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Morphological Description of Endangered Seaweed Species in Abu Qir Bay, the Mediterranean Coast of Egypt

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ABSTRACT

Protecting the biodiversity of macroalgae in aquatic ecosystems is crucial for ecosystem stability. Documenting endangered species is the first step toward understanding and conserving at-risk species, their threats, and implementing necessary conservation measures to maintain biodiversity and ecosystem health. The current work documented and provided detailed morphological description of some significant seaweed species thriving in the coastal city of Alexandria, specifically in Abu Qir Bay, which has long been recognized by its rich and diverse macroalgae population. Several seaweed species were recorded between 2020 and 2022, including the green algae *Codium decorticatum*, *C. effusum*, *C. taylori*, *C. vermilara*, and *Caulerpa cylindracea*; the red algae *Asparagopsis taxiformis*, *Chondracanthus acicularis*, *Gelidium crinale*, *Hypnea musciformis*, and *Petalonia fascia*; and the brown alga *Padina boryana*. However, since 2023, the invaluable biodiversity reported previously has been lost due to extensive construction activities that reshaped the landscape of the Abu Qir area, except for several *Ulva* species. Recognizing the critical importance of preserving natural habitats against urbanization, prioritizing conservation efforts, raising awareness on sustainability challenges, and strengthening laws supporting species conservation are key steps to protecting biodiversity and ensuring a sustainable future.

INTRODUCTION

Seaweeds act as ecosystem engineers, playing a crucial role to realizing sustainable development goals and restoring environmental health. Seaweeds enhance ecosystem resilience and productivity and provides essential ecosystem services. The conservation of macroalgae is of utmost importance **(Gibbons & Quijon, 2023)**. Currently, there are 12,337 species of macroalgae, divided into 2695 Ulvophyceae (green algae), 7554 red algae, and 2124 Phaeophyceae (brown algae) **(Guiry & Guiry, 2024)**.

Alexandria is the second-largest city in Egypt, extending approximately 60km along the Mediterranean Sea coast. Historically, Abu Qir Bay—a shallow, semicircular basin in Alexandria—was recognized as a habitat for a wide variety of macroalgae, due to the presence of diverse substrates suitable for algal growth **(Nasr, 1940a, b)**. **Aleem (1945)**

collected and described 107 species, several of which were identified as having been introduced via the Suez Canal. However, the number of recorded macroalgal species significantly decreased over time: fewer than 56 species were documented by **Negm (1976)**, 78 species by **Khalil (1987)**, 47 species by **Nabih (1989)**, and only 25 species by **Soliman (1997)**.

El-Zayat (2012) conducted a study on seaweeds at five sites along the Alexandria coast during 2006–2007, revealing the presence of 40 species. However, by 2013, **Labib *et al.* (2015)** identified only 30 species from Abu Qir Bay, attributing the decline to severe human activities in the area.

There is evidence that some algae are now endangered or have even become extinct in recent years **(Brodie *et al.*, 2009)**. Both natural and human-made disturbances—such as coastal infrastructure, pollution, overharvesting, and global warming—can disrupt the natural dynamics of coastlines, making them more vulnerable to erosion and biodiversity loss. Therefore, understanding how human activities impact shoreline dynamics is a crucial aspect of sustainable coastal management.

Various morphological and structural characteristics of macroalgae have been linked, directly or indirectly, to their ability to tolerate and adapt to coastal disturbances. These attributes play a vital role in their survival and ecological success. Examining such features at both individual and population levels is not only important for scientific research but also aids in conservation efforts—especially for species that are threatened or experiencing prolonged declines **(Tummon Flynn *et al.*, 2019)**.

Currently, the Egyptian Government is undertaking several developmental projects as part of establishing the new city of Abu Qir. These include preparing the largest beach along the eastern Alexandria coast—spanning approximately 385 acres—constructing a 9 km-long breakwater, developing the new Abu Qir Port on 985 acres, excavating the port basin, leveling the quay, and outfitting the navigation channel to accommodate incoming ships.

Thus, the aim of this research paper was to document the most important macroalgal species—particularly those once described as endemic but now disappeared due to human encroachments on biodiversity hotspots in Alexandria.

MATERIALS AND METHODS

Study area

Alexandria is a historic city in the center of the Mediterranean coast of Egypt; it extends to about 40km northwest of the Nile Delta. Alexandria has been characterized by its undulating shorelines interrupted by rocky headlands, forming pocket beaches **(Frihy *et al.*, 2004)**. The geomorphology of the beaches of Alexandria has created a suitable habitat for the settlement of seaweeds. Unfortunately, Alexandria beaches are subjected to coastal constructions that severely affected the biodiversity of seaweeds due to the

destruction of their natural habitats. Abu Qir Bay, located at 31°19'25"N 30°03'37"E east of Alexandria, is a sheltered rocky embayment characterized by chains of natural exposed rocks extending for about 100m seaward from the coast, which provides a suitable substratum for a rich algal flora.

Seaweeds collection and reference material

Seaweeds were collected monthly between the years 2020 and 2023 from the rocky shores of Abu-Qir Bay. Samples were placed in plastic bags, kept in ice boxes, and transported immediately to the laboratory for sorting and processing. The collected samples were carefully cleaned from epiphytes and washed. The algal specimens were fixed in a solution of 4% formalin and seawater. Subsequently, thin sections were treated with 1% aniline blue, acidified using 1% HCl, and then examined under a compound microscope (GZM-TR-745 with 5.1MP mounted digital camera; Gippon, Inc., Japan). Voucher specimens were archived in the Herbarium Collection at the Hydrobiology Laboratory of the National Institute of Oceanography and Fisheries (NIOF).

