SYNOPSIS of BIODIVERSITY and DISTREBUTION of MACROPHYTES along the SUEZ CANAL in TIME and SPACE

M.S. FARGHALY *and G. A. El-SHOUBAKY **

Abstract : The large project of the new Suez Canal ,started by August 2014 will change many aspects in its characteristics especially the biological .We need to establish a picture of the existing fauna and flora , in order to build a base line on which we can follow any possible changes .(fig.1)

Development of the physiognomy and Hydrography along the Suez Canal had been occurred during the last 20 years specially in the Northern part. (fig.2)

The marine vegetation of the Eastern branch North of the Suez Canal with the new container Port was the object of intensive investigations 2000/2011 ; 100 taxa of seaweeds,20 of Blue-greens and 3 Sea-grasses had been collected.This contribution helped us to complete a good Knowledge about the macro-phytes inhabiting the canal as well as an expectation of a future role in migration between the Red Sea and the Mediterranean .

We could have a final figure of the Suez Canal benthic flora as a conclusion of 30 years investigations on the Marine flora of the Suez Canal region .

Discussion and analysis with the previous works on these major benthic primary producers illustrates a good speculation and best understanding of the development of the flora in time and space .

Our list from the Northern branch added some 40 species to the previous recorded Macro-phytes from the Suez Canal .

We present hereby our vision on the diversity and distribution of these plants through 4 eras in 5 different Eco-zones.

Keywords : *Biodiversity, Blue greens, Seagrasses , Seaweeds, Suez Canal..*

I . INTRODUCTION

Thirty years passed , of Marine Botany researches and investigations in the Suez Canal University on the Marine flora of the Red Sea , Eastern Mediterranean and the Suez Canal . The remarks of Farghaly 1985 [6] was the first outcome reporting on the marine vegetation and describing 4 different sectors of the renewed canal , reporting 105 species . Tow of the team , I. El-Manawy and G. El-Shoubaky with M. S. Farghaly had concentrated since 1985 on the Macro-phytes , and added many scientific publications on their environmental and distributional patterns as in [3], [4] , [5] , [6] ,[7] and [15] .

The Suez Canal had been the subject of colonization by Macro-phytes since its opening in 1869 . The first record (8 species) was 1908 by Mushler [13] . The Cambridge Expedition 1924 , collected 25 species ,identified by Rendle and Lyle , published in Roy 1926 [14] .

Some additions by few species had been published occasionally,[6] and [3] . After the Israeli evasion of the Suez Canal 1967 , Lipkin published 1972 an addition of 45 species to the list .

During the last 30 years we focused on the seasonal Diversity , phyto-sociology , Eco-physiology and Utilization of Seaweeds and Seagrasses along the canal raising the records to128 [3] at the end of the 20th Century.

Following the construction of the Eastern branch of the Northern part gave us a picture of the colonization of new substrates by Seaweeds . Moreover we had encountered the disappearance and reappearance of some species in time and space . We now arrived to an estimation of about 123 Taxa of permanent Flora inhabiting this part of the canal .

By 2015, today we can find about 200 species along the Suez Canal of Macrophytes . These results helped in having a synoptic view on the Spatial and Temporal Diversity of Macro-phytes in the Suez Canal system .

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(fig.1)

(fig.2)

(fig.3)

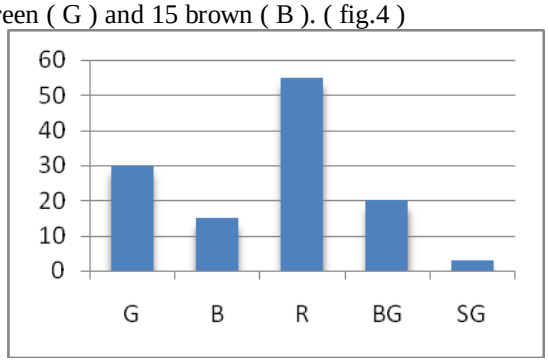
II . METHODS

Monthly investigations and seasonal collections by standard methods including dredging had been made in 5 sites with 20 stations respecting the different substrates in the Northern branch of the Suez Canal from Ras El Esh Northward to the canal entrance (about 10km each side of the branch).Identification and preservation of taxa made in the Marine Botany labs.and compared with reference collection and monograph descriptions . Slandered methods used , had been described in all our publications eg; [3], [4] , [5] , [6] and [7] .

