Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.7, No.22, 2017

Growth Rate Evaluation of the Alcyonacean Soft Coral Sinularia polydactyla (Ehrenberg, 1834) at Hurghada, Northern Red Sea, Egypt

TAA MOHAMMED[1 (*)] MM EL-KOMI[2] FM SHOUKR[3] MAH EZZ EL-ARAB[1]
1.National Institute of Oceanography & Fisheries (NIOF), Hurghada, Red Sea, Egypt
2.National Institute of Oceanography & Fisheries (NIOF), Alexandria, Egvpt
3.Zoology Department, Faculty of Science, Tanta University, Egypt

Abstract
Growth rate of *Sinularia polydactyla* has been studied to determine the changes of surface area using 2D method as modified method for measuring growth increasing. The measurements indicate to that restricted and slow growth rates in the big samples under the variable oceanographic conditions. Summer recorded the highest rates of growth. The mean growth rate of the biggest colonies recorded 51.83±4.90mm^2 while the small colonies recorded 20.8±6.25 mm^2 in summer. On contrary, autumn showed the lowest and restricted rates during. The annual growth reached 116.28±10.57 and 33.78±12.45mm^2/y in the big and small colonies respectively. The growth ratio in relation to the original colonies size appears to grow with a relatively faster ratio in the small colonies (9.73±1.62% with a range of 6.67-12.68%) than the elder one (5.79±0.34% with a range of 4.37-6.72%). The temperature changes, gonads and gametes maturation, sedimentation rates are major controlling factors affect the growth rates. ANOVA Bivariate correlation illustrated a positive relationship (without significant difference) between the growth and temperature (ºC) (at P=0.38 and R^2=0.62). By comparing the present study and the available growth data of *Sinularia* sp., we found that, the annual growth of *S. polydactyla* is higher (116.28±10.57 - 33.78±12.45mm^2/yr) than the previous studies.
Keywords: Growth Rate *Sinularia polydactyla*, Hurghada, Red Sea

1- Introduction

The presence and diversity of soft corals (Cnidaria; Alcyonacea) are from the most striking features of the Indo-Pacific coral reefs. Soft corals form calcareous skeleton in the form of free microscopic sclerites within fleshy tissue as internal support (Fabricius and Alderslade, 2001), concentrated in the gastrodermis of the polyps and feet of the colony, unlike the stony corals which form hard calcareous skeleton (Tentori, et al., 2004). Whatever, the soft corals are considered as a major space competitors for the hard coral forms and may cause necrosis due to the expulsion of zooxanthellae and prevention of larval settlement (Coll, 1992). The growth rate of family Alcyoniidae has been avoided due to the difficulties in the growth determination and due to the softness of the coral animal. Where, water flow induces expansion by corals and is one of the most important factors modifying cora morphology (Khalesi et al., 2007). On the other hand, most of the growth rate investigations are applied on the hard corals but recently a very few investigations that refers to or achieve the growth rate in the soft corals and other invertebrates.

There are very few investigations on the soft coral reproduction and many gaps in the knowledge of their coral biology in the Red Sea, especially with regard to the sexual reproduction. Mohammed et al., (2007) and Dar and Mohammed (2009) illustrated that, the growth rate increase in summer and decrease in winter due to the environmental conditions as temperature and salinity (during summer), gonads maturation and spawning (during winter).

Sinularia spp. are from the largest, most predominant and important soft corals inhabit reef corals which have a wide and better adaptive to the different specific conditions of light and location on the reef (Borneman, 2001), they have diverse locations and forms covering most shallow water areas with low flat, fingered and encrusting growth forms (Sammarco and Coll, 1987) depending on the large supplemental feedings of the deteriorate water or deleterious effects (Delbeek and Sprung, 1994) and depends on the Bacterio-plankton as food not on zooplankton (Kinsey, 1991). Fabricius (1995) studied the growth rate of the soft coral *Sinularia* on the mid- and the outer-shelf reefs of the Great Barrier Reef, using tagging colonies over 3.5 years. Where, *Sinularia* average radial growth reached about 0.5cm.yr^{-1}. He illustrated that, the general growth rate is slow over time in the indo-pacific reefs; while other species as *Dendronephthya hemprichi* has a fast growth in the Red Sea; however, Sinularia sp. grows with 9%±1.3SE in the healthy colonies (Fabricius et al., 1995). *Sinularia polydactyla* is one of the most prevalent soft coral species on the shallow coastal reefs in Hurghada. On the other hand, studies on the soft corals growth rates are lacking from the inshore reefs off the Red Sea especially Hurghada (Mohammed et al., 2009).