RESULTS

The present study recorded several seaweed species between 2020 and 2022. These included green algae such as *Codium decorticatum*, *Codium effusum*, *Codium taylori*, *Codium vermilara*, and *Caulerpa cylindracea*; red algae including *Asparagopsis taxiformis*, *Chondracanthus acicularis*, *Gelidium crinale*, *Hypnea musciformis*, and *Petalonia fascia*; and the brown alga *Padina boryana*. However, since 2023, most of these species have disappeared, with only a few *Ulva* species still present. The following section provides a taxonomic description of the recorded species.

Phylum: Chlorophyta
Class: Ulvophyceae
Order: Bryopsidales
Family: Codiaceae

1-*Codium decorticatum* (Woodward) M. Howe

Type locality: Mediterranean Sea
Worldwide distribution: Indo-Pacific Ocean, Atlantic Ocean, the Mediterranean Sea, Antarctic and Antarctic islands **(Guiry & Guiry, 2024)**.
Description: Erect dark green thallus, up to 50cm long, regularly dichotomously branched with truncate tips. Branches cylindrical but flattened at the dichotomy (Fig. 1a). Utricles cylindrical to clavate, 950 to 1100µm long and 150 to 440µm in diameter (Fig. 1b). Apices rounded to truncate, sometimes with central depression.
Voucher specimens: Shabaka_July2020_COD_dec_AQ,
Shabaka_Aug2021_COD_dec_AQ, Shabaka_Sep2022_COD_dec_AQ

2-*Codium effusum* (Rafinesque) Delle Chiaje

Type locality: Sicily, Italy
Worldwide distribution: Atlantic Islands, Indo-Pacific Ocean, Mediterranean Sea, Subantarctic Islands **(Guiry & Guiry, 2024)**.
Description: The specimens had dark-olive green color; the thallus is flat and thick, ranging from 5 to 10cm in width and up to 1cm in thickness (Fig. 1c). The compact thallus has a swollen appearance with rounded tips. Clavate utricles 870 to 1750µm long, and 150 to 360µm wide (Fig. 1d). Apices truncate, sometimes with central depression.
Voucher specimens: Shabaka_Aug2020_COD_eff_AQ.

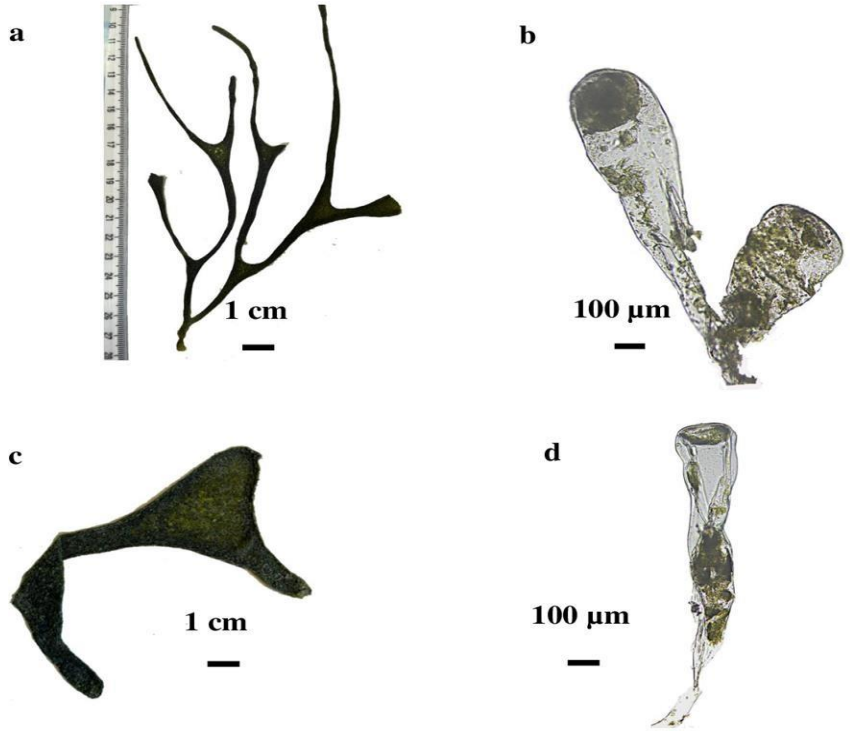

Fig. 1. a-b *Codium decorticatum*, a) General aspect of the thallus, b) Calvate utricle with rounded apex. c-d *C. effusum*, c) General aspect of the thallus, d) Calvate utricle with truncated apex

3-*Codium taylorii* P.C.Silva

Type locality: Florida- USA
Worldwide distribution: Atlantic Islands, Indo-Pacific, Red Sea, North and South America, South Africa **(Guiry & Guiry, 2024)**. *Codium taylorii* has been introduced into the Mediterranean via shipping and/or aquaculture activities **(Verlaque *et al*., 2015)**. It is now widely distributed in the Levantine and on North-African coasts.

Description: Erect dark green thallus, 5 to 10cm long. Irregular dichotomously branched thallus, and the branching of an unequal growth, giving the thallus cervicorn appearance (Fig. 2a). Branches frequently flattened, with truncate or rounded tips. Utricles clavate, pyriform, or cylindrical, 95 to 250µm in diameter and 430 to 950µm long (Fig. 2b). Apices rounded to slightly truncated.
Voucher specimens: Shabaka_Aug2020_COD_tay_AQ,
Shabaka_Aug2021_COD_tay_AQ

4-*Codium vermilara* (Olivi) Delle Chiaje

Neotype locality: Portore, Croatia
Worldwide distribution: European coast of the Atlantic Ocean and the Mediterranean Sea **(Guiry & Guiry, 2024)**.
Description: Erect vivid green thallus of up to 15cm in length, with cylindrical fronds of 3-5mm thick near the base and about 2mm thick at the tips, irregularly dichotomously branched (Fig. 2c). Utricles clavate to cylindrical, 70 to 150µm in diameter, and 430 to 600µm long (Fig. 2d). Apices rounded to slightly truncated
Voucher specimens: Shabaka_Aug2020_COD_ver_AQ,
Shabaka_Aug2021_COD_ver_AQ.

