

RESEARCH ARTICLE

**Sexual reproduction of *Anemonia sulcata* (Pennant, 1777)  
in Moroccan western Mediterranean coast**

**Mouna Daoudi<sup>1\*</sup>, Rachid El Halimi<sup>2</sup>, Benlahcen Rijal Leblad<sup>3</sup>,  
Oussima El Haroufi<sup>1,4</sup>**

**ORCID IDs:** M.D. 0000-0003-2032-7345; R.E.H. 0000-0002-3846-8827;  
B.R.L. 0000-0002-9713-9492; O.E.H. 0000-0002-5785-9583

<sup>1</sup> Laboratory of Fisheries, National Institute of Fisheries Research, Tangier, MOROCCO

<sup>2</sup> Department of Mathematics and Statistics, Faculty of Science and Technic of Tangier, University Abdelmalek Essaadi (UAE), MOROCCO

<sup>3</sup> Laboratory of Monitoring of Coastal Environment, National Institute of Fisheries Research, Tangier, MOROCCO

<sup>4</sup> Department of Earth Sciences, Faculty of Sciences and Technic of Tangier, University Abdelmalek Essaadi (UAE), MOROCCO

**\*Corresponding author:** daoudimouna80@gmail.com

---

**Abstract**

The sexual reproduction of the sea anemone, *Anemonia sulcata* (Pennant, 1777), was studied for the first time at Cape Mazari in the Moroccan Mediterranean coast over an annual cycle from May 2017 to May 2018. A total of 330 individuals of *A. sulcata* were sampled during 11 months. The sampled individuals were measured, weighed, and fixed for histological analyses. The pedal disc diameter (PDD) of the species ranged from 1.2 cm to 6.6 cm with a mean value of  $2.7 \pm 0.6$  cm. The weight of the species varied from 2.6 g to 94.0 g with a mean value of  $19.9 \pm 12.7$  g. Results of histological analyses indicated a sex ratio of 2.3 female: 1 male. Gonads were observed generally throughout the study period and mature ones were encountered from February to June. Five possible maturity stages of *A. sulcata* for each gender were recorded. Based on this study, the exploitation of *A. sulcata* can be managed in the Moroccan Mediterranean coast by the application of the biological rest period from February to June as well as monitoring its weight.

**Keywords:** *Anemonia sulcata*, sexual reproduction, biological rest period

**Received:** 15.07.2021, **Accepted:** 23.12.2021

---

**Introduction**

Sea anemones are sessile marine invertebrates found in both the deep and shallow waters of tropical and temperate seas. They predominate in tropical waters

(Wallace and Taylor 2003). They belong to Class Anthozoa, which are, according to Grasshoff (1984), the stem of Phylum Cnidaria. They play a very important role in the following ways: i) ecologically, they host many species of crabs and fish and they enjoy a symbiotic relationship with a species of dinoflagellates known as Zooxanthellae (Fitt *et al.* 2000). Moreover, they could be used as a bio-indicator (Bellante *et al.* 2016; Parrinello *et al.* 2017) and ii) economically, they provide sustainable income and nourishment for humans (Molea and Vuki 2008).

Many studies have been conducted on the taxonomy (Ocaña and Hartog 2002; Häussermann 2004; López-González *et al.* 2005; Ocaña *et al.* 2015), the anatomy (Gadelha *et al.* 2013), reproduction and gametogenic cycle (Ford 1964; Schmidt 1972 in Shick 1991; Dunn 1982; Schaefer 1984; Acuña 1996; Scott and Harrison 2009; Bocharova and Kozevich 2011; Utrilla *et al.* 2019), genetics (Wiedenmann *et al.* 2000), and growth (Dalyell 1848; Stephenson 1928; Chia and Rostron 1970; Chia and Spaulding 1972; Bucklin 1987) of many species of sea anemones. *Anemonia sulcata* is an anthozoan sea anemone present in the infralittoral zone of the Mediterranean Sea and Atlantic Ocean, stretching from the Strait of Gibraltar as far as the coasts of Scotland (Ocaña *et al.* 2015). Reproduction of this species takes place both sexually and asexually. Investigations of the reproduction cycle of *A. sulcata* are very scarce (Schmidt 1972 in Shick 1991; Schaefer 1984; Utrilla *et al.* 2019). In Morocco, there is a dearth of studies on the population structure and the reproduction of *A. sulcata* and our research consists of the first investigation into this topic. Our research on this species began in 2016, involving the entire Moroccan Mediterranean Sea coasts in order to map the distribution of *A. sulcata*. In this paper we aim to: i) describe the sexual reproductive cycle of *A. sulcata* through an 11-month period of sampling and research, ii) determine the ratio of males to females, and iii) establish the biological rest period.