Khalesi *et al*. (2007) studied the specific growth rates (μ) of colonies of *Sinularia flexibilis* in response to water velocities. The growth measurements were done at biweekly intervals for 12 weeks, whilst the PVC plates containing the coral nubbins were weighed using the underwater (buoyant weight) technique. Specific growth rates (μ) were [low (3 cm s^{-1}), medium (7 and 11 cm s^{-1}) and high (15 and 19 cm s^{-1})] throughout 12 weeks and the observed differences in the mean μ during this period at the varying velocities were significant (ANOVA, $P < 0.05$; $R^2 \approx 0.97$). The maximum mean μ was 0.019 d^{-1} at a velocity of 11 cm s^{-1}. Generally, many physical and chemical factors affect the growth of the corals such as temperature, salinity, dissolved oxygen, sedimentation, turbidity and water motion (Loya, 1976; Bak, 1976; Bradbury and Loya, 1978; Bradbury and Young, 1980; Sheppard, 1982; Mc Cain *et al*., 1984; Benayahu, 1985; Kotb, 1996; Mohammed, 2003). Additionally, Vine (1986) reported that the sea water temperatures in shallow areas of the Red Sea were close to the optimum range for coral growth (25-29 ºC). Temperature is known to be the most important physical factor controlling the growth rate of corals (Baker and Weber, 1975), as well as the anthropogenic impacts (Cary, 1931). Recently, *S. polydactyla* enters the medical biotechnology field, where many bioactive material were discovered and extended from to be used as anti-allergic, anti-inflammatory, etc. The present study aimed to apply the changes in the surface area to study the growth rate of the dominant encrusting soft coral species *Sinularia polydactyla* by detection the changes on its dimensions and surface area. Moreover, correlate the environmental conditions which affect the growth rate.

2- MATERIALS AND METHODS

2.1- Areas of the Study:-

The present study focused the investigation in the coastal area, 5km north to Hurghada City facing the National Institute of Oceanography and Fisheries (NIOF) at latitudes of 27˚ 17' 13" N and longitudes of 33˚ 46' 43" E (Figure 1). This site is not affected by any human activities but is affected by sedimentation (Mohammed, 2003; Ammar and Mahmoud, 2004; Mohammed and Mohamed, 2005; Mohammed et al., 2009) throughout the transportation by the water current from the northward especially during winter due to the wind blow.

2.2- Physico-Chemical Parameters Measurements:-

Some physical factors, as temperature (ºC), salinity (‰), PH and dissolved oxygen (mg. l^{-1}) were measured as averages for one year at each site and were measured seasonally in the marine area off NIOF (at Al-Ahyaa Bay) using Hydrolab instrument (Model Surveyor 4, 1997). Seawater samples were collected and prepared for estimation of the nutrient salts (such as nitrate and nitrite) according to Mohammed (2003), using double beam UV-visible spectrophotometer (Camspec-M350).

2.3- Determination of the Growth Rate:-

The soft coral *Sinularia polydactyla* is one of the most common and abundant soft coral species at the studied site (Mohammed et al., 2009) belonging to family Alcyoniidae so it was chosen to measure and determine the growth rate using English *et al*. (1997) method which depends on the measuring of the colony surface area of most encrusting coral forms. This is due to the stability of the *Sinularia polydactyla* colonies. The surface area method is based mainly on the colony dimensions (width and length) to determine the surface area seasonally as an application of the increase in the colony size. Ten parts of colonies were cut with varied dimensions and divided into two groups (small and large parts). The small parts were ranged between 1.35-2.4cm length and 1.2-2.3cm width, while the big parts were ranged between 4.25-5.5cm length and 3.4-4.5cm width. Thus, the initial surface areas of the large colonies are ranged between 1615-2475mm^2 and the small colonies are ranged between 162-540mm^2 (Table I). The collected colonies should not be damaged or cut at their bases as it possible to avoid any infections or stresses on the coral colonies (Ellis & Sharron, 1999), and then each colony was fixed on a part of ceramic or plastic plates (Figure 2).

The collected samples were fixed either on hard substrate (as rocky substrate or plastic plates) using few epoxy glue material. After the colonies fixation, they were transferred and left in particular place in the field to avoid any stress. The dimensions (length and width) of each colony were measured seasonally in the field using SCUBA equipments and by crisscross ruler and calipers (Stephenson & Stephenson, 1933). Then by calculating the surface area, we can determine their growth rates at the different seasons (according to the growth shape of each colony according to English *et al.* (1997), as illustrated in the two diagrams of figure (3), in which figure (3a) is applied to some samples, takes the triangular shape-like and their surface areas have been calculated according to the following equation:

[Surface area = (Length X Width)/2].

The other figure (3b) is applied to the rest colony samples that take the rectangular shape-like, so the surface areas have been calculated as the rectangular area as follow: [Surface area = (Length X Width)]. All measurements are in mm-mm^2.

The recorded data were analyzed using the multivariate analysis using Bivariate Correlations procedure with their significance levels (at P=0.05) to determine the significant differences and the association between the growth rate and the different factors (such as temperature, salinity, dissolved oxygen, pH, nitrate and nitrite using SPSS 11 program). The Bivariate Correlations based on the rank order were used to define and visualize which factors affect the growth rate by whether direct or contrary proportion. The samples of *Sinularia* were identified as it possible to the nearest species according to the Great Barrier Reef Expedition (Macfadyen, 1936), Xeniidae of Red Sea (Gohar, 1940), Des Roten Meeres (Reinicke, 1995) and Soft corals and sea fans (Fabricius and Aldersdale, 2001) according to the shape and size of the internal sclerites or spicules (Figure 4), which are differed in their shape and sizes. Sclerites were obtained by dissolving soft coral tissues in 10% sodium hypochlorite (Benayahu *et al*., 2002). In addition to the sclerites; taxonomy depended on the presence or absence of the Siphonozooids among the Autozooids (Dimorphism); especially to differentiate between *Sarcophyton* and *Sinularia* genera (Thomson & Dean, 1931 and Versevldt, 1982), where, the colonies morphology act to differentiate and defining the genera.