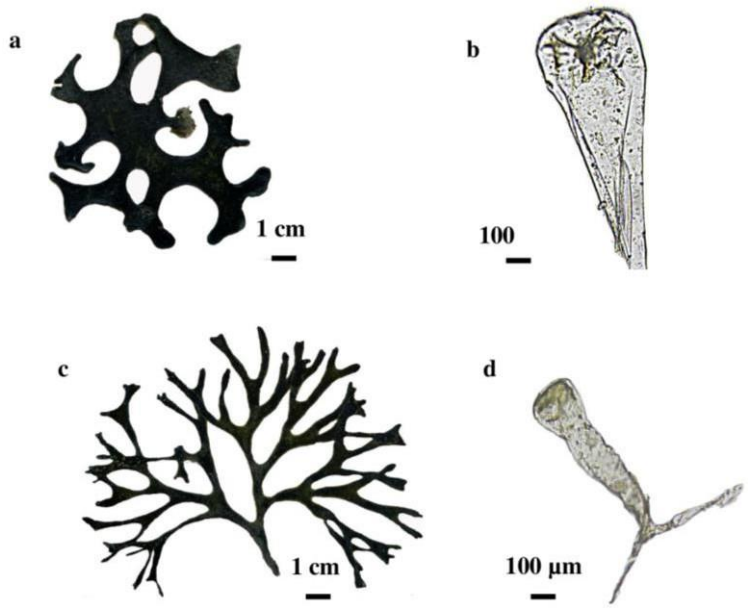

Fig. 2. a-b *Codium taylori*, a) General aspect of the thallus, b) Pyriform utricle with truncated apex. c-d *C. vermilara*, a) General aspect of the thallus, b) Calvate utricle with truncated apex

Family: Caulerpaceae

5-*Caulerpa cylindracea* Sonder

Type locality: Western Australia
Worldwide Distribution: It has been reported on Atlantic Islands, and in North Atlantic Ocean and Indo-Pacific Ocean. *C. cylindracea* is widespread in the Mediterranean Sea as introduced species **(Verlaque *et al*., 2015; Guiry & Guiry, 2024)**.
Description: the slender thallus is fixed to the substratum via thin rhizoids, 7-15mm long and 0.3mm in diameter (Fig. 3a). The stolon is 0.5 – 1.0mm in diameter and bears simple upright axes, 35 – 60mm high. The basal part of upright axes shows a slight swelling just above its connection to the stolon. Upright axes carry crowded ramuli that are radially arranged on a cylindrical rachis. The ramuli are clavate, 2.5- 3.5mm long and 1.1 – 1.7mm diameter (Fig. 3a, b).
Voucher specimens: Shabaka_Aug2020_CAU_cyl_AQ, Shabaka_Aug2021_CAU_cyl_AQ, Shabaka_Aug2022_CAU_cyl_AQ

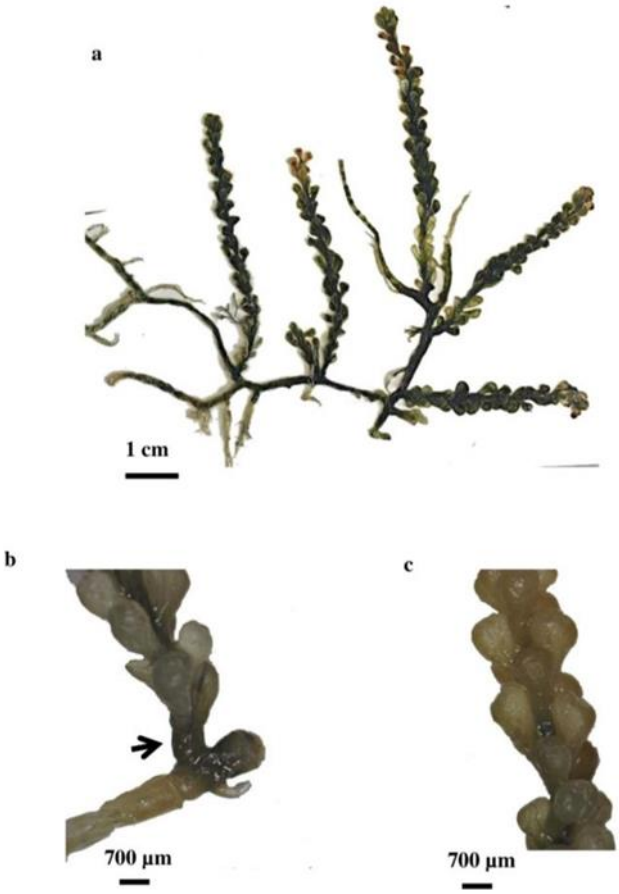

Fig. 3. *Caulerpa cylindracea* Sonder 1845 a) Plant habit, b) Detail of the attachment of upright axes to the stolon (arrow), c) Detail of radial arrangement of *ramuli*

Phylum: Heterokontophyta
Class: Phaeophyceae
Order: Dictyotales
Family: Dictyotaceae

