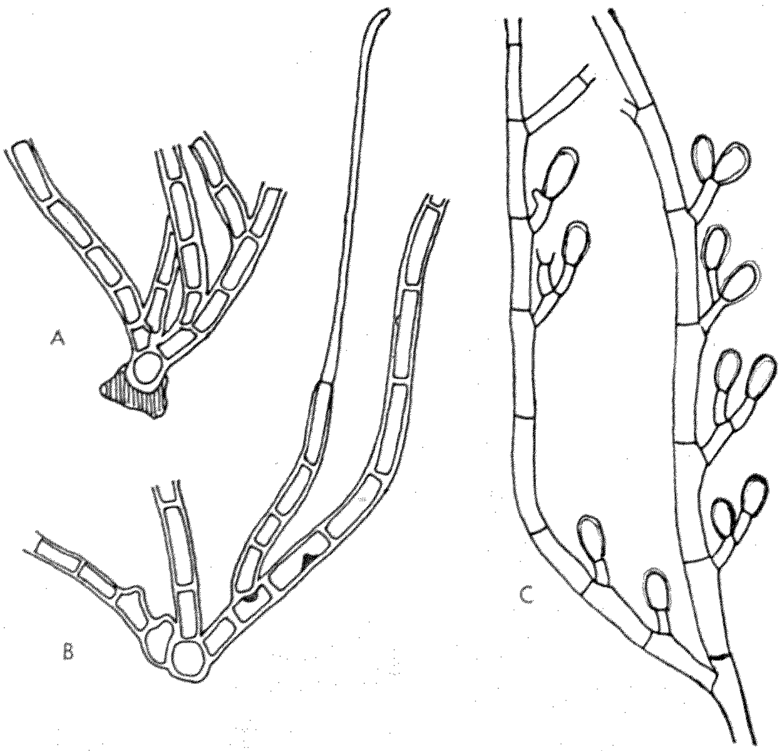

Fig. 4. *Kylinia spathoglossi*, A basal cell; B young plant with a hair; C monosporangia. — ×500.

which the Mediterranean plants grow or to other causes. For this reason and owing to the fact that the species does not seem to have been recorded elsewhere after its discovery in the Indian Ocean, I prefer to give a description of my plants together with some illustrations so that this might help to show the range of morphological variations within the species.

The plant grows in tufts reaching up to 400 μ long and attaches itself to the substratum by a more or less large rounded cell which is partly immersed in the host tissue (Fig. 4 A). From this cell grows out an erect filament as well as others, from the sides, which are prostrate for a little while and soon bend upwards. Branching takes place near the base as well as higher up. The branches arise irregularly.

The basal cell is about 7—10 μ in diameter and the first cells next to it are about 4—5 up to 7 μ wide and are about 7—10 μ long. The cells gradually increase in length higher up, where they reach up to 30 μ long. The cells contain a parietal chromatophore with a large pyrenoid.