3-Results

Colonies of *Sinularia polydactyla* are encrusting and densely lobed with varying lengths of imbricate knobs or finger-like lappets. The single colony may cover areas in square meters and may cover several centimeters across. In the near-shore water and mostly on the reef flat *S. polydactyla* are dominant and widely distributed and scattered in a variety of colors throughout the Red Sea. The colony is tough and hard, due to a dense mass of large spindle shaped sclerite in the colony anterior. Polyps are monomorphic, retractile, and small with short bodies and mostly white in color. Speculation of the polyp-bearing part of the colony shows the very long pointed spindles and clubs with a head showing a central wart and a zone of lateral warts.

3.1-Determination of Growth

Sinularia polydactyla possesses a restricted and slow growth rate during a year for the used fragment either for the big or the small samples (six samples of big size which ranged between 1615-2475 mm^2 and the four small samples which were ranged between 162-540 mm^2). The seasonal growth appear to be faster during the warm summer season than the remaining seasons (Table II), whereas the mean growth rate of the big colonies reached 51.83±4.90mm^2 (increase in the colony surface area fluctuated between 40-72mm^2) but the small colonies reached 20.8±6.25 mm^2 (increase in the colony surface area fluctuated between 9-38mm^2) followed by Spring season which recorded mean growth of 28.8±4.91mm^2 (for the big colonies) and 11.75±4.81mm^2 (for the small colonies). On contrary, the cold seasons (during winter and autumn) illustrated low and restricted rates of growth, which appeared to be stopped during autumn (Figure 5a). The mean growth for the big colonies reached 17.0±4.02mm^2 and 17.67±4.44mm^2 during winter and autumn respectively; while the small colonies recorded a little growth (1.5±1.5mm^2) during winter but during autumn did not possess any change in their growth. Finally, it is appeared that, the increased area of the big colonies is greater than the small ones especially in summer.

The annual growth rates of the big colonies appear to increase with higher rates than the small ones due to the high increase in area. However, the annual growth reached 116.28±10.57mm^2 and 33.78±12.45mm^2 in the big and small colonies respectively (Table III). Whereas the real growth percentage in relation to the original colonies size appear to grow faster in the small colonies than the elder one, where the percentage of the area increase in the small colonies reached 9.73±1.62% (with a range of 6.67-12.68%) and in the big and elder ones reached 5.79±0.34% (with a range of 4.37-6.72%) (Figure 5b). Generally, the small and younger colonies grow with relatively higher ratios, when compared to their original sizes, than the elder colonies.

3.2-Correlation between the Physico-Chemical Factors and Growth

The general growth rate in the four seasons appeared more sensitivities in autumn and winter to the cold weather, while summer appeared the maximum growth rates. It was indicated that, using ANOVA Bivariate Correlation procedure, there is a positive relationship between the growth rate and the temperature (ºC) (at $P=0.38$ and $R^2=0.62$) where, there is no significant difference using the Pearson Correlation. Another direct and strong positive relationship between pH and growth was obtained with a significant difference (at $p \leq 0.05$ and $R^2=0.95$) where its p-value reached 0.05 (Table IV and Figure 6). While salinity possesses a very weak correlation without any significant difference (at $P=0.8$ and $R^2=0.202$). On contrary, the dissolved oxygen illustrated an inversely relation (at $P=0.39$ and $R^2= -0.614$) which may affect negatively on the growth rate. Moreover, the Pearson Correlation illustrated a strong positive relation (but not significant) between the nitrate and growth rate, where ($R^2 = 0.903$) and p-value equal 0.09. Finally, a slightly weak positive correlation was obtained (Figure 6) between nitrite and growth rate ($R^2=0.45$ and p-value reached 0.55).

4-Discussion

The growth rate of family alcyoniidae was avoided due to the difficulties in the growth determination and due to the softness of the coral animal, and most of the growth rate investigations are applied on the hard corals. Determination and calculation of coral growth rates was done using many different methods depending on the nature of the organism, whatever, soft corals, hard corals, horny corals or sea anemones (eg., Bak, 1973 and Mitchell *et al*., 1993). However, the direct liner growth and Alizarin methods were done in the hard corals (eg.

Kotb 2001 and Mohammed et al., 2007). While, Mitchell *et al.* (1993) applied new method for measuring the growth rate of two gorgonians corals *Leptogorgia hebes* and *Leptogorgia virgulata* through the study of the annual periodicity. Moreover, Marschal *et al*., (2004) used another new technique to determine the age of the red coral *Corallium rubrum* colonies and another method for the sea anemone growth rate (Holbrook and Schmitt 2005). *S. polydactyla*, during the present study, is one of the commonest and the most frequent alcyonarian soft coral species (which have definite and stable shape) in the Red Sea especially in Hurghada as illustrated by Mohammed et al. (2009) so, we use the increase in surface area methods (English et al., 1997) as an application for growth rate in the selected soft coral species, due to its size and shape consistencies (Field observations). The surface area was measured using the product calculations of the colony dimensions (width and length) according to English et al., (1997), where it cut from the mother colonies in a rectangular shape-like due to its stability (in a form of encrusting shape). *S. polydactyla* is one of the most frequent and common species that, recorded the highest soft corals cover (8.08 %) and the studied site recorded the highest species diversity (2.4).