6-*Padina boryana* Thivy

Type locality: Friendly Islands, Polynesia.
Worldwide distribution: Indo-pacific waters and the Red Sea **(Guiry and Guiry, 2024)**. *P. boryana* is an introduced species into the Mediterranean Sea **(Verlaque *et al*., 2015)**.
Description: Plants are yellowish brown in color, not twisted; the holdfast is 2-5mm in diameter. Thalli are 2-5cm in height and 1.5-4cm in breadth, cuneate at base, fan-shaped at upper portions (Fig. 4a, b). The margins of thalli are simple and split into lobes, lightly calcified. Sori are only on the outer surface, without indusium, and arranged as continuous lines just distal to the hair bands (Fig. 4c, d).
Voucher specimen: Shabaka_May2020_PAD_bor_AQ

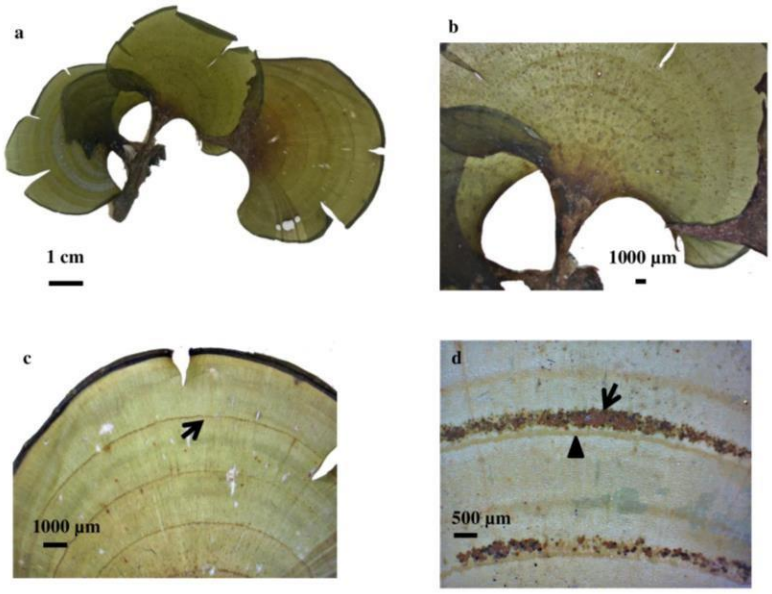

Fig. 4. *Padina boryana* Thivy. a) Habit of sporophyte, b) Surface view showing the base of the thallus, c) Involute-margin and arrangement of tetrasporangia (arrow). d) Surface view of the thallus showing relationship of the hair lines (triangle) and the sporangial sori on the upper surface (arrow)

Order: Ectocarpales
Family: Scytosiphonaceae

7-*Petalonia fascia* (O.F.Müller) Kuntze

Type locality: Near Kristiansand, Norway.
Worldwide distribution: the Atlantic Ocean, South-east and southwest Asia and South Africa & the Mediterranean Sea **(Guiry & Guiry, 2024)**.
Description: The frond varies in length from 5 to 25cm and in width 4-5cm. The blades are broad lanceolate with ruffled margins arising from a common holdfast, brown to dark brown-reddish color (Fig. 5a). The medullary structure is composed of large ellipsoid cells (Fig. 5b).
Voucher specimen: Shabaka_Feb2021_PET_fasc_AQ,
Shabaka_Apr2022_PET_fasc_AQ.

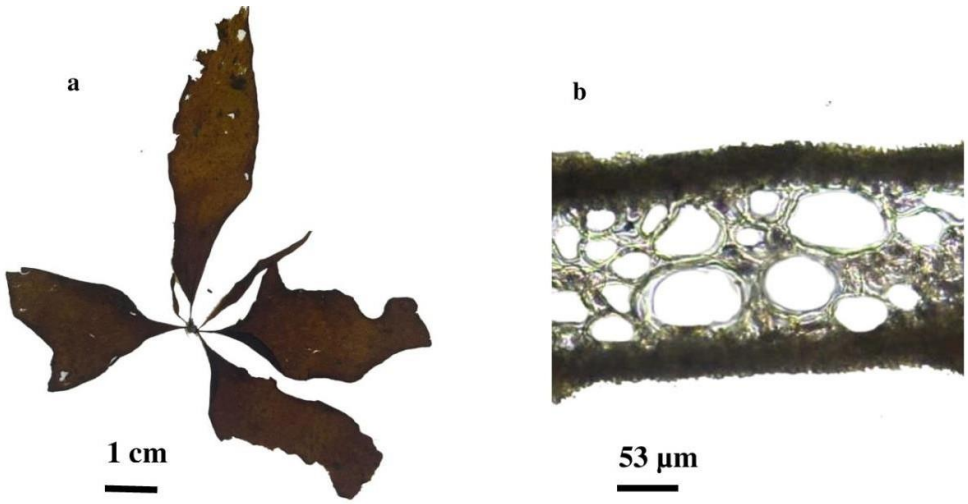

Fig. 5. *Petalonia fascia*, a) Habit of the sporophyte, b) Transverse section of thallus

Phylum: Rhodophyta
Class: Florideophyceae
Order: Bonnemaisoniales
Family: Bonnemaisoniaceae