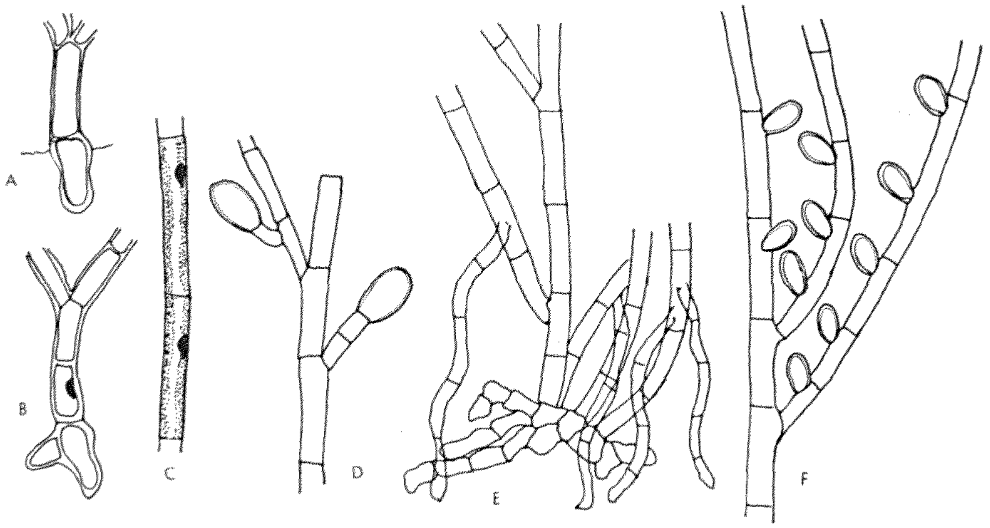

Fig. 5. *A. sargassicola*, A basal cell; B basal cell with an accessory cell; C cells in the upper branches; D monosporangia. — *A. subseriatum*, E basal attachment with rhizoids; F monosporangia. — ×350.

Monosporangia (Fig. 4 C) are oval to oblong, about 5—6 up to 7 μ broad, and about 10—12 (13) μ long. They are either pedicellate or sessile. The former occur mostly on the main filaments, while the latter may occur on side branchlets. I have been able to observe hairs on young plants. They are (Fig. 4 B) rather long, slightly broader at their base, then maintain a constant width throughout.

Børgesen gives the width of basal cell as about 5 μ, the filaments as 3—4 μ, while the monosporangia as 3—4×7 μ. Apart from these differances I cannot see any character which could serve to separate the two plants. Moreover, I do not want to create a new variety for the Mediterranean plant for the reason that the original material of Børgesen might not have been well preserved since he states at the beginning of his paper »since the material was kept in (6 % sea water formalin) for many years, sometimes as long as 20 years, the algae were not always in their best condition».

Geographical distribution: Indian Ocean (Southern coast of India), East Mediterranean.

Acrochaetium sargassicola Børg. 1932 b p. 115 figs. 3—5 (*cf. Rhodochorton robustum* (Børg.) Nakamura 1941 p. 284). — Fig. 5 A—D.

Specimens in my collection from Port Said contain a species of *Sargassum*, the upper leaves of which are covered on both sides with a slender *Acrochaetium*, forming erect tufts up to 2 mm high. This *Acrochaetium* agrees very well with Børgesen's Indian species cited above and, likewise, grows on *Sargassum*.

The basal cell (Fig. 5 A) is 10—13 μ wide and about 25 μ long, with a slight constriction in the middle. Moreover, an accessory basal cell (Fig. 5 B) was sometimes also met with among individuals teased out from the leaves of *Sargassum*.

The plant is sparsely branched below, but more branched upwards, branches are irregularly given off from the main shoots. The cells are little broader and shorter near the base of the plant than higher up; they are about 10 μ broad and 15—20 μ long in the former, while they measure about 6—8 μ broad and up to 50 μ long in the latter case (Fig. 5 C). The chromatophore is parietal with a rather large pyrenoid.

Monosporangia (Fig. 5 D) are about 10—12 μ wide and 18—20 μ long. They are either sessile or carried on a short, 1—2 celled, stalk.

Geographical distribution: Indian Ocean (Bombay shore), East Mediterranean (Port Said).

A. subseriatum Børg. 1932 b p. 118, figs. 6—7 (non Jao 1936 p. 243). — Fig. 5 E—F.

This species seems to be much more common in the Eastern Mediterranean than the other two preceding ones, which appear to be restricted to special hosts. I found it on *Acanthophora Delilei*, *Sarconema furcellatum* and on *Gelidium crinale* at Port Said, Port Fouad and El Arish, where it grows in tufts up to 1.5 mm long on these hosts. The plants growing on the different hosts show but little variations among themselves. For example, in the case of individuals growing on *Gelidium crinale*, I have observed several multicellular rhizoids (Fig. 5 E) emerging from the cells of the main filaments or from their branches, near the base and growing downwards until they reach the host tissue upon which they creep. These rhizoids may be as thick as or slightly thinner than the branches. They can arise from any of the first few basal cells. Børgesen (1942 p. 15) observed one such rhizoid emerging from the second basal cell of the main shoot of a plant belonging to this species and growing on *Griffithsia Weber-van-Bosseae* from Mauritius.