There are very few investigations were achieved on the growth rate of the soft corals especially on *Sinularia* sp. in the Red Sea. Where, the high growth rates of asexual reproduction were found in the Red Sea xeniid *Xenia macrospiculata* (Benayahu & Loya 1984), while the nephtheid *Litophyton viridis* shows high growth rates, ability to re-attach colonies and asexual propagation by runner formation (Tursch and Tursch 1982) and finally, the high potential for asexual propagation, fast growth rates characterize the nephtheid *Dendronephthya hemprichi* from the Red Sea (Fabricius *et al.,* 1995). Moreover, Fabricius (1995) studied the growth rate of the two common soft coral genera, *Sinularia* and *Sarcophyton* on the mid- and the outer-shelf reefs of the Great Barrier Reef, using tagging colonies over 3.5 years. He pointed out that, some colonies grow in fast rates but the other colonies are very slow. Khalesi *et al*. (2007) studied the specific growth rates (μ) of *Sinularia flexibilis* in response to water velocities and pointed out that, the water flow affect the growth and give inaccurate data.

In the present study, the average seasonal growth rate is relatively high in the warm seasons especially in the big colonies which reached the maximum value of increase in area (51.83±4.90mm^2) in summer, while the small colonies increased about 20.80±6.25mm^2 in the same season. On contrary, the surface area of the big colonies increased with a low rate (17.0±4.02mm^2) in winter, while the small colonies appeared to grow slowly with very small rates (1.5±1.5mm^2) in winter. This may be referred to the changes in the temperature degrees from summer to autumn and winter and the changes of some other physical conditions and agreed with Bradbury and Young (1980); Mc Cain *et al*. (1984); Benayahu (1985); Kotb (1996) and Mohammed (2003) who illustrated that the environmental conditions (Temperature, salinity and dissolved oxygen) could affect the coral growth. On the other hand, temperature is considering one of the most important factors that influence and control the growth rate of corals and their distribution, particularly in the Red Sea (Sheppard and Sheppard, 1991 and Mohammed *et al*., 2007). This was proven during the present study, where the slow growth may related to the decrease in dissolved oxygen which was illustrated inversely correlated at P=0.39 and R^2= -0.614, which may affect negatively on the growth rate

Vine (1986) mentioned that, the sea water temperatures in shallow areas of the Red Sea were close to the optimum range for coral growth (25-29 °C) in the warm season. So, the growth of *Sinularia polydactyla* is promoted and fast in summer (warm season) but it is almost very slow (in the big and elder colonies), restricted, crippled and approximately stopped (in the small and younger colonies) in winter and autumn (cold season). On the other hand, the slow growth especially in the big colonies during winter may be due to the devotion of a large part of colony energy and metabolism in the reproduction process rather than in growth (Mohammed et al., 2007). The animal exploits its energy in the formation of their gonads. So, most of year is being highly exploited during winter and autumn seasons in the formation of the gametes stages in *Sinularia polydactyla* (Slattery *et al.*, 1999). While during the spring and summer seasons, the highest growth rate may be referred to that, the animal had finished the gonad formation and gametes releasing. This agreed the findings of Slattery *et al*. (1999), Cornish *et al*. (2004) and Mohammed et al. (2007). Whereas Fabricius (1995) and Cornish *et al*. (2004) reported that, colonies of large sizes grew with higher rates than the small sizes for the alcyoniid corals as obtained in the present study illustrated that for the elder colonies which appeared to grow faster than the smaller ones.

By comparing the growth data of the present study and the available data of *Sinularia* sp., we found that, the annual growth rate of *Sinularia polydactyla* during the present study appeared to grow with higher rates (average ranging from 116.28±10.57mm^2/yr. to 33.78±12.45mm^2/yr. in the bigger and smaller colonies respectively) than Fabricius (1995) who found the length increase ranged between 0.6±0.5cm and 1.4±0.5cm/yr (Table V). On the other hand, the growth rate of Alcyoniids is very low rate compared to Scleractinian corals (Fabricius, 1995); where, the growth of *Stylophora pistillata* ranged between 5.89 and 6.86 mm/yr. and *Acropora humilis* between 6.83 and 7.42mm/yr (Mohammed et al., 2007). Benayahu (1982) illustrated that, nutrients affect the alcyoniids growth rate and have a wide range of physiological tolerance. During the present study there is no obvious effects for the nutrients especially nitrite on the growth rate. ANOVA illustrated that, there is no significantly differences between the growth rate and the physical oceanographic parameters with exception of pH which may affect the growth positively with significantly difference (at P=0.05) as it increase in summer by increasing pH-value.

Conclusion

- From the previous study we can concluded that, the growth rate of *S. polydactyla* is slow especially in winter and autumn in which the colonies affected by low temperature and gonads formation causing low growth rate, while in summer shows a reversible results with higher growth rates.
- Growth rate illustrated a positive correlation and relationship (without significant difference) with seawater temperature. While oxygen affect negatively the growth possession.
- The percentage of growth is relatively higher in the small colonies (in relation to the initial size) than the bigger colonies (in relation to the initial size).