8-*Asparagopsis taxiformis* (Delile) Trevisan

Type locality: Alexandria, Egypt.
Worldwide distribution: Tropical to subtropical species, particularly abundant in the Mediterranean Sea as an introduced species **(Guiry & Guiry, 2024)**.
Description: Vertical thallus, up to 8cm and about 2mm in diameter, cartilaginous, cylindrical, filiform, bare in their lower part or with rudimentary branches, branched into

elongated and dense short branches in the upper parts giving it pyramidal shape (Fig.6a). The plant is pinkish red when fresh and turns dark red when dried. The branches are very close together; become sag and stick to each other in case of being out of water (Fig. 6b). The main axis is about 2mm in diameter. Erect axes arise from discoid holdfast; the basal portion of the thallus has stolon-like and descending branches formed from their lower part (Fig. 6c). In surface view, the cortical cells are regularly arranged in longitudinal rows throughout the thalli (Fig. 6d). In transverse section, the thalli possess one layer of pigmented cortical cells and rounded colorless medullary cells (Fig. 6e).
Voucher specimens: Shabaka_June2020_ASP_tax_AQ,
Shabaka_July2021_ASP_tax_AQ

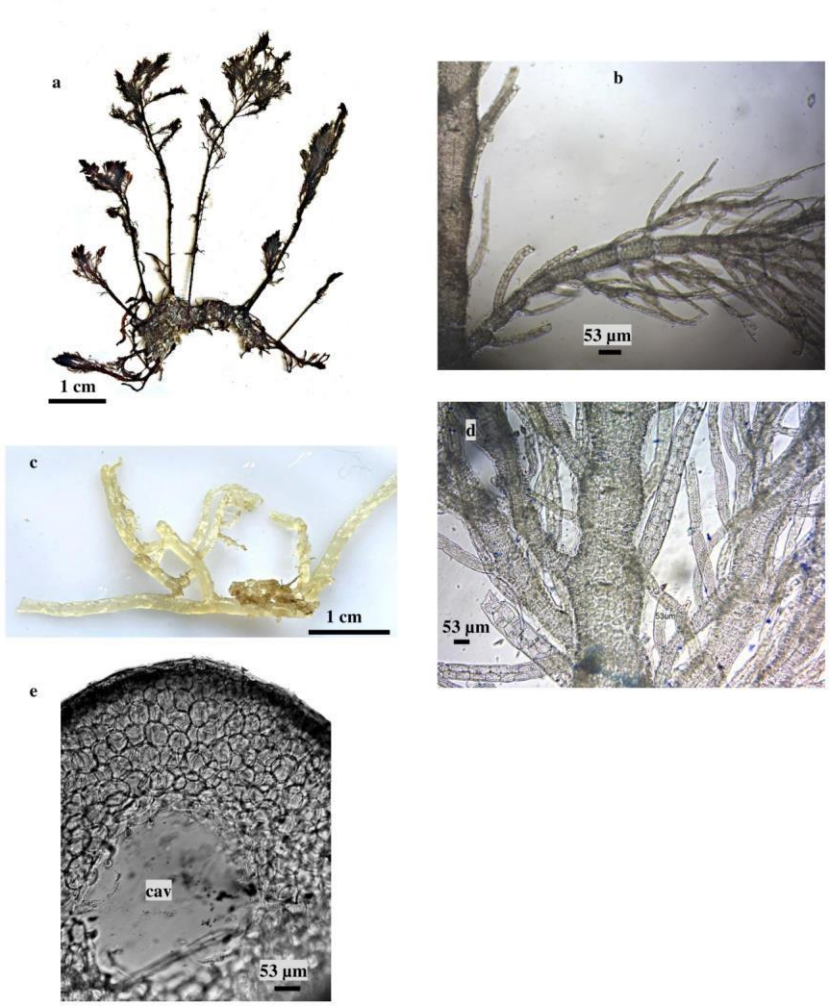

Fig. 6. *Asparagopsis taxiformis* a) Habit of the plant, b) Details of the branches, c) Basal stolon and rhizoids, d) Young gametophtyte, e) Transverse section in the main thallus showing cortical cells, medullary cells, and central cavity (cav)

Order: Gelidiales
Family: Gelidiaceae

9-*Gelidium crinale* (Hare ex Turner) Gaillon.

Lectotype locality: Ilfracombe, Devonshire, England.
Worldwide distribution: Widely distributed in the Atlantic Ocean, the Mediterranean Sea, and Indo-Pacific Ocean **(Guiry & Guiry, 2024)**.
Description: Bushy and cartilaginous thallus, dark brownish red, 20-30mm long. Prostrate axes terete, 100-200µm in diameter, bearing erect pinnate branches, with acute apex (Fig.7a). Tetrasporangia show several stichidia in the terminal branches, sometimes furcate (Fig.7b). Cystocarps are formed subterminal in clustered branchlets (Fig.7c, d). Voucher specimens: Shabaka_May2020_GEL_cri_AQ, Shabaka_May2021_GEL_cri_AQ.