The basal attachment (Fig. 5 E) is a group of decumbent filaments which are irregularly branched. From these, erect filaments arise which are about 8—11 μ broad (in plants from different hosts). The cells are usually 3—5 times as long as broad and possess a parietal chromatophore with a large pyrenoid. Monosporangia are seriately arranged along the upper sides of the branches (Fig. 5 F) and sometimes also arise separately on the main shoots. They are obovate, usually sessile and in the case of the plants growing on *Gelidium crinale* measure about 7—8 μ × 12—14 μ; this is almost in exact accordance with the original description of the species. In the case of the plants growing on *Acanthophora*, and which also display the main characteristics of the species, the sporangia are slightly larger; they are about 10 μ wide and up to 16 μ long. In this latter respect the plants growing on *Acanthophora* may bear resemblance to *A. seriatum* described also by Børgesen (1915) from the West Indies. In fact the relation between these two species is so close that they can hardly be distinguished as separate species. In this respect, one may remark that a number of nearly related species of *Acrochaetium* have been described as separate by different authors either because they were discovered on different hosts or because they occur in two localities which are widely apart; both cases are not always justified.

Geographical distribution: Indian Ocean (India, Mauritius), East Mediterranean (Port Said, Port Fouad, El Arish),

Solieria dura (Zanard.) Schmitz 1896 p. 149; *Rhabdonia dura* Zanardini 1858 p. 278 pl. XI fig. 1. — Fig. 6—7.

This species (Fig. 6) was found attached to the quays at Port Said Harbour, together with *Sarconema furcellatum* and *Rhodymenia erythrea* described by the writer in an earlier paper (Aleem 1948). It was also collected from the banks of the Suez Canal near Ismailia during the same month, and later in 1946 from Suez (at Port Tewfic).

Since it was first described by Zanardini from Yemen in 1858, the species seems to have been only rarely recorded. Schmitz (1896), who referred the species to the genus *Solieria* on account of his examination of original material from Zanardini's Herbarium, reports the presence of sterile plants at Dar es Salam (East Africa). No clear figures showing the anatomy of the plant seem to have been published and Børgesen does not record the species among

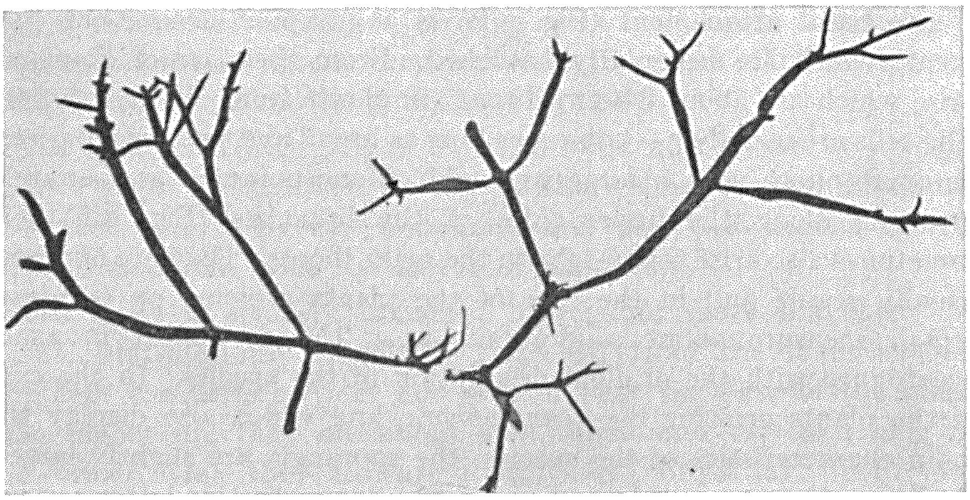

Fig. 6. *Solieria dura* (Zanard.) Schmitz. — ×0.8.