References

Ammar MSA, Mahmoud MA. 2004. Distribution and monopolization by corals in the middle reef at Hurghada Research Station, Red Sea, Egypt. J. Egypt. Acad. Soc. Environ. (D-Environmental studies). Vol. 5 (2): 69-83.

Bak RPM. 1973. Coral Weight Increment in situ. A new method to determine coral growth. Marine Biology (20): 45 – 49.

Bak RPM. 1976. The growth of coral colonies and the importance of crustose coralline algae and burrowing sponges in relation with carbonate accumulation. Neth, J. Sea Res. Vol. 10 (3) :285–337.

Baker PA, Weber JN. 1975. Coral growth Rate: Variation with depth. Earth and Planetary science letters vol. (27): 57-61

Benayahu Y. 1982. Population dynamics of soft corals (Octocorallia, Alcyonacea) at the coral reefs of the Gulf of Eilat. Ph.D Thesis, Tel Aviv University (in Hebrew, English summary)

Benayahu Y. 1985. Faunistic composition and patterns in the distribution of soft corals (Octocorallia, Alcyonacea) along the coral reefs of Sinai Peninsula. Proceedings of the Fifth International Coral Reef Congress, Tahiti, Vol. 6

Benayahu Y, Loya Y. 1984. Life history studies of the Red Sea soft coral *Xenia macrospiculata* Gohar, 1940. I. Annual dynamics of gonadal development. Biol. Bull. (166): 32 – 43.

Benayahu Y, Yosief T, Schleyer MH. 2002. Soft Corals (Octocorallia Alcyonacea) of the Southern Red Sea. Israel Journal of Zoology (48): 273-283.

Borneman, E. (2001). Aquarium corals: husbandry, selection and natural history. Microcosm Ltd., Shelburne, Vermont, 464p.

Bradbury RH, Loya Y. 1978: A heuristic analysis of spatial patterns of hermatypic corals at Eilat (Red Sea). The American Naturalist, 112 (985): 493-507.

Bradbury RH, Young PC. 1980). The effects of a major forcing function wave energy, on a coral reef ecosystem. Mar. Ecol. Prog. Ser., (5): 229-241.

Cary LR. 1931. Studies on the coral reefs of Tutuila, American Samoa, with special reference to the Alcyonaria. Papers from the Tortugas Laboratory, Carnegie Institute of Washington (37): 53–98.

Coll JC. 1992. The chemistry and chemical ecology of Octocorals (Coelentrata, Anthozoa, Octocorallia). Chem. Rev. 92: 613-631.

Cornish AS, DiDonato EM. 2004. Resurvey of a reef flat in American Samoa after 85 years reveals devastation to a soft coral (Alcyonacea) community. Marine Pollution Bulletin. Volume (48): 768-777.

DAR, M. A. and Mohammed, T. A. A. (2009). Seasonal variations in the skeletogensis process in some branching corals of the Red Sea. Thalassas (An International Journal of Marine Sciences). Vol. 25 (1): 31-44.

Delbeek JC, Sprung J. 1994. The reef aquarium. Ricordea publishing, Coconut Grove, Florids, 544p.

Ellis SC, Sharron L. 1999. the Culture of Soft Corals (Order: Alcyonacea) for the Marine Aquarium Trade. Center for Tropical and Subtropical Aquaculture. Publication No. 137. Waimanalo, Hawaii, USA 73 pp.

English, S. Wilkinson, C. Baker, V. (1997). Survey manual of tropical marine resources. 2nd Edition, Australian institute resources, Townsville. 385 pp.

Fabricius KE. 1995. Slow population turnover in the soft coral genera *Sinularia* and *Sarcophyton* on mid-shelf and outer-shelf reefs of the Great Barrier Reef. *Marine Ecology Progress Series* vol. (126): 145–152.

Fabricious K, Aldersdale P. 2001. Soft corals and sea fans: A comprehensive guide to the shallow-water genera of the Central West Pacific, the Indian Ocean and the Red Sea. Australian Institute of Marine Science, Townsville, Australia. p. 264.

Fabricius K, Benayahu Y, Genin A. 1995. Herbivory in asymbiotic soft corals. Science (268): 90-92.

Gohar HAF. 1940. Studies on the Xeniidae of the Red Sea. Publ. Mar. Biol. Sta. Ghardaqa, Red Sea, Egypt vol. (2): 25 – 118.

Holbrook SJ, Schmitt RJ. 2005. Growth, reproduction and survival of a tropical sea anemone (actiniaria): benefits of hosting anemone fish. Coral reefs vol. (24): 67 – 73.

Khalesi MK, Beeftink HH, Wijffels RH. 2007. Flow-dependent growth in the zooxanthellate soft coral *Sinularia flexibilis*. Journal of Experimental Marine Biology and Ecology. vol. 106-113.