## **Materials and Methods**

### *Study area*

The rocky coast of Cape Mazari is part of the southern coast of Tetouan (NW of Morocco: 35.5488°N, 5.23182°W) (Figure 1) characterized by Mediterranean temperate climate. It is surrounded by Azla coast in the north and Amsa beach in the east. Each beach is 1.5 km long and receives the effluent of two streams: Oued Azla and Oued Amsa.

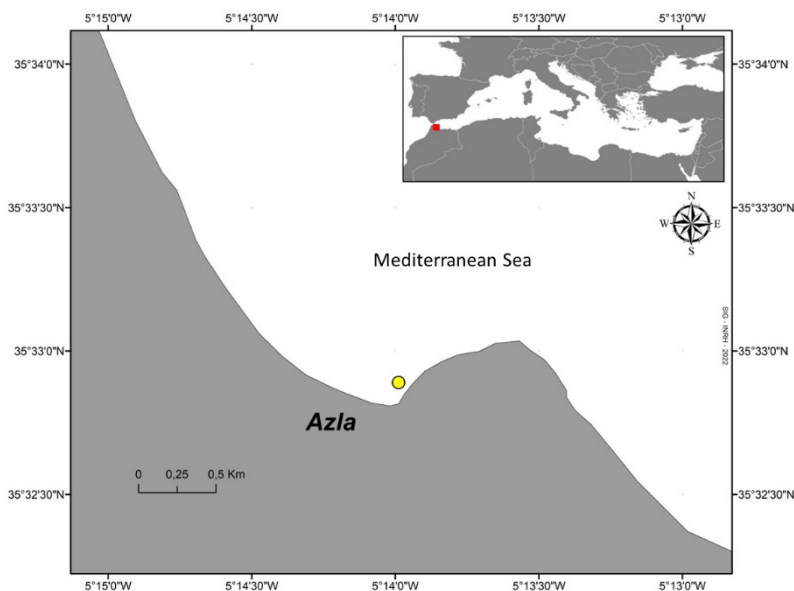
### *In situ measurement*

Water temperature and salinity were measured using a Hanna multiparameter probe.

### *Sampling*

Specimens of *A. sulcata* were collected by diving randomly using a 0.25 m<sup>2</sup> quadrat at Cape Mazari. The population of this area was already assessed during the stock assessment campaign for this species in 2016 and in the whole Moroccan

Mediterranean coast. The sampling area was at a depth of 0.5-1.0 m (Figure 1). During a period of 11 months, 30 specimens were sampled on a monthly basis except April 2018. Samples of the sediment on which *A. sulcata* was attached was analysed in the Geochemical Laboratory of the National Institute of Fisheries Research in Tangier.



**Figure 1.** Sampling area of *Anemonia sulcata*

#### *Biological measurements*

The collected individuals were relaxed in  $MgCl_2$  (6%) solution for 30 minutes then weighed with an electronic scale of 0.01g precision. Three morphometric parameters were measured using a caliper: pedal disc diameter (PDD), column length (CL), and tentacle length (TL).

#### *Histology of A. sulcata*

After the morphometric measurements were made, 30 specimens were dissected, the tentacles were removed, and the column was cut into smaller pieces and saved in Davidson solution (Ostrand 2000) for fixation. The histological sections were prepared following the procedure described by Humason (1962). After drying, the slides were observed under a Leica optical microscope. The images were taken by a Leica camera connected to the microscope. The image processing was made using the Leica Application Suite LAZ EZ software.

#### *Statistical analyses*

The Chi-square ( $\chi^2$ ) analysis was applied to compare the proportion of females to males. The Kruskal-Wallis test was implemented in order to compare the mean

sizes of females, males, and undetermined individuals across the months. All statistical analyses were performed using software ‘R’ version 4.0.3 (R Development Core Team 2020).

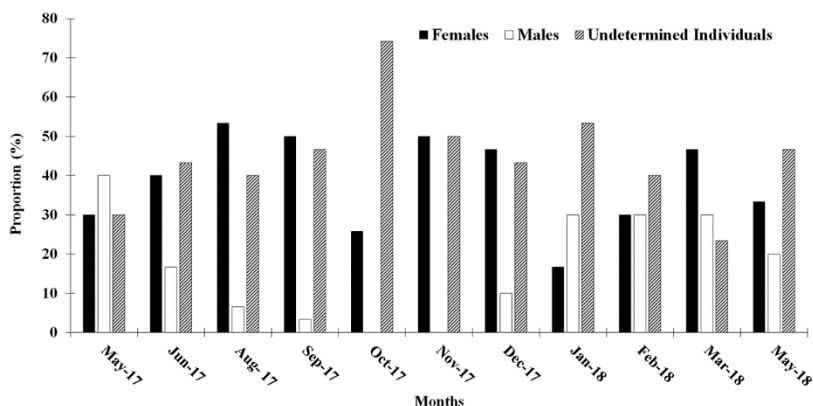
## Results

### *Habitats*

It was found that *A. sulcata* lived in water with a temperature ranging from 15 to 22°C and salinity ranging from 36.57 to 37.34 PSU. The sedimentary environment is composed of sandstone rocks on which this species attaches itself to different surfaces (top, sides, and crevices).