his collection from the Indian Ocean, but records two others *viz. S. robusta* and *S. natalensis;* the latter is found at Mauritius. However, during his revision of Forsskål's algae (in the »Flora Aegyptiaco—Arabica») kept at the Botanical Museum, Copenhagen, Børgesen (1932 a) found two specimens which resemble *Rhabdonia dura* Zanard. and to which Forsskål had given the name *Fucus divaricatus* some eighty years before Zanardini. Although Forsskål's name was adopted by J. Agardh (1851—63 p. 702), Børgesen found that this name is invalid as Linné had already applied it to a different plant.

In a collection by J. Murray in 1881 from Karachi, kept in Kew Herb., Børgesen (1934 p. 10) also found specimens named *Solieria dura* (Zanard.) Schmitz, but comparing them with Forsskål's specimens he found that they cannot be referred to this species, but rather to *S. robusta.*

Apart from the information just mentioned, I could not find any more records of this species and as our knowledge of it seems insufficient, I am including an account of my specimens.

At first, it might be desirable to clear the question of the generic name which has caused some authors to refer species belonging to *Solieria* incorrectly to *Rhabdonia.* It was due to Kylin (1932) that this distinction was made clear and based on the anatomy of the thallus. Since in the type of the genus *Rhabdonia,* created by Harvey in 1847 (*R. coccinea*), the development of the thallus is

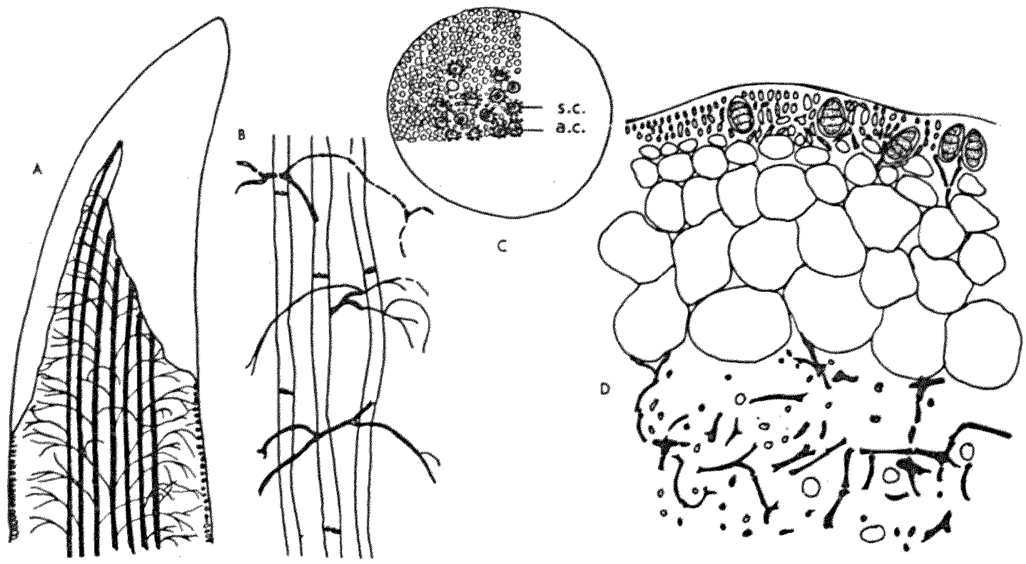

Fig. 7. *Solieria dura*, A length section at tip of a shoot showing the multiaxial development (semidiagrammatic); B three axes enlarged, with somewhat oblique septa between the elongated cells; C cross section at the growing tip showing the development of the multiaxial medulla, *a. c.*, axial cell; *s. c.*, hyphal cells; D cross section in mature thallus with tetrasporangia. — A ×120; B—D ×330.