Biodiversity was based on the analyses of all major previous records of the benthic flora and environmental conditions along the Suez Canal .Diversity estimation considered as ;the total number of species present as well as some index which incorporates both the number of species and the relative abundance of each.

III. RESULTS

During the period of study 123 taxa of marine macro-phytes were collected from the 2 branches of the Northern Suez Canal System ; 20 Blue greens (BG) , 3 Sea-grasses(SG) and 100 Seaweeds .Of the Seaweeds encountered ; 55 Red (R) , 30 Green (G) and 15 brown (B). (fig.4)



(fig. 4)

List of the Macrophytes in the Northern branch of the Suez Canal .

Green Seaweeds

Acetabularia calyculus Quoy et Gaimard
Bryopsis plumosa C. Agardh
Caulerpa mexicana Sonder ex Kutzing
C. prolifera (Fork.) Lamour
C. scalpelliformis (Brown) Agardh
C. sertularioides (Gmelin) Howe
Chaetomorpha area (Dillwyn) Kutzing
C. linum (Mull.) Kutzing
Cladophora albida (Huds.) Kutzing
C. patentiramea Montagne
C. prolifera (Roth) Kutz.
Cladophoropsis herpestica (Mont.) Houte
Codium tomentosum Kützing
Derbesia lamourouxii (J. Agardh) Solier
Enteromorpha clathrata (Roth) Grevile
E. compressa (Linn.) Kutzing
E. flexuosa (Wulf) Agardh
E. intestinalis (Linn.) J. Agardh
E. linza (Linn.) J. Agardh
E. prolifera Agardh
E. ralfsii Bilding
Halimeda tuna (Ellis et Sol.) Lannur
Neomeris annulata Dickie

Phaeophila dendroides (Crouan) Batters

Rhizoclonium kochianum Kutzing

Ulva fasciata Delile

U. lactuca Lamour

U. rigida C. Agardh

Valonia utricularis (Roth) C. Agardh

Brown Seweeds

Cystoseira myrica (Gmelin) C. Agardh
Dictyopteris sp.
Dictyota ciliolata Kützing
D. dichotoma (Hudson) Lamouroux
Ectocarpus elachistaeformis Heydrich
E. siliculosus (Dillwyn) Lyngbye
Feldmannia irregularis (Kützing) Hamel
Giffordia mitchelliae (Harvey) Hamel
Halopteris scoparia (Linnaeus) Sauvageau

Padina pavonica (Linn.) Thivy.
Pilayella litoralis (Linn.) Kjellman
Punctaria tenuissima (C. Agardh) Greville
Scytosiphon dotyi M.J. Wynne
Spatoglossum variabile Figari & De Notaris

Red Seweeds

Achrochaetum unifilum Levring

Asparagopsis taxiformis (Delile) Trevisan

Asterocystis ornata (C. Ag.) Hamel

Bangia fuscopurpurea (Dillwyn) Lyngbye

Centroceras clavulatum (C. Ag.) Montagne
Ceramium codii (Richords) G. Mazoyer
C. gracillimum (Harv.) Mazoyer
C. taylorii Dawson

C. tenuissimum (Mertens) Okamura

Champia irregularis (Zanardini) Piccone
C. parvula (J. Agardh) J. Agardh
Chondria dasyphylla (Wood.) C. Agardh
C.tenuissima (Good.Wood)C.Ag.
*Corallina tenella(*Kutzing)Heydrich
C. elongata Ellis et Solander
Dasya flocculosa Zanardini
Dermatolithon cystoseirae (Hauck) Huve
Digenea simplex (Wulfen) C. Agardh

Erythrotrichia carnea (Dillwyne) J. Ag.

E. reflexa (Cr.) Thuret

Fosliella farinosa (Lamouroux) Foslie
Galaxaura elongata J. Agardh

Gelidiella acerosa (Forsk.) Feldm. Et Hamel

Gelidium crinale (Tumer) Lamouroux

G. pusillum (Stack.) Le Jolis
G. pusillum (Stackhouse) LeJolis
Goniotrichum alsidii (Zanardini) Howe

Gracilaria arcuata Zanardini

G. canaliculata (Kutz.) Sonder

G. confervoides (L.) Grev.

Grateloupia filicina (Wulf.) Ag.