### *Population structure – Sex ratio*

The population of *A. sulcata* studied showed the presence of females, males, and undetermined individuals without any gonads (Figure 2).



**Figure 2.** Proportion of females, males, and undetermined individuals of *Anemonia sulcata* by month

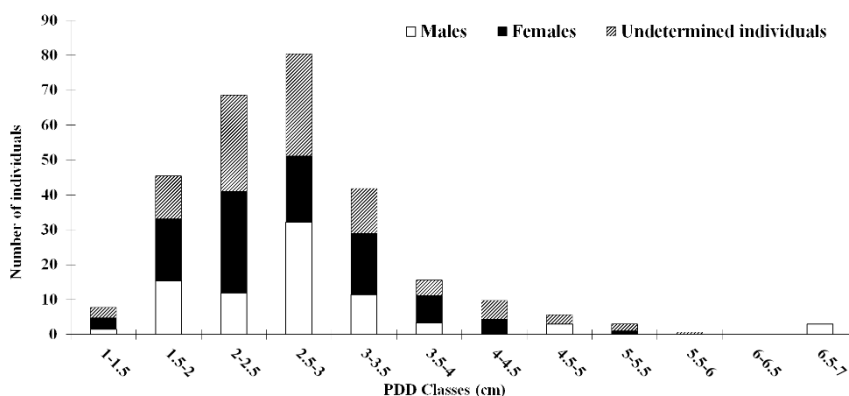
The females were observed each month, while the males were not observed in the samples obtained between October and November 2017. The proportion of females varied slightly during August, September, November and December (53%, 50%, 50% and 47%, respectively) and decreased in October (26%). In the following year, between March and May, the proportions varied from 53% to 40%. The proportion of male anemones attained their greatest rise during May 2017 with a value of 40%. During the following months, the proportions had significantly fluctuated or remained stable, with the highest value of 30%. Undetermined individuals were present during all months and their proportion increased sharply to a maximum of 74% during October 2017. Among 330 individuals of *A. sulcata* sampled, the dominance of females was observed. The evolution of the sex-ratio throughout the year shows that there were more females

than males with exception of the month of May 2017 followed by January, February, March, and May of the following year.

The sex-ratio was 2.3 female: 1 male and significantly different from 1:1 ( $\chi^2 = 32.337$ ,  $p < 0.001$ ).

#### *Pedal disc classes*

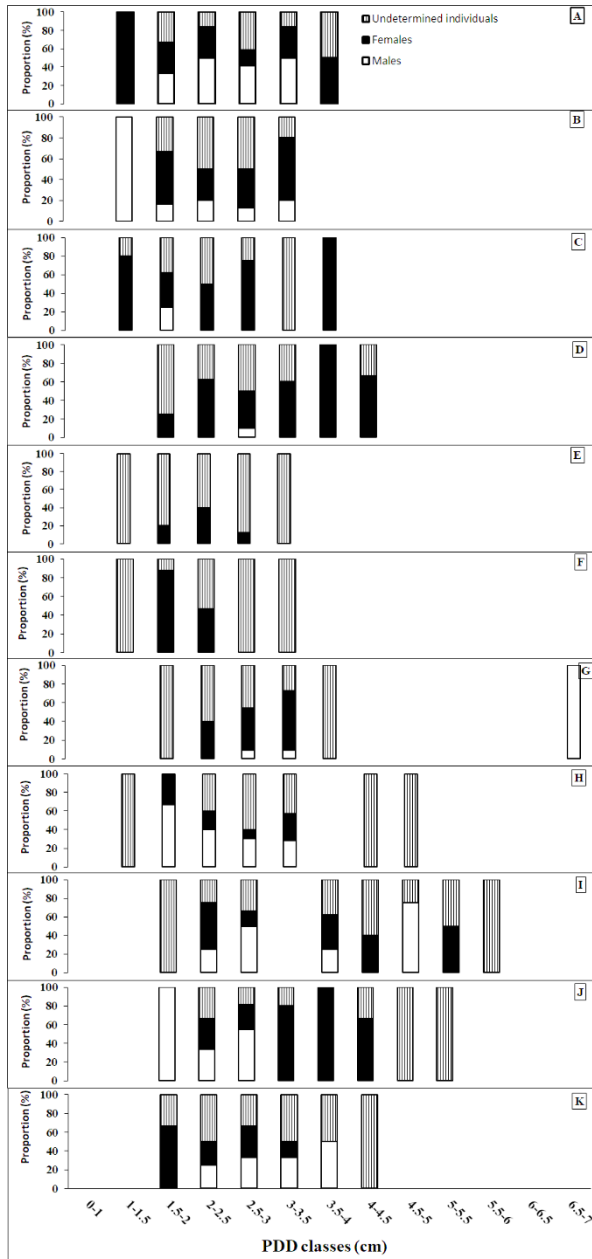
The analyses of the pedal disc classes of over 330 specimens of *A. sulcata* (Figures 3 and 4) showed a PDD ranging from 1.2 to 6.6 cm with a mean value of  $2.7 \pm 0.6$  cm. The lowest value of PDD was measured in September 2017 (1.2 cm) in undetermined individuals, while observing a significant increase for the month of December 2017 (6.6 cm) in male individuals. A growth of PDD of the individuals was observed in February 2018, with a mean value of  $3.8 \pm 1.0$  cm, whilst a decrease of the PDD was recorded in August 2017 with a mean value of  $2.1 \pm 0.6$  cm (Figure 4).



