



Geographical distribution of *Eunicella gazella* (Studer, 1878) (Alcyonacea :Octocrallia: Anthozoa:Cnidaria) in Atlantic West Africa: First record in Moroccan Atlantic coasts.

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Abstract

Octocorals gorgonians of Atlantic Moroccan coast are poorly studied. Despite his ecological role in marine ecosystems, the investigations about this zoological group are rare and limited to the north of the country where some species were cited. For example, *Eunicella gazella* Studer, 1878 (Alcyonacea: Anthozoa: Cnidaria) which was cited along the West African and South West European coasts (Portugal) was never recording in West Moroccan coast. Our investigations carried on Agadir bay (South West Moroccan coasts). They allowed us to identify for the first time a gorgonian *Eunicella gazella*, which was collected in 15m depth. This record expands the known geographical distribution of this octocoral gorgonian in Atlantic African coasts.

Key words: Agadir Bay - Anthozoa – Gorgonian – *Eunicella gazella* – Marine Biodiversity – Morocco.

1. Introduction

The subclass *Octocorallia* contains approximately 3200 species, 340 genera and 46 families [1, 2]. In sublittoral marine ecosystems, Gorgonian species, characterized by supporting axial structures and slow growth, are one of the best representative group of this subclass. Despite the benthic group's role and importance in maintaining of equilibrium of littoral ecosystems [3], this zoological group is still poorly studied in the different marine ecosystems habitat. While, intertidal invertebrates of the Moroccan coast have been studied in several localities [4, 5]. According to Grasshoff (1992) [6], in Northwest African littoral, this group is represented by 3 genera (*Leptogorgia*, *Eunicella* and *Filigorgia*) and 46 species. In Moroccan coasts, despite their richness, only 12 species were identified; probably because the research investigations are very rare in this zoological group. In fact, a few scientific expeditions explored the Atlantic shores of Morocco, are reserved an interest for gorgonian group (e.g. *Vanneau*, 1923-1926 and *CANCAP I*, 1976). Indeed, in the first expedition (*Vanneau*), a part of sampling was loosed because of a failing conservation [7]. While, in *CANCAP I* expedition, the investigations were conducted at bathymetric levels usually deeper than 50 m, and they were limited to only a few localities such as Essaouira- Safi, Tantan-Akhfenir, Eljadida and, Casablanca [6].

Our investigations began 5 years ago and carried on the octocorals gorgonians in Moroccan coasts in order to reactualize the knowledge of this zoological group (list of species, geographical distribution, etc.). In this paper, we focused our interest especially on the species *Eunicella gazella* well reported in Atlantic West African and

South Atlantic European coasts [6], but never recorded in Moroccan Atlantic ecosystems. In fact, according to Grasshoff (1992) [6], this specie exists from Angola to Portugal, except Morocco. The goal of our investigation is to confirm the presence or absence of this species in Moroccan shores and describe the morphology and variability of their local populations.

2. Experimental

To attempt the goals of this study, two representative localities were selected from Moroccan coasts, Agadir (9°39'1.08" W, 30°25'28.48"N) which is located in the middle of Moroccan Atlantic coast and M'diq (5°17'40.49" W, 35° 41' 9.56" N, north of Morocco) on the Mediterranean Sea.

In the Atlantic study locality (Fig. 1), three transects (3 x 200 m long) carried: natural substrate which presented by Aghroud (9°47'36.6"W 30°36'44.7"N), Taghazout (9°43'39.7"W 30°32'43.8"N), and artificial structure which presented by commercial harbour in Agadir (9°38'53.48"W 30°25'17.59" N). The two first sites are characterized by a sandy substrate with some dispersed rocky substrate. For the last site, which protects the harbor, is characterized by a high hydrodynamic due it exposition to the ocean and is composed concrete tetrapods submerged up to 12 m depth, followed by blocks of rocks up to 21 m depth with steep slope.

In different transects we verified the presence or not of the species. The 3 Atlantic colonies used for our systematic study was collected in the Commercial harbor.

On Mediterranean ecosystem, the colonies of *Eunicella gazella* were collected along two transects (2 x 200 m long) perpendicular to the coast line (Fig. 1). This study area comprised cliff zones until 14 meters in depth with a strong slope and characterized by the presence of boulders and blocks in deeper zones of the explored transect. For the systematic study, 2 whole colonies were collected.