»monoaxial»[1]), Kylin (1932 p. 13) regarded this character as distinctive for the family *Rhabdoniaceae*, in contrast to the »multiaxial»[2]) development in the family *Solieriaceae* (including the genus *Solieria*). Consequently, Kylin (1932 p. 34) showed the affinity of certain species of *Rhabdonia* to *Solieria* and transferred them to the latter genus.

The structure of the thallus in my specimens shows the multiaxial type. This is especially clear in longitudinal sections made at the summits of the shoots (Fig. 7, A). The differentiation of the multiaxial »core» was also shown in successive transverse sections made at the growing tip. Fig. 7 C shows one such sections in which large cells of the axis (*a. c.*) are seen surrounded by smaller cells (*s. c.*) which are later differentiated into the filamentous elements connecting the axes with the cortex (hyphae). Moreover the growing point in my material is a group of cells. Accordingly, my plants belong to *Solieria*.[3])

[1]) and [2]) These terms are after Fritsch (1945) and seem to correspond with Kylin's terms »Zentralfadentypus» and »Springbrunnentypus».

[3]) The structure of the thallus in *Solieria* is similar to that in *Agardhiella*. However, the presence of a large fusion cell in the cystocarp of *Solieria* separates the two genera (see Kylin 1932).

In texture, colour, habit etc. my specimens agree well with those described by Zanardini, except that my plants are somewhat smaller. In transverse section of the mature part of the thallus (Fig. 7 D) the epidermal cells are elongated and rather small (about 15—20 μ long and 5—8 μ wide). These are followed by large cortical cells attaining a diameter up to 110 (120) μ. The medulla with its multiaxial elements is widest in the younger parts of the thallus; it is connected with the cortex with thin branching and elongated filaments (»hyphae») which are directed downwards. Tetrasporangia are scattered in the epidermal layer all over the thallus; they are zonately divided and measure about 40—50 μ × 15—25 μ in the preserved material.

Geographical distribution: Indian Ocean (Red Sea, East Africa), East Mediterranean (Port Said).

Discussion

In a previous paper (Aleem, 1948) the writer has recorded the presence of a number of Indopacific algae in the Mediterranean and has discussed in detail the possible ways by which such species could have succeeded in establishing themselves in that sea. It was concluded that, to all intents and purposes, this migration could have taken place from the Indian Ocean in recent times, via the Suez Canal connection between the Mediterranean and the Red Sea and that such algae could possibly be conveyed on ships' bottoms or aided by the Suez current. The latter, owing to the difference in salinity between the two seas as well as to other considerations, makes it possible for water from the Red Sea to reach the Mediterranean.

The fact that several of the larger species recorded in this paper as well as in the previous one cited above (e. g. *Rhodymenia erythrea*, *Solieria dura*, *Sarconema furcellatum*) are found attached to the quays at Port Said at the outlet of the canal, or in other words, are more common just at that place (in certain cases only found there) than, for example, at Alexandria or at El Arish, lends further support to the view in question. The recent discovery of some of these species (e. g. *Caulerpa racemosa* and *Solieria dura*) in the Suez Canal watercourse establishes the continuous distribution of these species between the Indian Ocean and the Mediterranean and lends strength to the view that a continuous stretch of land is essential for the spread of marine algae.

It had also previously been suggested that the newly recorded species in the Eastern Mediterranean might in course of time spread into other localities further west in that sea and it is interesting to add that one of the species recorded from Alexandria, (Aleem 1948) namely *Acetabularia Mobii* has been discovered by J. and G. Feldmann (1948) as far west as the coast of Algeria. This species, which is apparently absent from the Atlantic, was recorded recently by Børgesen (1940 p. 44) from Mauritius. J. and G. Feldmann also point out that this particular species has been discovered at Naples and was described by Schussnig in 1928 as *A. Wettsteinii*.