Herposiphonia tenella (C. Ag.) Ambronn
Heterosiphonia wurdemanni Falkenberg
Hypnea cornuta (Kutz.) J. Ag.
H. esperi Bory

H. musciformis (Wulf.) Lamour.

H. valentiae (Turner) Montagne

Jania adhaerens Lamouroux
J. pumila Lamouroux

J. rubens (Linnaeus) Lamour.

Laurencia obtusa (Hudson) Lamouroux
L. pinnatifida (Hudson) Lamour.
Leveillea jungermannioides Harvey
Liagora farinosa Lamouroux
Lomentaria irregularis Zanardini
Lophosiphonia obscura (C. Ag) Falkenb
Nitophyllum punctatum (Stack) Gerville
Polysiphonia variegata (Agar.) Zanardini
Porphyra umbilicalis (Linnaeus) J. Agardh

Pterocladia nana Kamura

Rhodymenia erythrea Zanardini

Sarconema filiformis (Sonder) Kylin

S. furcellatum Zanardini

Solieria dura (Zanardini) Schmidt
Spyridia filamentosa (Wulfen) Harvey

Blue Greens

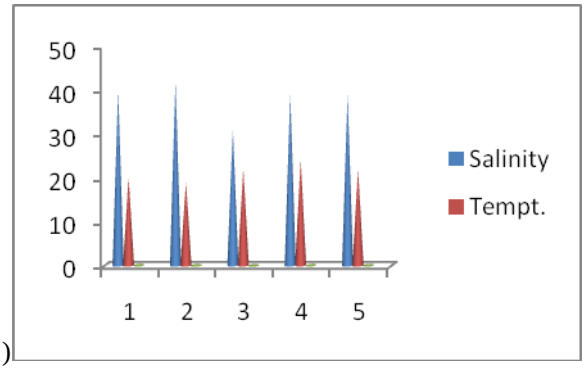
(The most common and recognized)
Aphanocapsa elachista
Brachtrichia balani
Calothrix aeroginae
C. contarina
C. fusco-violacea
C. scoparia
Chrococcus turjidus
Entophysalis granulosa
Gleocapsa atrata
G. crepidinum
G. minuta
Lyngbya aesturi
L. confervoides
L. majuscule
Merismopedia minima
Oscillatoria geminate
O. limosa
O. nigroviridis
Plectonema batersii
Spirulina subsalsa

Seagrasses

Cymodocea major (Caval) Grand
= *C . nodosa* Asch.
Halophila stipulacea (Forsskal) Ascherson
Posidonia oceanic (L,) Delile

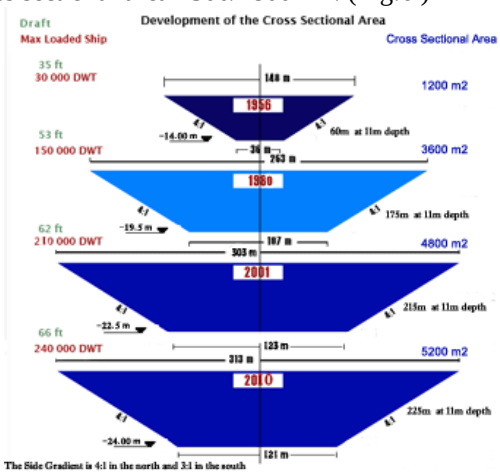
IV Discussion

Tow major factors control the distribution of Macrophytes in the Suez Canal; Salinity and Temperature . Consulting about 20 research works we arrived to the following speculation in the 5 different parts of the Suez Canal . (fig. 5)



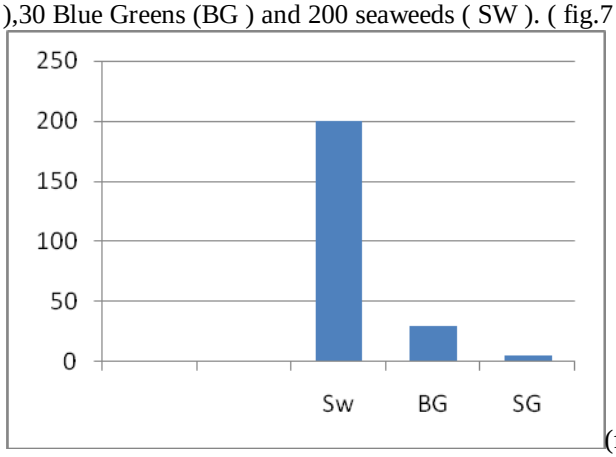
(fig..5)