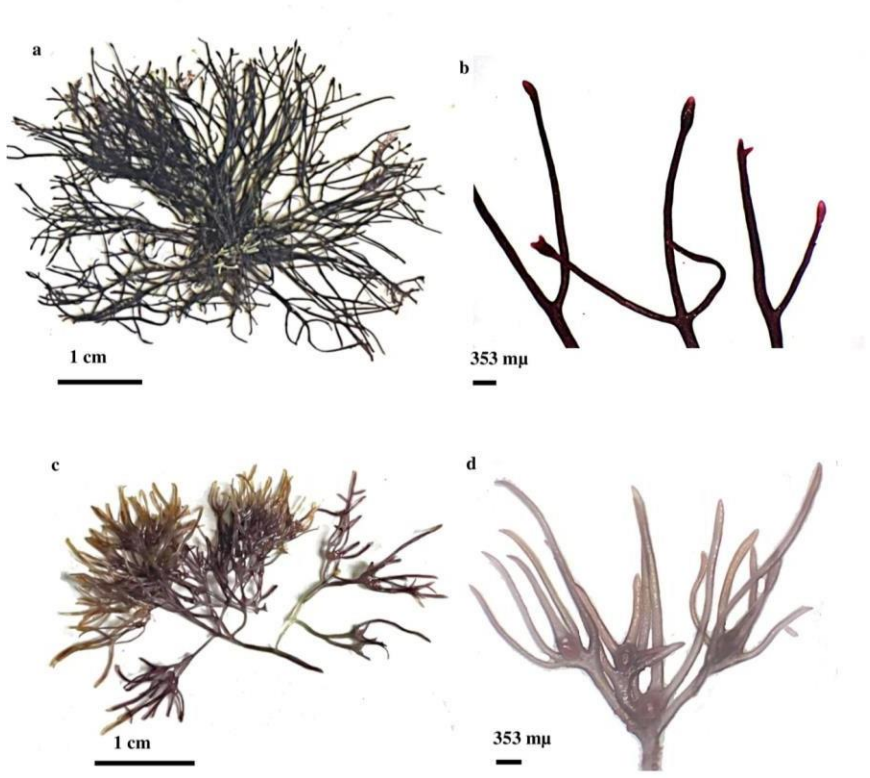

Fig. 7. *Gelidium crinale.* A) Thallus with erect branches and terminal *stichidia*, b) A terminal stichidium, c) Fertile female gametophytes, d) Cystocarpic thallus bearing mature cystocarps on erect branches

Order: Gigartinales
Family: Cystocloniaceae

10-*Hypnea musciformis* (Wulfen) J.V.Lamouroux

Type locality: Trieste, Italy.
Worldwide distribution: Cosmopolitan **(Guiry & Guiry, 2024)**.
Description: The plant is terete, cartilaginous in texture, 3–7cm long (Fig. 8a). The branches are entangled, greenish when fresh, and turn dark red when dry. Anastomoses absent. Main axis is about 600µm in diameter. Branching irregular with spine-like branchlets, irregularly scattered throughout the thalli, straight or curved, 300–700µm long and 150-200µm in diameter (Fig. 8b). Apices of the main axes are swollen forming hooks or tendrils. Tetrasporangia in sori surround the basal swollen portions of branchlets (Fig. 8d).
Voucher specimens: Shabaka_March2021_HYP_mus_AQ;
Shabaka_May2022_HYP_mus_AQ.

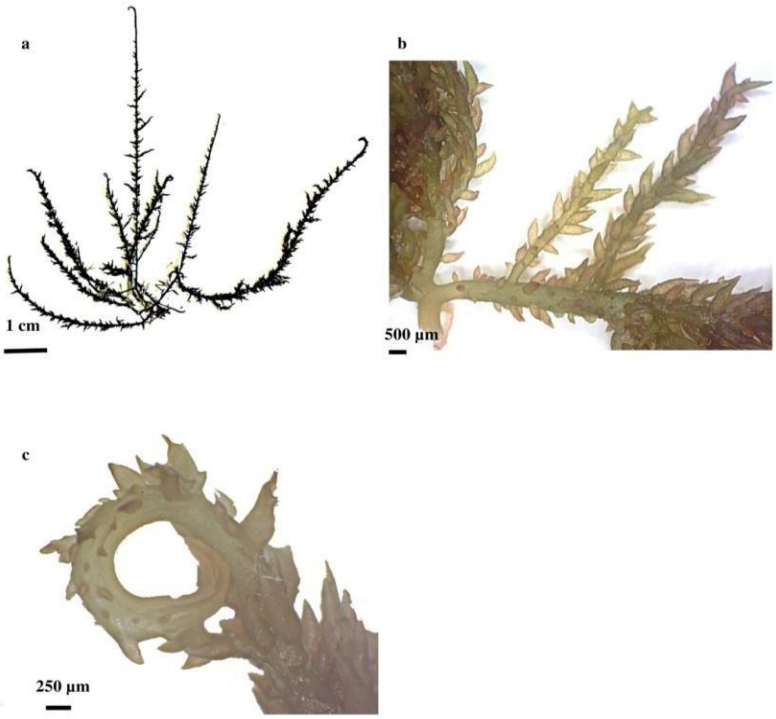

Fig. 8. Hypnea musciformis. a) Habit of a tetrasporangial plant showing branchlets densely grouped and branches with hooks and tendrils, b) Tetrasporangial branchlets showing sori at their basal portions, c) Detail of a tendril showing tetrasporangial spiny-like branchlets

Family: Gigartinaceae

11-*Chondracanthus acicularis* (Roth) Fredericq

Type locality: Adriatic Sea.
Worldwide distribution: widely distributed on the European Atlantic Coast, in the Mediterranean Sea, and Indo-Pacific Ocean **(Guiry & Guiry, 2024)**.
Description: Plants exhibit a rubbery texture, terete, dark brownish red, up to 5cm long. The branches are cylindrical; 0.5mm in diameter, with irregular branching in different planes, branching is often anastomosing (Fig. 9a, b). Side branchlets are perpendicular on the main branches, with acute apices (Fig. 9 c, d).
Voucher specimens: Shabaka_May2020_COND_Acci_AQ.