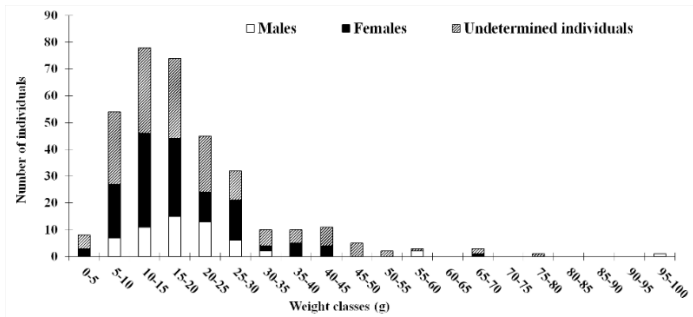
**Figure 3.** Pedal disc diameter (PDD) classes for males, females, and undetermined individuals of *Anemonia sulcata*

#### *Weight distribution*

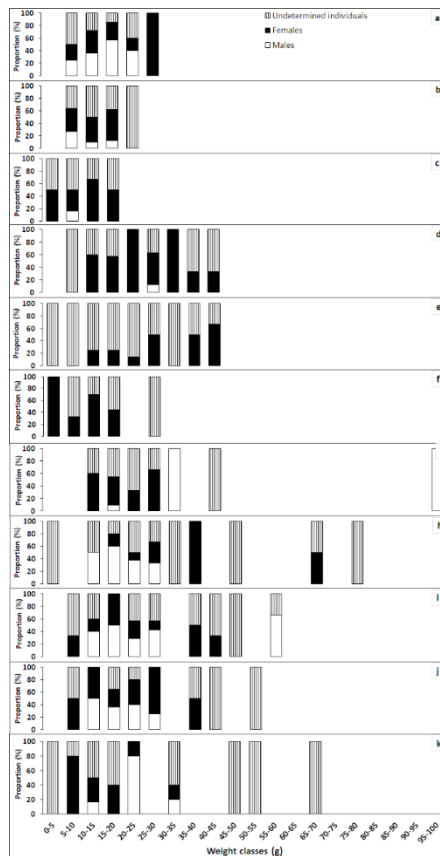
The weight of over 330 specimens of *A. sulcata* (Figures 5 and 6) ranged from 2.6 to 94.0 g with a mean value of  $19.9 \pm 12.7$  g. The lowest weight was measured during November 2017 (2.6 g) in undetermined individuals, while the highest value was observed during December 2017 (94.0 g) in male individuals. An increase in weight of the individuals was observed between January and February 2018, with a mean value of  $28.6 \pm 18.4$  g and  $27.6 \pm 15.4$  g, respectively. A decrease in weight was recorded during August 2017 with a mean value of  $9.5 \pm 3.9$  g.



**Figure 4.** Pedal disc diameter (PDD) classes for males, females, and undetermined individuals of *Anemonia sulcata* by months. (A) May 2017; (B) June 2017; (C) August 2017; (D) September 2017; (E) October 2017; (F) November 2017; (G) December 2017; (H) January 2018; (I) February 2018; (J) March 2018; (K) May 2018.