. The actual canal became until August 2014 much more developed than when opened in the 19th century . Its overall length became (193 km) ,length of double parts (68 km) ,width of water level 300/365 m, canal depth about 25 m and cross sectional area 4500/4800 m2. (fig.6)



(fig.6)

The present flora of the benthic Macro-phytes in the Suez Canal system comprises about 235 taxa ;5 sea-grasses (SG),30 Blue Greens (BG) and 200 seaweeds (SW). (fig.7)



(fig.7)

V. Conclusion

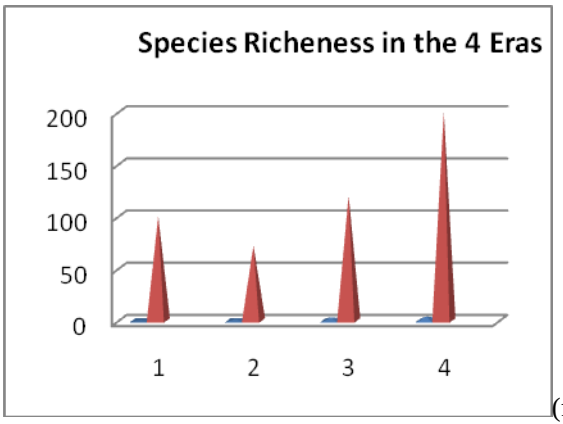
We can recognize 4 periods (Eras) passed the Marine Macro-phytes in the Suez Canal in 145 years according to the publications and observations which had been registered by different authors:

1- 1869 to 1956(Settlement and establishment era) [8][9][12][13]

2-1956 -1975(Turbulent & Disturbance era) [1][10][11]

3-1975-2000 (Restoration & Developing era) [2][3][4][5][6][7]

4-2000-2012 (New Progressive era especially in the North



(fig.8)

The marine biota in the canal had been suffered so much after the Israeli military invasion 1967 , closure 8 years , before the liberation in 1973 and cleaning in 1975 .

The 5 Eco-zones from the Red Sea to the Mediterranean;

1-southern (No inland water contribution and far from any domestic activities Dominance of Indo-Pacific species about88%)

(fig.9)

2-Bitter Lakes (Some agricultural effluents –regular ships transit- Electric Power plant cooling – high evaporation rates in Summer -Indo-Pacific species about 65%- well developed Sea-grass beds –presence of *Ruppia maritime*)

(fig.10)

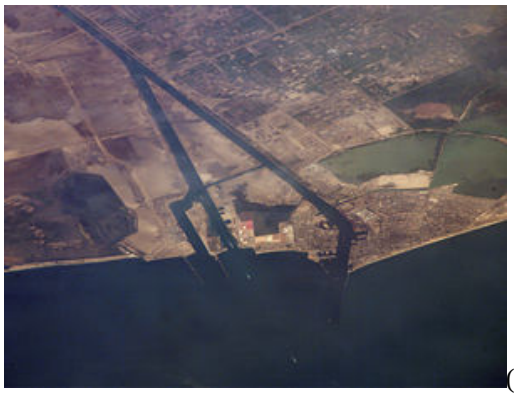
3-Timsah (Semi estuarial conditions with high rate of agricultural and domestic waste waters from lateral lagoons and fresh water canal – occasional anchoring – almost 20 species of Blue greens)

(fig.11)

4-Sub-Northern (longest part of the canal with 10 km double way – no transiting and no addition of inland water -with slight dominance of Indo-Pacific species) **. (fig. 12)**

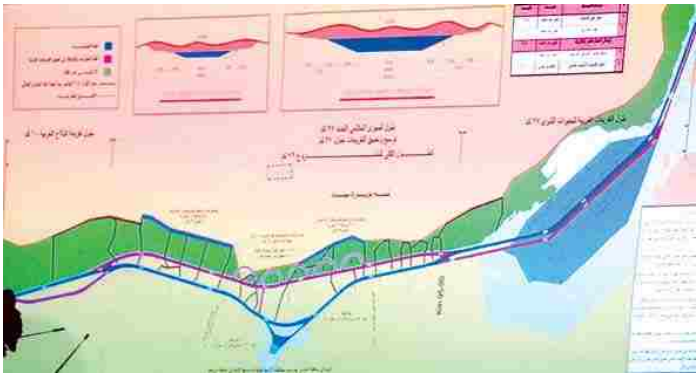
(fig,12)