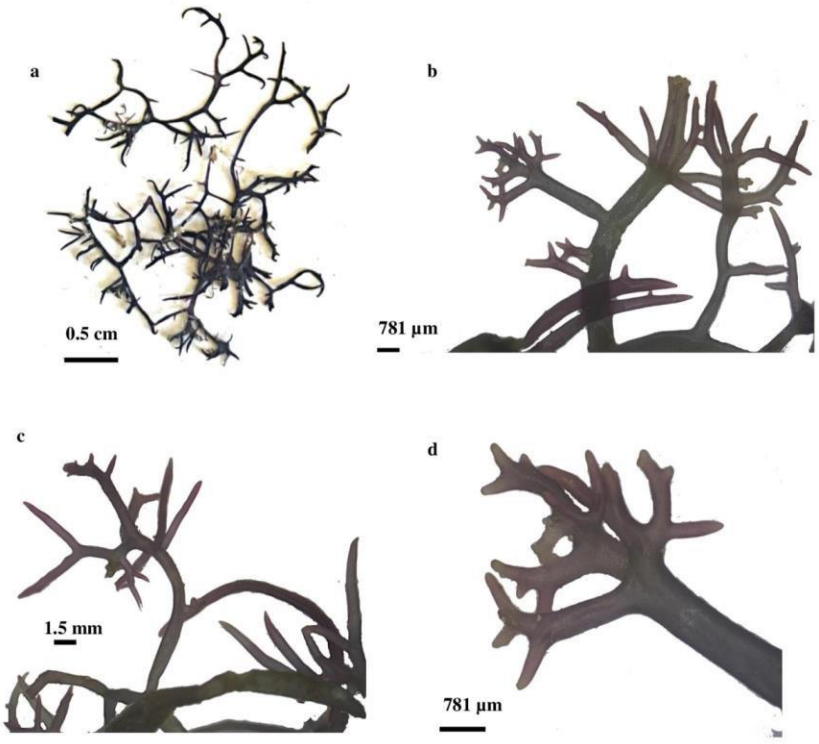

Fig. 9. *Chondracanthus acicularis* a) Habit of a plant, b) Details of the cylindrical branches, c) Side branches with acute apex, e) Details of a fertile branch

DISCUSSION

Abu Qir Bay has been recognized as a rocky plate surrounded by lagoons, which consist of chains of natural rocks with numerous tiny and fine pores that created ideal surfaces for algae attachment, resulting in outstanding biodiversity **(Khalil & Al-Taweel, 1982; Khalil *et al*., 2020)**. The current work reported several seaweeds species during the

period between 2020 and 2022. But since 2023, the substantial human encroachments have resulted in the disappearances of most species, except for several *Ulva* species that have been documented in our previous study **(Ibrahim *et al*., 2024)**.

Family: Codiaceae

The green algal genus *Codium* is among the largest genera, encompassing a total of 139 species at present **(Guiry & Guiry, 2024)**. According to **Stackhouse (1797)**, the genus *Codium* is distinguished by spongy fronds and stacked utricles. *Codium* exhibits phenotypic plasticity with varying thallus morphology, rendering it difficult to delineate due to the limited information of their morphological aspects and geographical distribution **(Verbruggen *et al*. 2007; Lee & Kim, 2015)**. *Codium* has been extensively studied for physiology, pollutants accumulation, pharmaceuticals, and bioactive compounds **(Lee *et al*., 2017; Kim *et al*., 2019, 2021; Muha *et al*., 2019; Carneiro *et al*., 2020; Monmai *et al*., 2020; Ahn *et al*., 2021; Meinita *et al*., 2022)**. This wide application of *Codium* spp. may result in unverified data. Six species are currently recognized for the Mediterranean Coast of Egypt: *C. bursa*, *C. decorticatum*, *C. effusum*, *C. taylorii*, *C. tomentosum*, and *C. vermilara* **(Aleem, 1993)**.

***Codium decorticatum* (Woodward) M. Howe**

This species was observed from late summer to autumn. **Aleem (1993)** reported polymorphic specimens along the beaches of Alexandria with different sizes, exhibiting both sparsely and densely branching fronds. According to **Nasr (1940a)**, *C. decorticatum* (as *C. elongatum*) identified from Alexandria shores, had three distinct features, the great length of their thallus; the wide angle of dichotomy; and the size of their utricles (900 to 1000µm long and 200 to 400µm in diameter).

***Codium effusum* (Rafinesque) Delle Chiaje**

This species was reported from late summer to autumn. It has been described by **Aleem (1993)**, where it was collected from Abu-Qir Bay. According to **Aleem (1993)**, the habit of this species resembles *C. adhaerens*, with thick and flat thallus having a few or no proliferations.

***Codium taylorii* P.C. Silva**

This species was observed from late summer to autumn. It has been reported previously in Alexandria **(Aleem, 1993)**.

***Codium vermilara* (Olivi) Delle Chiaje**

This species was observed from late summer to autumn. **Aleem (1993)** has recorded this species in Alexandria.

Family: Caulerpaceae

***Caulerpa cylindracea* Sonder**

This species was sparsely reported from late summer to autumn. **Aleem (1992)** reported *C. racemosa*, for the first time, along Alexandria shores. Three varieties of *C. racemosa* have been reported in Alexandria *C. chemnitzia* (Esper) J.V.Lamourouxi (as *C. racemosa* v. *occidentalis* (J.Agardh) Børgesen), *C. chemnitzia* v. *turbinata* (J.Agardh) Fernández-García & Riosmena-Rodríguez (as *C. racemosa* v *turbinata* (J.Agardh) Fernández-García *et* Riosmena-Rodríguez), and *C. racemosa* v. *lamourouxii* f. *requienii* (Montagne) Weber-van Bosse **(Shafik & Manawy, 2008)**. However, the specimens examined in the current study agree well with the general aspects of *C. cylindracea* **(Verlaque *et al*., 2003; Belton *et al*., 2014)**.