The sampling was carried out by scuba diving in rocky marine habitats, between 5 and 20 m in depth. Collected colonies were kept in sea water and immediately transported to the laboratory where they were photographed by a Panasonic Lumix FZ28 and let dry to air, sheltered from the solar rays. A fragment of 1 cm of each colony was treated separately, with commercial bleach to digest the conenchyme tissue, and sclerites were later treated with hydrogen peroxide (H₂O₂) to eliminate resting organic material on their surface. Sclerites were rinsed several times with fresh water and mounted as permanent mounts using Aquatex®. Observation and photography of sclerites was performed with a camera (ToupCam™) attached to optical microscopy (Olympus CX41). The colony and sclerites was mainly based on Bayer et al (1983) [8] and Grasshoff (1992) [6].

3. Results:

3.1. In site observations:

In Agadir Bay, some whole colonies of *Eunicella gazella* were observed in Commercial Harbour between 8 to 11 meters depth. The colonies were attached solely on concrete tetrapods. At the depth 20 m the substrate becomes muddy and the visibility was limited.

In this ecosystem, *E.gazella* exists just in the artificial structure (Commercial harbour) where the colonies were fixed on breakwater. Only 3 colonies were collected by the transect. However, gorgonians appeared from 5m depth, their abundance is relatively low compared to other sites. In spite of biodiversity richness and the existing of others species of gorgonian, the other surrounding that consist of natural bedrock, no colonies of *E. gazella* were observed in surveys carried out from 0 to 15m depth. The both areas were characterized by the abundance of the genus *Leptogorgia* (e.g *Leptogorgia lusitanica* Stiasny, 1937, *L.viminalis* Pallas, 1766, etc.).

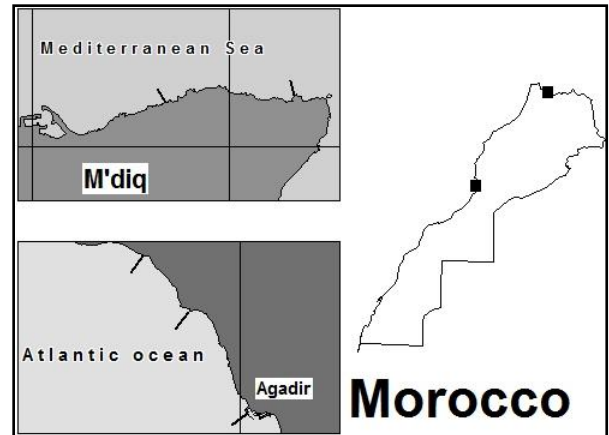


Figure 1: Map of studied area in Atlantic and Mediterranean ecosystems

In M'diq ecosystem, the species was present in the two site prospected. The two sites are constituted by 3 different habitats: 0 to 6 m depth, without gorgonian octocorals; 6 m to 15 m depth, with some gorgonians species such as *Eunicella singularis* Esper, 1791 and *Eunicella labiata* Thomson, 1927; and around 15 m depth, in which the substrate became horizontal, sandy and devoid of gorgonians. *Eunicella gazella* is distinctive gorgonians because of its growth form and color.

In the Mediterranean ecosystem, two colonies were collected along 2 transects of 200, both colonies were fixed on the boulders at 13 meters depth. This natural area was characterized by the abundance of the genera *Eunicella* from 6 to 15 m depth, especially *E. singularis* and *E. labiata* fixed on all types of rocky substrate. We considered that *Eunicella gazella* was rare compared to the others gorgonians.

3.2. Taxonomy and description of the species studied:

Class Anthozoa Ehrenberg, 1834
Subclass Octocorallia Haeckel, 1866
Order Alcyonacea Lamouroux, 1812
Suborder Holaxonia Studer, 1887
Family Gorgoniidae Lamouroux, 1812
Genus *Eunicella* Verrill, 1869

***Eunicella gazella* Studer, 1878**

Gorgonia furcata Studer 1878: 138 (Kapverden) – v; nom. Praeocc. : *Gorgonia furcata* Lamarck 1816; und *G.furfata* W.Koch 1886

Eunicella furcata, Studer 1879: 655, T. 4F. 22a-b

Eunicella gazella Studer 1878; 51; nom.nov. pro*G. furcata* Studer 1878

Eunicella gazella, Stiasny 1938 (c): 22, 1 F. 4 ("=*E.lata* oder *E.verrucosa* var. *stricta*").

(See Grasshoff, 1992 :36).