Kinsey DW. 1991. Can we resolve the nutrient issue for the reef? Search 22: 119-121.
Kotb MMA. 1996. Ecological and biological studies on the coral reefs at southern Sinai coasts, Red Sea, Egypt. Ph. D. Thesis., Faculty of Science, Suez Canal Univ., 174 pp
Kotb MMA, Abou Zeid MM, Hanafy MH. 2001. Overall evaluation of coral reef status along the Egyptian Red Sea Coast. Biol. Mar. Medit. Vol. 8 (1): 15-32.
Loya Y. 1976. Settlement, mortality and recruitment of a Red Sea scleractinian coral population. In G. O. Mackie (Ed.), Coelenterate Ecology and Behavior, Plenum press, New York. PP 89-100.
Macfadyen LMI. l936. Alcyonaria (Stolonifera, Alcyonacea, Telestacea and Gorgonacea). Scientific Report Great Barrier Reef Exped. Vol. 5(2): 19-71.
Marschal C, Garrabou J, Harmelin JG, Pichon M. 2004. A new method for measuring growth and age in the precious red coral *Corallium rubrum*. Coral Reefs vol. (23): 423 – 432.
McCain, J. C.; Tarr, A. B.; Carpenter, K. E. and Coles, S. L. (1984). Marine ecology of Saudi Arabia, a survey of coral reefs and reef fishes in the northern area, Arabian Gulf, Saudi Arabia. Fauna of Saudi Arabia, 6
Mitchell ND, Dardeau MR, Schroeder WW. 1993. Colony morphology, age structure, and relative growth of two gorgonian corals, *Leptogorgia hebes* (Verrill) and *Leptogorgia virgulata* (Lamarck), from the northern Gulf of Mexico. Coral reefs vol. (12): 65 – 70.
Mohammed TAA. 2003. Study of growth and reproduction of some corals at Hurghada region with reference to the effect of some pollutants in the area. Zool. Dept. Faculty of Science. Suez Canal University. 204 pp
Mohammed TAA, Mohamed MA. 2005. Some Ecological Factors Affecting Coral Reef Assemblages off Hurghada, Red Sea, Egypt. Egyptian Journal of Aquatic Research. Vol. 31 (1): 133-145.
Mohammed TAA, Kotb MMA, Ghobashy AFA, El-Deek MS. 2007. Reproduction and growth rate of two scleractinian coral species in the northern Red Sea, Egypt. Journal of Aquatic Research. Vol. 33 (2): 70-86.
Mohammed TA, Shoukr FA, El-Komi MM, Ezz El-Arab MAH. 2009. Distribution and diversity of alcyonacean soft corals and scleractinian hard corals in the northern Red Sea, Egypt. J. Egyp. German Soci. Zool. Vol. 58D: 67- 83.
Reinicke G. 1995. Xeniidae des Roten Meeres (Octocorallia, Alcyonacea), Essener Okologische Schriften, Band 6.
Sammarco PW, Coll JC. 1987. The chemical ecology and alcyonarian corals. Bioorganic Marine Chemistry (Springe-verlag, Berlin), 2: 87-116.
Sheppard CRC. 1982. Coral populations on reef slopes and their major corals. Mar. Ecol. Prog. Ser (7): 83-115.
Sheppard CR, Sheppard ALS. 1991. Corals and coral communities of Arabia. II. Fauna of Saudia Arabia, 12, 170 pp.
Slattery M, Hines GA, Starme J, Paul VJ. 1999. Chemical signals in gametogenesis, spawning and larval settlement and defense of the soft coral *Sinularia polydactyla*. Coral Reefs, vol. (18): 75 – 84.
Stephenson TA, Stephenson A. 1933. Growth and asexual reproduction in corals. Scient. Rep. Great Barrier Reef Exped. (3): 167 – 217.
Tentori E, Allemand D, Shepherd R. 2004. Cell growth and calcification result from uncoupled physiological process in the soft coral Litophyton arboretum. Marine Ecology Progress Series, 27E: 85-92.
Thomson JA and Dean LMI. 1931. Alcyonacea of the SIBOGA Expedition, with an addendum of Gorgonacea, vol. ($XIII_d$) 1-227.
Tursch B, Tursch A. 1982. The soft coral community on a sheltered reef quadrat at Laing Island (Papua New Guinea). Mar. Biol. Vol. (68): 321-332.
Verseveldt J. 1982. A Revision of the Genus Sarcophyton Lesson (Octocorallia, Alcyonacea), Zoologische Verhandelingen, No 192, Leiden, 91 pp.
Vine P. 1986. Red Sea invertebrates. Immel publishing, Ely House, 37 Dover St. London WIX 3 RB.

Table 1: The Dimensions and initial surface area of the used colonies

Category	Length (mm)	Width (mm)	Initial area mm^2
Average (n=6)	47.7±0.18	41.8±0.18	1999.2±132.6
Range (Big colonies)	42.5-5.5	34.0-4.5	1615-2475
Average (n=4)	18.4±0.27	15.3±0.29	336.5±96.39
Range (Small colonies)	13.5-2.4	12.0-2.25	162-540

Table 2: The seasonal growth rate of the big and small colonies

No. of colonies	Summer (mm^2)	Autumn (mm^2)	Winter (mm^2)	Spring (mm^2)
Mean	51.83±4.90	17.67±4.44	17±4.02	29.8±4.91
Range	40-72	0-28	5-32	11-42
Mean	20.8±6.25	0	1.5±1.5	11.75±4.81
Range	9-38	0	0-6	2-24.5