Undoubtedly a more thorough study of the algae in the Suez Canal and adjacent Mediterranean coasts, especially from the sublittoral region, would reveal the presence of more of these interesting algae belonging to Indian or Indopacific elements. Work on this problem was already started by the writer some years ago. The results will be published as soon as my specimens have been identified.

Summary.

The following species are new record for the Mediterranean algal flora: *Spathoglossum variabile* Fig. et De Not., *Kylinia spathoglossi* Børg., *Acrochaetium sargassicola* Børg., *A. subseriatum* Børg. and *Solieria dura* (Zanard.) Schmitz. It is suggested that they have migrated from the Indian Ocean via the Suez Canal in the same way as other species from that region, previously recorded from the Meditarranean (Aleem 1948).

The continuous distribution of *Caulerpa racemosa* and *Solieria dura* between the Indian Ocean and the Mediterranean is established.

Literature cited.

AGARDH, J., Species algarum, Vol. II, Lund 1851—63.

ALEEM, A. A., The recent migration of certain Indopacific algae from the Red Sea into the Mediterranean. — New Phytologist, Vol. 47, London 1948.

BØRGESEN, F., The marine algae of the Danish West Indies, Vol. 2. Copenhagen 1915.

— — A revision of Forsskål's algae mentioned in Flora Aegyptiaco-Arabica and found in his herbarium in the botanical museum of the university of Copenhagen. — Dansk bot. Arkiv, Bd 8, Copenhagen 1932 a.

— — Some Indian Rhodophyceae, especially from the shores of the presidency of Bombay, II and IV. — Kew Bulletin, London 1932 b and 1934.

— — Contributions to a south. Indian marine algal flora, I. — Journ. Ind. Bot. Soc. Vol. 16, Madras 1937.

— — Some marine algae from Mauritius, I Chlorophyceae. — Kgl. Danske Vidensk. Selsk., Biol. Meddell. Bd. 15, København 1940; III Rhodophyceae 1, Ibid. 17, 1942.

DE TONI, J. B., Sylloge algarum, Vol. 3, Fucoideae. Patavia 1895.

FELDMANN, J. ET G., Additions à la flore des algues marines de l'Algérie. — Bull. soc. hist. nat. de l'Afrique du Nord, T. 38, Alger 1948.

FRITSCH, F. E., The structure and reproduction of the algae, Vol. 2, Cambridge 1945.

HAMEL, G., Quelques algues rares ou nouvelles pour la flore méditerranéenne. — Bull. mus. hist. nat., T. 32, Paris 1932.

— — Chlorophycées des côtes françaises. — Rev. alg., T. 5, Paris 1930 a.

— — Les Caulerpes méditerranéennes. — Ibid. 5, 1930 b.

— — Phéophycées de France. — Paris 1931—39.

JAO, C. C., New Rhodophyceae from Woods Hole. — Bull. Torr. Bot. Club, Vol. 63, New York 1936.

KÜTZING, F. T., Tabulae phycologicae, Bd 9. Nordhausen 1859.

KYLIN, H., Die Florideenordnung Gigartinales. — Lunds Univ. Årsskrift, N. F. Avd. 2 Bd 28, Lund 1932.

LAMI, R., Quelques algues du grande lac Amer (Basse-Egypte) récoltées par M. le prof. Gruvel, en avril 1932. — Rev. alg., T. 6, Paris 1932.

NAKAMURA, Y., The species of Rhodochorton from Japan. — Scientific Papers from the Inst. of Algolog. Research, Vol. 2, Hokkaido 1938—41.

SCHMITZ, E., Marine Florideen von Deutsch-Östafrika. — Bot. Jahrb. Engler, Bd 21, Leipzig 1896.

ZANARDINI, J., Plantarum in mari rubro hucusque collectarum. — Mem. Ital. Roy. Instit. Venet., Vol. 7, Venice 1858.

Tryckt den 8 juli 1950.