Family: Dictyotaceae

Padina Adanson is identified based on several features, such as the thickness in different portions of the thalli and cell layers, calcification pattern; hairlines on the thallus surfaces; occurrence and position of sori on surface of the blade; the presence or absence of an indusium **(Allender & Kraft, 1983; Riosmena-Rodriguez *et al.*, 2009; Win *et al.*, 2010; Díaz-Martínez *et al*., 2016)**. 59 accepted species of *Padina* have been reported worldwide **(Guiry & Guiry, 2024)**. Seven species were confirmed in the Mediterranean Sea; *P. boryana* Thivy, *P. boergesenii* Allender *et* Kraft, *P. ditristromatica* Ni-Ni-Win *et* H.Kawai, *P. gymnospora* (Kützing) Sonder, *P. pavonica* (Linnaeus) Thivy, *P. pavonicoides*, and *P. tetrastromatica* Hauck **(Ni-Ni-Win *et al*., 2011, 2021; Pagana *et al*., 2023)**. Among them, *P. boryana* and *P. pavonica* **(Aleem, 1993)** were reported in Egypt.

***Padina boryana* Thivy**

Sporophytes were reported in early spring. This species has been recorded in a few locations along Alexandria beaches **(Aleem, 1993)**.

Family: Scytosiphonaceae

***Petalonia fascia* (O.F.Müller) Kuntze**

It was observed firmly attached to rocky substrata in both exposed and calm regions from late winter to spring. This species has been reported from several locations along Alexandria coast **(Aleem, 1993)**.

Family: Bonnemaisoniaceae

***Asparagopsis taxiformis* (Delile) Trevisan**

Young gametophytes were collected in summer. **Aleem (1993)** has reported gametophytes and tetra sporophytes (*Falkenbergia* phase) in Alexandria.

Family: Gelidiaceae

***Gelidium crinale* (Hare ex Turner) Gaillon**

This species was firmly attached to rocks in spring and early summer. It is widespread in Alexandria **(Aleem, 1993)**.

Family: Cystocloniaceae

***Hypnea musciformis* (Wulfen) J.V.Lamouroux**

It was found entangled with the red alga *Pterocladiella capillacea* on rocky substrates from late winter to spring. It has been reported previously in Alexandria **(Aleem, 1993)**.

Family: Gigartinaceae

***Chondracanthus acicularis* (Roth) Fredericq**

This species was reported in spring and early summer. **Aleem (1993)** observed this species in Alexandria as *Gigartina acicularis.* Previous records indicate the presence of endangered species along the Alexandrian coastline. This situation urgently requires intervention to safeguard macroalgal biodiversity. Conducting studies, such as the current one, to identify endangered species and to define protected areas is a crucial measure for protecting macroalgal biodiversity. This should be coupled with implementing laws and regulations that protect the marine environment, raising public awareness about the importance of biodiversity and the need for its preservation, continuously monitoring the marine environment and measuring water pollution, and developing plans for the rehabilitation of affected areas.

CONCLUSION

This study has documented some significant seaweed species thriving in the coastal city of Alexandria, specifically in Abu Qir Bay. Noteworthy for its distinctive rock formations, Abu Qir Bay has long been recognized by its rich and diverse macroalgae population. Unfortunately, the invaluable biodiversity reported previously and in the current work has since been lost due to extensive construction activities that reshaped the

landscape of the Abu Qir area. The removal and flattening of the rock formations have irreversibly altered the ecological balance that sustained these precious macroalgae species (Fig. 10). It is crucial to recognize the critical importance of preserving our natural habitats and ecosystems that are facing the rapid urbanization and development, and prioritize conservation efforts to safeguard the remaining biodiversity that enrich the region. Additionally, raising awareness about sustainability challenges and strengthening laws that support species conservation are crucial.

Fig. 10. The sampling site in Abu Qir Bay **(a)** in 2021, **(b)** in 2023.

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الملخص العربي

يعد الحفاظ على التنوع البيولوجي للطحالب الكبيرة في النظم البيئية المائية أمرًا بالغ الأهمية لاستقرار هذه النظم. يُعتبر توثيق الأنواع المهددة بالانقراض الخطوة الأولى نحو فهم وحماية الأنواع المعرضة للخطر، وتحديد التهديدات التي تواجهها، وتنفيذ تدابير الحفاظ الضرورية للحفاظ على التنوع البيولوجي وصحة النظام البيئي. وثق العمل الحالي وقدم وصفًا مورفولوجيًا مفصلًا لبعض أنواع الطحالب البحرية الهامة التي تزدهر في مدينة الإسكندرية الساحلية، وتحديدًا في خليج أبو قير، الذي اشتهر منذ فترة طويلة بتنوعه الغني من الطحالب الكبيرة. تم تسجيل عدة أنواع من الطحالب البحرية خلال الفترة ما بين 2020 و2022، بما في ذلك: الطحالب الخضراء *Codium decorticatum*، *C. taylori*، *C. vermilara*، *Caulerpa cylindracea*، والطحالب الحمراء *Asparagopsis taxiformis*، *Chondracanthus acicularis*، *Gelidium crinale*، *Hypnea musciformis*، *Petalonia fascia*، والطحلب البني *Padina boryana*. ومع ذلك، فمنذ عام 2023، فقد التنوع البيولوجي الثمين الذي تم تسجيله سابقًا بسبب أنشطة البناء المكثفة التي غيرت معالم منطقة أبو قير، باستثناء عدة أنواع من طحالب *Ulva*. إن الاعتراف بالأهمية الحاسمة للحفاظ على الموائل الطبيعية في مواجهة التوسع الحضري، وتحديد أولويات جهود الحفاظ، ورفع الوعي بتحديات الاستدامة، وتعزيز القوانين التي تدعم الحفاظ على الأنواع، هي خطوات أساسية لحماية التنوع البيولوجي وضمان مستقبل مستدام.