Table 3: The annual growth rate and the percentage increase in the colony area

Category	Big colonies (n=6)		small colonies (n=4)	
	Growth rate/yr	Area increase (%)	Growth rate/yr	Area increase (%)
Mean	116.28±10.57	5.79±0.34	33.78±12.45	9.73±1.62
Range	70.5 - 139.5	4.37 - 6.72	10.8 - 68.5	6.67 - 12.68

Table 4: Correlation of the physico-chemical factors and growth rate

		Temp. (ºC)	S (‰)	D.O. (mg/l)	PH	Nitrate (mg/l)	Nitrite (mg/l)
Growth Rate	Pearson Correlation	0.62	0.202	- 0.614	0.95	0.903	0.45
	P-value	0.38	0.8	0.39	0.05	0.09	0.55

Table 5: Comparison of the growth rate of *S. polydactyla* and the previous studies

Sinularia	References
0.6±0.5 - 1.4±0.5 cm/yr.	Fabricius (1995)
0.019 µ/day	Khalesi, et al. (2007)
0.92 cm/year	The present study

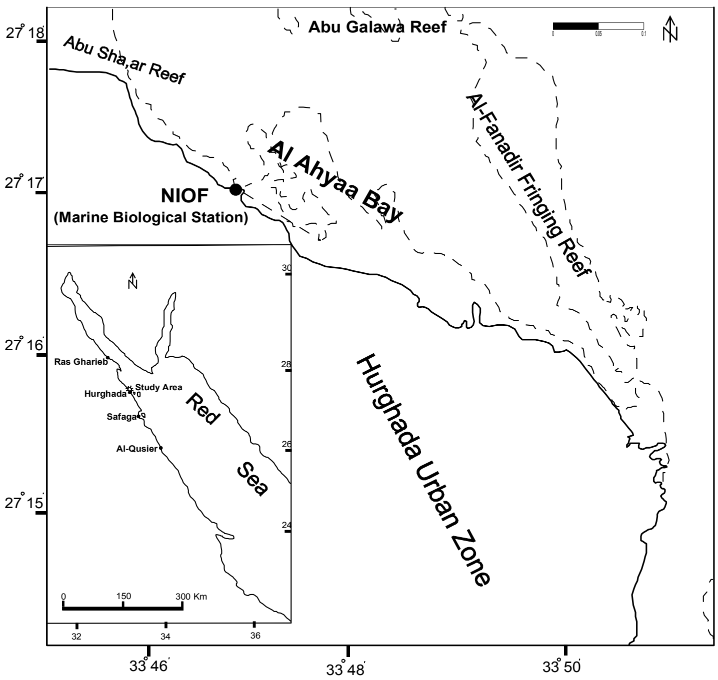

Fig. 1. Location map of the studied site north Hurghada.

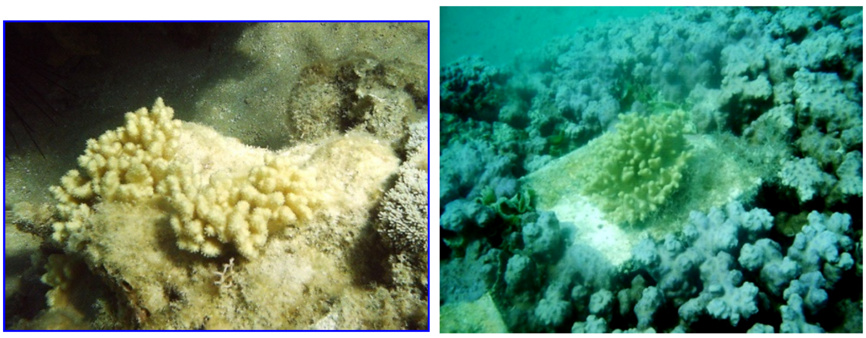

Fig. 2. The general view of fixed and measured colonies of *S. polydactyla*.

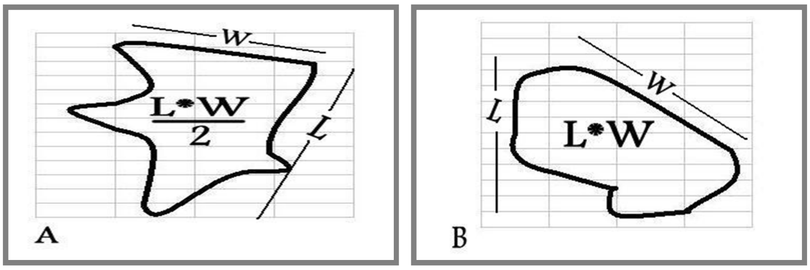

Fig. 3. The applied method of calculating the surface area of Sinularia colonies.