The description was carried on a colony collected in Agadir Bay. The colonies (Fig. 2-A) up to 220 mm wide and 180 mm high, planar growth form, irregularly dichotomous, densely branched, ramification in all directions (Fig. 2-B), angle branching about 90° (Fig. 2-C). Unbranched distal twigs cylindrical, 2.6 mm in diameter, varies from 8.2 to 28.2 mm in length, main stem 3.6 mm diameter at base. Internode length varies between 8 and 40 mm. Polyps with low calices, on all sides of branches, approximately 36 polyps per cm (Fig. 2-D). Colony and polyps white.

In the case of Mediterranean colonies (M'diq), the colonies shoed the same characteristics than the Agadir bay one (form of growth, ramification and size of colonies). However, we note some differences between the two populations in color, size and diameter of branches. In Mediterranean colonies, colony and polyps are white-yellowish. The branches of *Eunicella gazella* are thinner than those collected in the Atlantic ecosystem.

Our investigations are focused on sclerites because their importance in gorgonian species identification and systematic. Sclerites colorless (Fig. 3). Coenenchymal sclerite represented by two types: spindles and balloon club (club-shaped) (Fig. 3). Spindles (Fig. 4A-B-C) present the followed characteristics: fusiform, usually symmetrically sculptured, straight, curved form or budded, 131-270 µm long, 29-54 µm wide, with 6 or 8 whorls of warty tubercles, the ends blunt. Concerning Balloon club sclerite (Fig. 4D-E-F) characteristics, they are :87-142 µm tall, 29-63 µm wide, 2-8 whorls of warty tubercles. Our observations show three types of club-shaped: Short sclerites (Fig. 4D) (87-116 µm length and 29-53 µm width, thick portion with 2-3 whorls of warty tubercles, the end round) ;Sclerites short with trace of crack at the middle (Fig. 4F) (96-112 µm length and 40-63 µm width, thick portion budded with 2-3 whorls of warty tubercles) ;Sclerites long and thin (Fig. 4E) (136-142 µm length and 36-39 µm width, thick portion very warty 5-7 whorls of warty tubercles, the both ends pointed). Anthocodial rods were flattened with smooth warts (Fig. 4G), 117-127µm long.

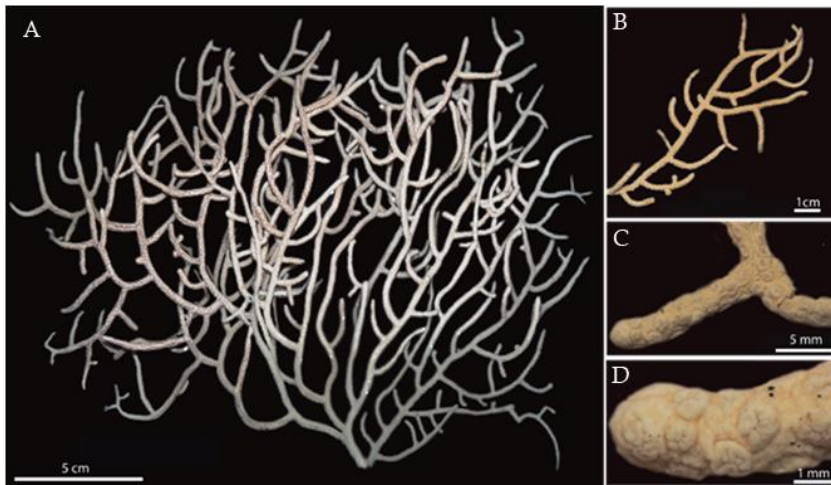


Figure 2: Colony of *Eunicella gazella* Studer, 1878. (A) Whole colony. (B) and (C) Details of branches ramification. (D) Distribution of polyps on a terminal branch.

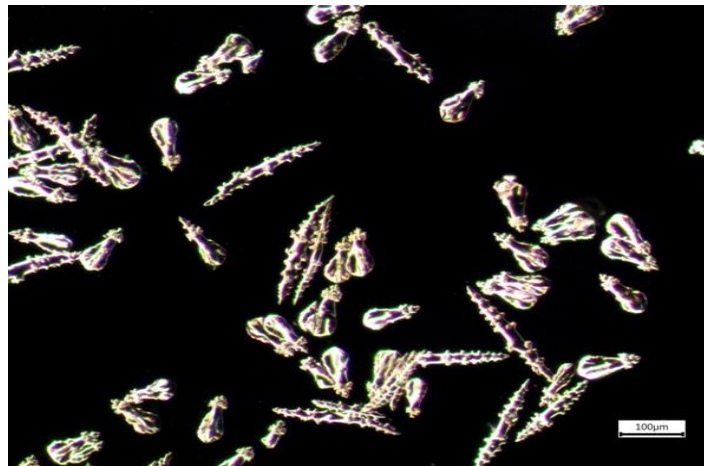


Figure 3: Sclerite of *Eunicella gazella* Studer, 1878.