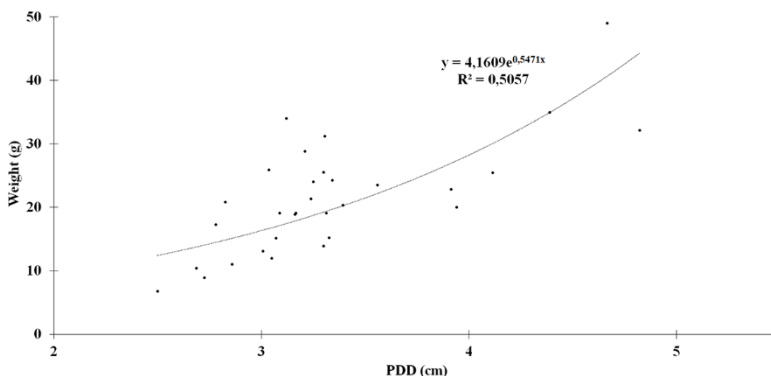
**Figure 5.** Weight distribution for males, females, and undetermined individuals of *Anemonia sulcata*



**Figure 6.** Weight distribution for males, females, and undetermined individuals *Anemonia sulcata* by month. (a) May 2017; (b) June 2017; (c) August 2017; (d) September 2017; (e) October 2017; (f) November 2017; (g) December 2017; (h) January 2018; (i) February 2018; (j) March 2018; (k) May 2018.

### *Pedal disc diameter/weight relationship*

The PDD/weight relationship (Figure 7) showed that there was a moderate correlation between PDD and weight ( $R^2 = 0.5$ ). The weight increased at less rate than the PDD ( $b < 3$ ,  $p < 0.0001$ ) which demonstrates that there is a negative allometry (Gayon 2000; Katsanevakis *et al.* 2006).



**Figure 7.** Pedal disc diameter (PDD)/weight relationship *Anemonia sulcata*

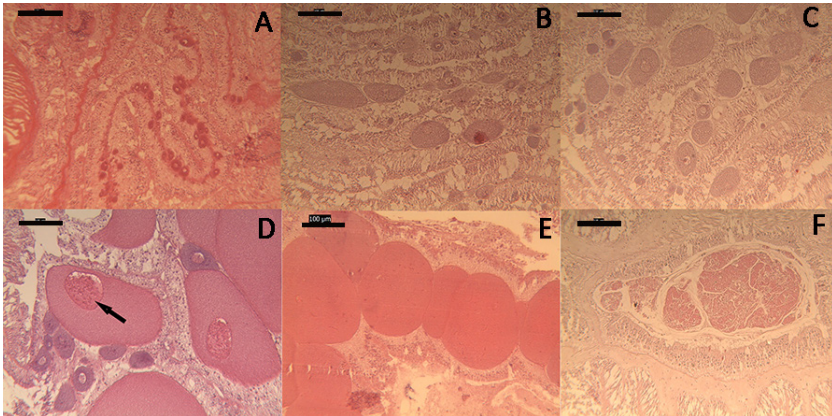
### *Gonadal appearance*

Gender was generally determined according to the colour of the gonads. For *Entacmaea quadricolor*, female gonads are characterized by green colour while male gonads and undetermined individuals have creamy colour (Scott and Harrison 2009). In our study, the dissection of some individuals of *A. sulcata*, and the examination of a smear under a light microscope showed the colour of the tissues was light pink. Based on the size, it indicated to be female gonad. While others had creamy or grey colour that may be referred to undetermined gender or male gonads, microscopic examination of the smear does not allow distinction of gender.

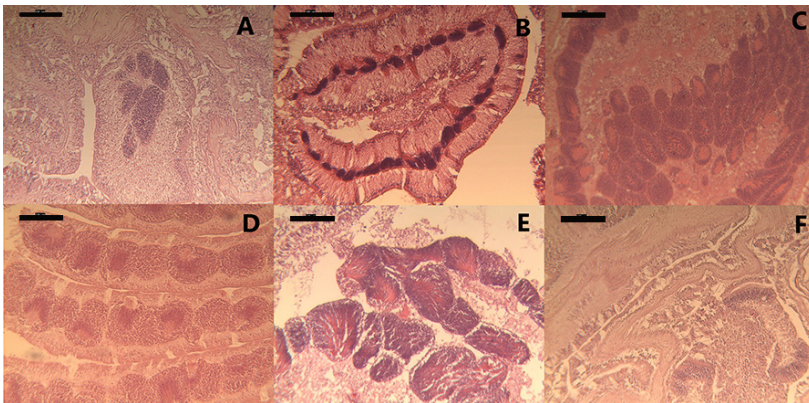
After the histological section was prepared, the determination of gender was made on a microscopic scale. The presence of oocytes or spermatogenic cells and their absence allows the distinction between females, males, and undetermined gender (Figures 8 and 9).

Female gonads, located in the mesentery (Figure 8), were greater than those of males and had a longer shape with a lighter colour. In their early stages, oocytes had a size of about 16  $\mu\text{m}$ . When they became mature, they reached a size of about 300  $\mu\text{m}$ . At this stage, they occupied the entire mesentery.