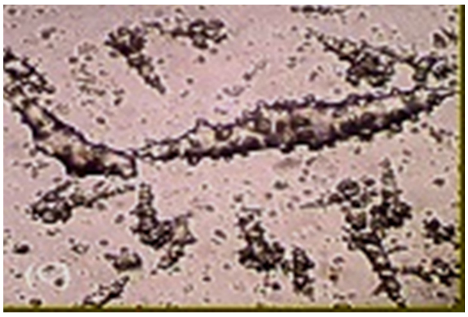
Fig. 4. The endoskeleton or sclerites of *Sinularia polydactyla*

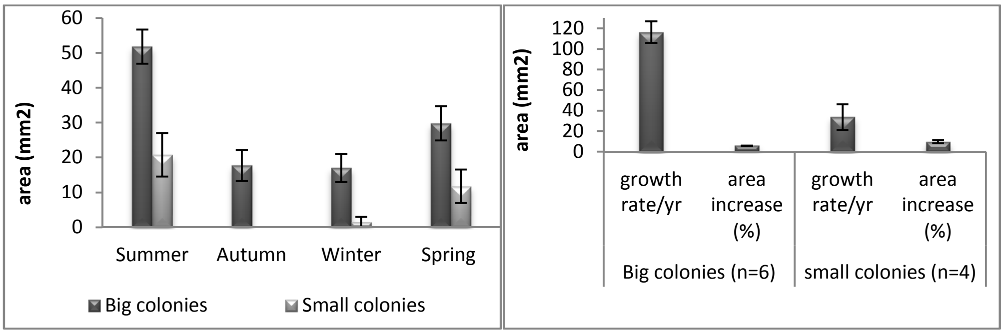

Fig. 5. The seasonal and annual growth rates with the percentage area invrease.

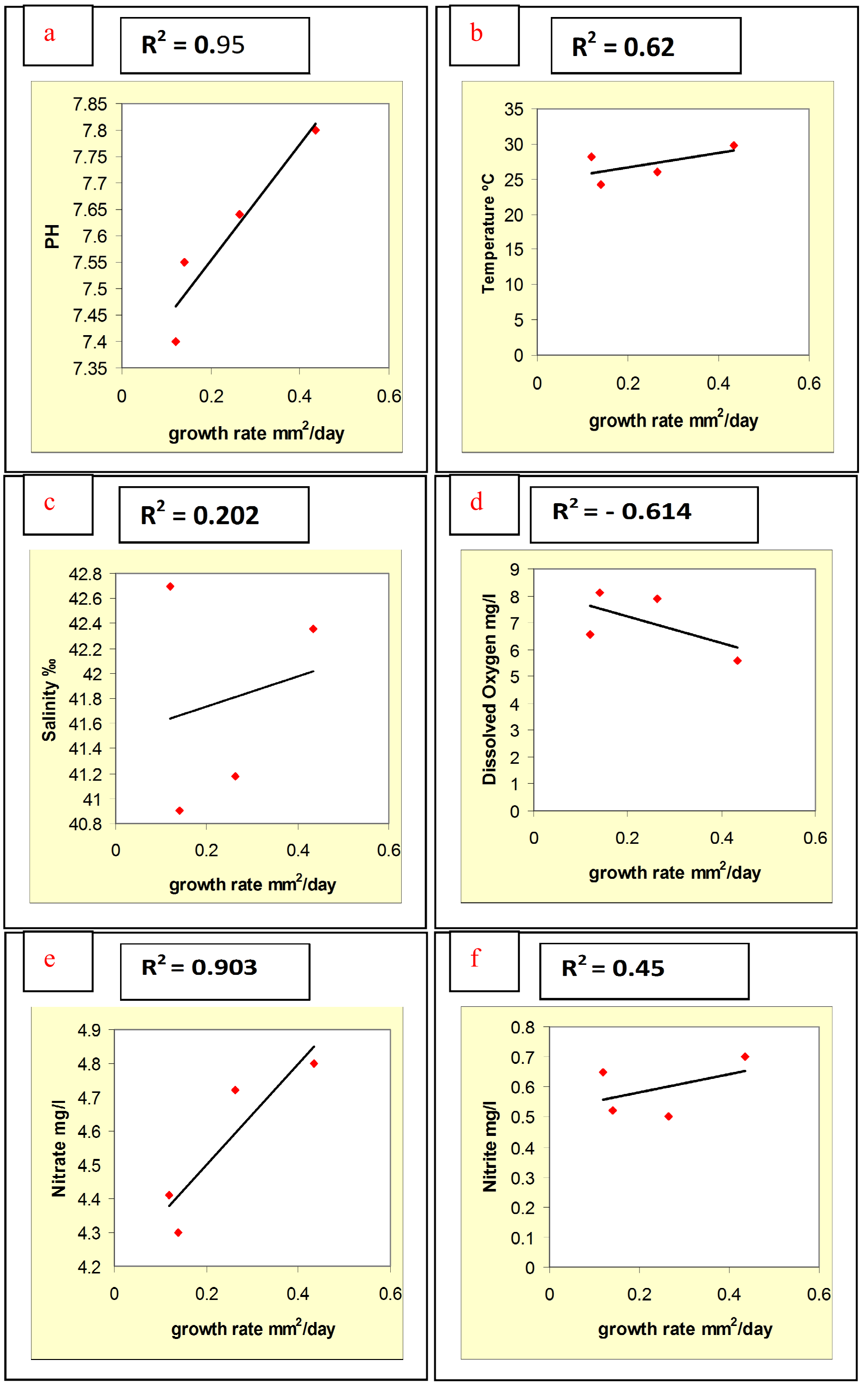

Figure (6): Correlation between the oceanographic parameters (a-d) and nutrient salts (e-f) with the growth rate of *S. polydactyla*.