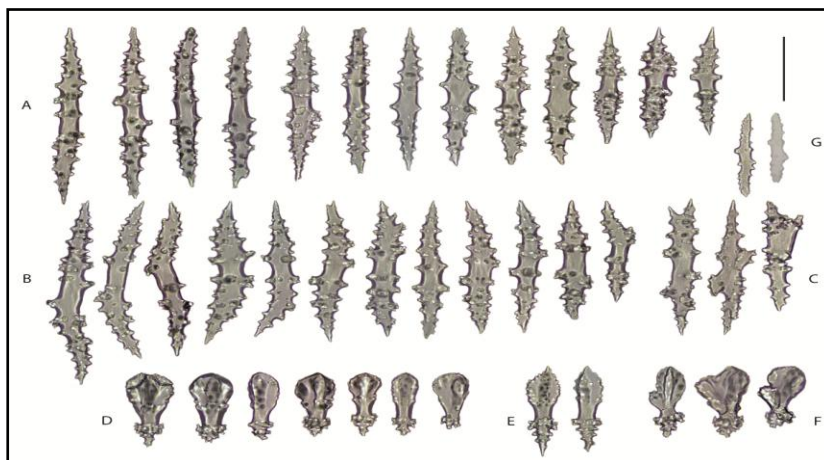


Figure 4: Sclerites diversity of *Eunicella gazella* Studer, 1878.
A to F: Coenenchymal sclerites; G: Anthocodial rods. A,B and C: Spindles sclerite;
D,E and F: Club-shaped sclerite. Scale bar : 100 µm

4. Discussion:

The description of *Eunicella gazella* colonies realized in the present research is similar to the Grashoff's description [6] of colonies which collected in African Atlantic coasts (between Mauritania and Angola) and in Portuguese and Spain Atlantic coasts [9, 12]. However, for the sclerite description, Grasshoff (1992)[6] was mentioned one type of club-shaped sclerites, while we found three types of them; short, fusiform and sclerite with a bud and a crack in the middle. Probably this variation is due to depth environmental effects. According to West (1993) [13], the colonies which live in the deep have a longer sclerite than shallow colonies.

In another hand, *E. gazella* collected in Atlantic (Agadir Bay), compared to the one collected and in Mediterranean (M'diq), present some difference of color, size and diameter of branches. Probably this fact is related the environmental conditions in the two ecosystems. According Grasshoff 1988 [14], the colonies of the same species can have different color (e.g *Leptogorgia viminalis*), form and size of colonies (see Gori et al.,) [15]. Many environmental parameters could influence gorgonian growth, morphology and biology. West (1993) [13] proved that the colony form, branch's diameter and polyp density varies from shallow to deep, between the colonies of an octocoral gorgonian *Briareum asbestinum* Pallas, 1766. Several authors suggested that the hydrodynamic has great effects on structure and morphology of gorgonian [16, 17]. Moreover, these authors reported adaptation possibilities in gorgonian colonies to the environment conditions [16].

In the case of our study, the difference between Atlantic and Mediterranean colonies could be explained by the hydrodynamic parameters. The Atlantic site (Agadir Bay) is characterized by an intensive hydrodynamic [18, 20] compared to the Mediterranean site (M'diq). Probably the hydrodynamism is the main factor that influences the morphology variation between the gorgonians colonies of *E. gazella* in the both ecosystems.

Other authors noted that the environmental conditions, like depth gradient, influenced morphology of the sclerite form [13, 21]. In other hand, according Caprine (1975) [22], the distribution of colonies could be influenced too by the depth in which the temperature, hydrodynamics and the nature of substrate varies.

Concerning the biogeographical distribution along Atlantic African coasts, the previous manuscript were reporting the presence of *E.gazella* from Mauritania to Angola and Mediterranean coasts Alboran Sea [6, 12] (Fig. 5) as well as some localities from the Iberian Peninsula and the Atlantic coast of France [6, 10] and in Spain [23]. But this species had never cited in Moroccan Atlantic coasts.