Male gonads also located in the mesentery were oval-like with dense coloration (Figure 9).



**Figure 8.** Microscopic photos of female gametes at various stages. (A) first stage; (B-C) second stage; (D-E) fourth stage; (F) fifth stage. The arrow indicates the nuclei. A scale bar shows 100µm.



**Figure 9.** Microscopic photos of male gamete at various stages. (A) first stage; (B) second stage; (C) third stage; (D-E) fourth stage; (F) fifth stage. A scale bar shows 100µm.

### *Gonadal stages*

#### *Oogenesis*

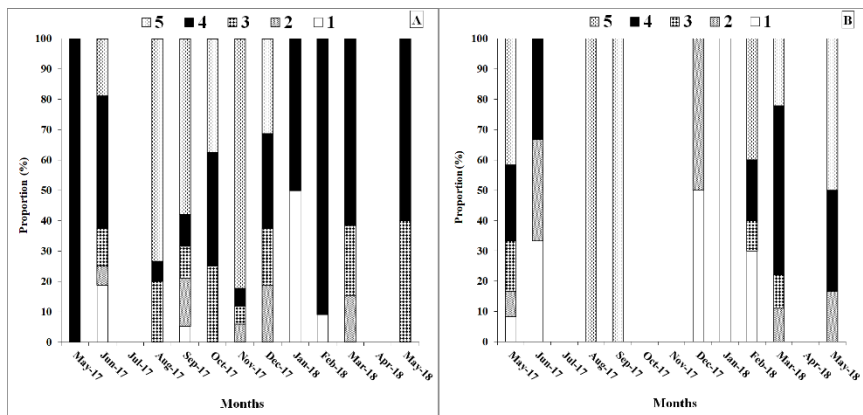
Microscopic observation of histological sections allowed the identification of gonad stages of both sexes. Oogenesis stages were identified for females according to the size of oocytes. Oocytes were round or oval stretched. Anemones with a female gametes cell size of about 16 µm were probably a primary oogonia (Figure 8A). Those with a size of 44 µm were probably a secondary oogonia (Figure 8B and C). While the oocytes were different, they appeared with a nucleus located at the periphery of the cell. When the oocytes attained a size of about 300 µm, they had a nucleus (Figure 8D and E) and they disappeared. After spawning, broken oocytes and deteriorated cells were observed. (Figure 8F).

### *Spermatogenesis*

Male gametes were located in the mesentery, and at their first stage, they appeared small with a size of about 60  $\mu\text{m}$  (Figure 9A). At the second stage, the spermatogonia occupied one-quarter of the mesentery (Figure 9B). At the third stage, they occupied more than half of the mesentery width (Figure 9C). At the fourth stage, gamete cells appeared with a tail and occupy more than three-quarters of the mesentery, then the sperm vesicles occupied the entire width of the mesentery (Figure 9D and 9E).

### *Reproductive cycle*

The intact oocytes were present during the entire year from May 2017 to May 2018, while the broken ones were recorded from June to December with peaks in August and November (Figure 10). Sexually undetermined individuals were present during the entire period. Small oocytes (1st stage) were encountered during the year 2017 only in Jun and September, and during the year 2018 only in January and February (Figure 10), while mature ones were observed every month with different proportions. During May 2017, 100% of females were mature (4th stage) with an oocyte size  $\geq 300 \mu\text{m}$ . As of February 2018, 91% of females were mature. During the months of January, March, and May 2018, the proportion of mature females was 50%, 62% and 60%, respectively. From August to December 2017, a proportion interval of 7% to 38% of mature females was found. In June 2017, 41% of females were mature.



**Figure 3.** Gonadal stages of *Anemonia sulcata* by month. (A) Females; (B) Males. Numbers indicate the development stages.

Broken oocytes (indicator of spawning period) were observed from June 2017 to December 2017 with a high proportion during August and November (71% and 93%, respectively).

Male gonads were observed from May to December 2017 and from January to May 2018. Mature gonad males (4<sup>th</sup> stage) (Figure 9B) were recorded during May

and June 2017 (25% and 33%, respectively) and during February, March, and May 2018 (20%, 56%, and 33%, respectively). During August and September 2017, all male gonads were deteriorated. Immature male gonads were observed in different proportions especially during December 2017 and January 2018, with 100% in the latter case.

## Discussion

This study is the first one carried out in Morocco about the sexual reproduction of sea anemones, such as *Anemonia sulcata*. We investigated the population structure of *A. sulcata* and its reproductive cycle. Our study is in concordance with the sexual reproduction of *A. sulcata* reported in Malaga, Spain and Naples, Italy (Schäfer 1984; Utrilla *et al.* 2019). Gonads shape of many other sea anemones (Schmidt 1972 in Shick 1991; Jennison 1979, 1981; Sebens 1981; Scott and Harrison 2009; Gadelha *et al.* 2013) were similar to those observed in *A. sulcata* in this study.