5-Northern Branch (Tow Ports in and populated city- high water circulation – high shipping activities –small coactions with lake Manzlah polluted waters – dominance of Mediterranean species) (fig.13)



(fig.13)

SISI_GYPTIAN MIGRATION and FUTURE PROSPECTS FOR THE MACROPHYTES IN THE NEW SUEZ CANAL (AUGUST 2015……)



(fig.14)

A new substrates will be ready to host many species of the canal flora to inhabit the virgin 35 km added with about 5.4 % more water . As primary producers and base of nutrition thy will establish new communities and habitats to economic animals . (fig.14)

Water circulation will changes allover the canal system giving opportunity to new distribution especially in the 70kms north of the Bitter Lakes .

Development of the canal area will change the hydrographic conditions and affect the biological patterns of distribution , therefore we have to be ready to follow these changes positively .

About 18 species of native Seaweeds reported to be of economic value could give the base of Algo-culture in the Great Bitter lake .

Some hot spots along the canal has to be well monitored and plans of restoration must be ready for any accidental changes .

Salt marsh plants in the canal region had been studied in our laboratories ; some are promising as sea water irrigated crops .

Migration of marine organisms is a biological must spatial and temporal . Many migrant Macro-phytes had been incorporated within the new home adding and contributing to the ecosystems .Some had an impact on the native biota in limited areas and within temporal changes in the environmental conditions .

During the life span of the Suez Canal 145 years about 22 species of Macro-phytes had passed from the Red Sae to the Mediterranean and 4 species only succeeded to take the opposite way .

We have to differentiate between migration , introduction and invasion. About 87 Seaweeds are known as exotic in the Mediterranean. The analysis of that list showed that :

1- Some Seaweeds of Indo-pacific origin ,eg; (*Acanthophora nayadiformis, Asparagopsis taxiformis, and Ulva fasciata).* had been recorded from the Mediterranean before the opening of the canal in 1869 . Marc Verlaque (©ciesm 2009) .

2- Out of about 87spp of Indo-pacific origin reported as exotic ;
   - 20% had not been recorded in the Suez Canal,.
   - 30% of the records were depending on few records or single locality ,or on known way of introduction . So it is not a well established migrant to the Mediterranean .
   - 15% are not Red Sea algae , *Chorda filum* , *Undaria pinnatifida* , *Saccharina japonica* , *Sargassum muticum* ,
   - 27 % of Atlantic origin as well as Indo-Pacific ; eg. *Pylaiella littoralis* , . *Cladosiphon zosterae* , *Halothrix lumbricalis* , *Leathesia difformis* ,*Punctaria tenuissima* , *Desmarestia viridis* , *Asparagopsis armata* , *Bonnemaisonia hamifera* , *Anotrichium okamurae* , *Feldmannophycus okamurae* , *Antithamnion nipponicum* , *Antithamnionella boergesenii* , *Dasya sessilis* , *Herposiphonia parca* , *Polysiphonia morrowii* , *Pterosiphonia tanakae* , *Ulva pertusa* , *Ulvaria obscura* .
   -

3- So the possible migrants via the canal could be 22 species only .

4-

A new era starting August 2015 by adding a bypass , doubling the canal navigation channel .

The New addition to the Suez Canal 37 Km sand excavation , 70 Km dredging , addition of about 5.4% water mass to the Canal .

The Marine Botany team has made important contributions to protecting and improving the marine environment, as well as helping to implement good marine policy in the region .

We have to have a new prospects and programs gaining this opportunity to satisfy our curiosity for bitter understanding of the dynamic biology in the most famous canal in the world (The Suez Canal) .

Marine plant herbaria is a national and international heritage as well as a bank of gens .Specimens of Marine Macro-phytes collected by the team and their students , during 30 years ,from the Suez Canal , Red Sea and Eastern-Mediterranean need to be incorporated in a National or International reference Herbarium .

Observations ,conclusions and results giving illustrations about the Natural History and Biodiversity of Macro-phytes in the Northern Indian Ocean and Red Sea is ready to be published .

Efforts had been made in preparing a book on the Marine Flora of the Old Suez Canal for the canal authority , waiting to be published .

Finally the Suez Canal added to the geographical map in the 19th century . considered as an artery for the navigation and trades . It will be of great value for the national and international economy after the Egyptian bypass operation.

The Diversity of the Indo-Pacific originated biota in the Suez Canal , changed in Time and Space , merits to be well conserved and developed by generations.

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