Our investigations show that the species exist in Moroccan Atlantic ecosystems and there is continuity of distribution of *Eunicella gazalla* along the Atlantic coasts between France to Angola.

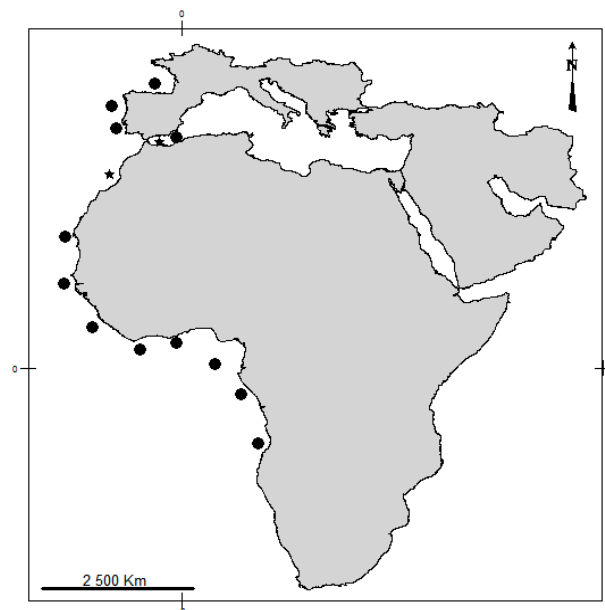


Figure 5: Map of Geographical distribution of *Eunicella gazella* Studer, 1878
(● Previous records, ★ current record)

On the other hand, if the species had not cited in Moroccan Atlantic shores until now, it's probably because there the few scientific expeditions explored the Moroccan Atlantic coasts, did not take consideration the octocoral gorgonian studies. Furthermore, octocoral gorgonian in the region between Agadir and Lgwira have not been well studied such as the area between Senegal and Angola which explored by many oceanographic expeditions. Moreover, the CANCAP expedition carried out Moroccan coast was limited to the colonies from 48-637 m depth, excluding the shallow water species. For instance, the *Vanneau* expedition focused to the area between Tanger and Sidi Ifni, lost the majority of collected colonies [7]. Consequently, the list of Moroccan octocoral gorgonians doesn't reflect the existing species.

The wide distribution of *E. gazella* along the Atlantic African and European coasts (from Spain to Angola) witnessed its adaptability to different conditions. Weinbauer (1995) [16] reported that gorgonian adapts to environmental conditions of the area.

In addition to the main role of marine currents in the dispersal of species, the extent of geographical area of species has been facilitated also by maritime trades [24, 25]. Moreover, the Moroccan coasts, characterized by upwelling, are known by their nutrients richness [20, 26] and they are favorable to the species installation.

In our investigation area, gorgonians are less abundant in the site *Agadir Commercial harbour* than *Aghroud* and *Taghazout* sites, in spite of biodiversity more importance in these last sites. This fact could be explained by the slope very low in *Aghroud* and *Taghazout* and the dominance of sandy substrate. So, our investigations in these sites concerned the rocky substrate at 15m depth. Then, the habitats where the depth is more than 15 m were not explored. Against, the steep slope in commercial harbour allowed us to dive until 21m depth upon a 200 m in transect length. As reported by Grasshoff (1992)[6], the *E. gazella* have a wide bathymetric distribution range from 5 to 135 m in depth, but the most colonies were observed in depth more than 15m.

In *Agadir Commercial harbour*, the colonies of *E. gazella* are fixed on artificial breakwater of harbour. A similar result was reported by Ben-Yousef (1999) [27] in Red Sea. In fact, these authors reported that the gorgonian *Acacia biserialis* has a high abundance on the vertical underwater structures of artificial substrata in Red Sea, but rare on the adjacent natural reefs because of the adequate light regime and exposure to flow [27].

Conclusion

In this investigation, we record for the first time *Eunicella gazella* in Moroccan Atlantic. This new record allows to increase the knowledge about geographical distribution of this species. Our results complete the Atlantic distribution East coasts data of the species. In fact, we confirmed the continuity of *Eunicella gazella* distribution along the Atlantic East coasts from Portugal to Angola. This large geographic distribution of the species witnesses its great adaptability in the different marine ecosystems.

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