Regarding the sex ratio, females are more abundant than males in some other sea anemones such as *Entacmaea quadricolor* (Scott & Harrison 2009), *Anthopleura elegantissima* (Jennison 1979), *Nematostella vectensis* (Eckelbarger *et al.* 2008), *Actinia tenebrosa* (Ottaway 1979), *Anthopleura bandi*, and *Haliplanella luciae* (Dunn 1982). During our sampling in October and November, suspended matter was abundant and no males were observed, which implies the effect of stressful conditions for sexual differentiation of males. Stress factors can influence the proportion of genders and favour the increase of females in *A. sulcata* (Utrilla *et al.* 2019). Populations which consist of only females and non-reproductive individuals are also known for *Aulactinia stella* (Verill 1864) in addition, females use amitotic parthenogenesis. (Bocharova and Mugue 2012; Bocharova 2015). However, according to studies such as Häussermann and Försterra (2001) and Chen *et al.* (2008), the absence of males and the presence of only females in the population of *Aiptasia pulchella* and *Anemonia alicemartina* n.sp, is linked to seasonal sexual reproduction or to exclusively asexual reproduction. The population structure of *A. sulcata* in the present study had generally a similar PDD size structure and weight distribution in both genders. In the eastern part of Moroccan Mediterranean coast (Nador Lagoon) the individuals of *A. sulcata* sampled were smaller than those reported in the western side and out of the lagoon (Daoudi *et al.* 2017). Furthermore, the *A. sulcata* individuals sampled in the Moroccan Mediterranean coast were bigger than those encountered in Malaga (Utrilla *et al.* 2019). Several factors may explain this size difference, such as richness in phytoplanktons, water salinity, temperature, currents and predation. The higher salinity recorded in the Nador Lagoon (Daoudi *et al.* 2012) may put the species under stressful conditions, which inhibits its normal growth. The osmoregulation mechanism allows the cnidarian *Cordylophora* sp. to survive under a wide range of salinity (Folino-Rorem and Renken 2018) and leads to morphological and growth variation of the species.

The maturation period for *A. sulcata* found in our study is close to the maturation period of the following species, *Phymanthus crucifer* (Jennison 1981), *Entacmaea quadricolor* (Scott and Harrison 2009), and *Sagartia troglodytes* (Nyholm 1943 in Shick 1991). During the period from February to June, the proportion of both male and female gonads was important, while in the other months we found different gonads maturation levels and different sizes. Similar to other sea anemones (Bocharova and Kozevich 2011), different stages of development of gonads were found in *A. sulcata*. In the current study, the prolonged spawning period of the females could be associated to the asynchronous oocysts' developments.

The absence of males in our samples during October and November 2017 may be related to the decrease of their number, because after spawning they become non-sexual. The peak of the spawning period of littoral sea anemones species corresponds generally to the peak in annual temperature (Schmidt 1972 in Shick 1991; Jennison 1979; Carter and Miles 1989). The delay of the increase of water temperature recorded during 2018 (18.3°C recorded in May 2018 and 20.0°C in May 2017) created a difference in gonads composition between May 2017 and May 2018 and lead to a small shift in the maturity of both sexes.

The present study allowed us to determine, for the first time, the reproductive period of *Anemonia sulcata* in the Moroccan Mediterranean coast. Recognition of a biological rest period from February to June is proposed. Further investigations will be conducted in the future in order to propose a management plan for a rational and sustainable exploitation of this species.

### **Acknowledgements**

We are grateful to Abderahim Chiaar for his helpful suggestions in the histological analyses, and Abdelkrim Kalmouni for his help in preparing the map.

### **References**

- Acuña, F.H. (1996) Population structure and sex ratio of the intertidal sea anemone *Phymatis clematis* DANA, 1849 (Actiniaria; Actiniidae). *Biociencias* 4(2): 3-16.
- Bellante, A., Piazzese, D., Cataldo, S., Parisi, M.G., Cammarata M. (2016) Evaluation and comparison of trace metal accumulation in different tissues of potential bioindicator organisms: macrobenthic filter feeders *Styela plicata*, *Sabella spallanzanii*, and *Mytilus galloprovincialis*. *Environmental Toxicology Chemistry* 35: 3062-3070.
- Bocharova, E.S. (2015) Reproductive biology and genetic diversity of the Sea Anemone *Aulactinia stella* (Verrill, 1864). *Hydrobiologia* 759(1): 27-38.

- Bocharova, E.S., Kozevich, I.A. (2011) Modes of reproduction in sea anemones (Cnidaria, Anthozoa). *Biology Bulletin* 38(9): 849-860.
- Bocharova, E.S., Muge, N.S. (2012) Sea anemones *Aulactinia stella* (Verrill, 1864) (Hexacorallia, Actiniidae) can brood offspring from other individuals of the same species. *Doctady Biological Science* 444: 173-175.
- Bucklin, A. (1987) Growth and asexual reproduction of the sea anemone *Metridium*: Comparative laboratory studies of three species. *Journal of Experimental Marine Biology and Ecology* 110(1): 41-52.
- Carter, M.A., Miles, J. (1989) Gametogenic cycles and reproduction in the beadlet sea anemone *Actinia equina* (Cnidaria: Anthozoa). *Biological Journal of the Linnean Society* 36: 129-155.
- Chen, C., Soong, K., Chen, C.A. (2008) The smallest oocytes among broadcast-spawning actinarians and a unique lunar reproductive cycle in a unisexual population of the sea anemone, *Aiptasia pulchella* (Anthozoa: Actiniaria). *Zoological Studies* 47(1): 37-45.
- Chia, F.S., Rostron, M.A. (1970) Some aspects of the reproductive biology of *Actinia equina* (Cnidaria: Anthozoa). *Journal of the Marine Biological Association of the United Kingdom* 50: 253-264.
- Chia, F.S., Spaulding J.G. (1972) Development and juvenile growth of the sea anemone, *Tealia crassicornis*. *The Biological Bulletin* 142 : 206-218.
- Dalyell, J.G.S. (1848) Rare and Remarkable Animals of Scotland, Represented from Living Subjects: With Practical Observations on Their Nature. Van Voorst, London, United Kingdoms.
- Daoudi, D., El Fanichi, C., Baali H., Gomez Gonzalez, J.A. (2017) Mapping and stock assessment of *Anemonia sulcata* along the Moroccan Mediterranean coast. Internal Report of the National Institute of Fisheries Research (French), 27p.
- Daoudi, D., Serve, L., Rharbi, N., El Madani, F., Vouvé, F. (2012) Phytoplankton distribution in the Nador Lagoon (Morocco) and possible risks for harmful algal blooms. *Transitional Waters Bulletin* 6(1): 4-19.
- Dunn, D.F. (1982) Sexual reproduction of two intertidal sea anemones (Coelenterata: Actinaria) in Malaysia. *Biotropica* 14(4): 262-271.
- Eckelbarger, K.J., Hand, C., Uhlinger, K.R. (2008) Ultrastructural features of the trophonema and oogenesis in the starlet sea anemone, *Nematostella vectensis* (Edwardsiidae). *Invertebrate Biology* 127(4): 381-395.

- Fitt, W.K., McFarland, F.K., Warner, M.E., Chilcoat, G.C. (2000) Seasonal patterns of tissue biomass and densities of symbiotic dinoflagellates in reef corals and relation to coral bleaching. *Limnology & Oceanography* 45(3): 677-685.
- Folino-Rorem, N.C., Renken, J.R. (2018) Effects of salinity on the growth and morphology of the invasive, euryhaline hydroid Cordylophora (Phylum Cnidaria, Class Hydrozoa). *Invertebrate Biology* 137(1): 78-90.
- Ford, C.E.J.R. (1964) Reproduction in the aggregating sea anemone, *Anthopleura elegantissima*. *Pacific Science* XVIII: 136-145.
- Gadelha, J.R., Morgado, F., Soares, A.M.V.M. (2013) Histological staining approaches for high-quality imaging of *Actinia equina* and *Anemonia sulcata* anatomy. *Microscopy Society of America* 19(4): 53-54.
- Gayon, J. (2000) History of the concept of allometry. *American Zoology* 40: 748-758.
- Grasshoff, M. (1984) Cnidarian phylogeny - a biomechanical approach. Recent advances in the paleobiology and geology of the Cnidaria. *Palontographica Americana* 54: 127-135.
- Häussermann, V. (2004) Identification and taxonomy of soft-bodied hexacorals exemplified by Chilean sea anemones; including guidelines for sampling, preservation and examination. *Journal of the Marine Biological Association of the United Kingdom* 84: 931-936.
- Häussermann, V., Försterra, G. (2001) A new species of sea anemone from Chile, *Anemonia alicemartinae* n. sp. (Cnidaria: Anthozoa). An invader or an indicator for environmental change in shallow water? *Organisms Diversity & Evolution* 1: 211-224.
- Humason, G. (1962) Animal Tissue Techniques. Freeman and Company, United States of America.
- Jennison, B.L. (1979) Gametogenesis and reproductive cycles in the sea anemone *Anthopleura elegantissima* (Brandt, 1835). *Canadian Journal of Zoology* 57: 403-411.
- Jennison, B.L. (1981) Reproduction in three species of sea anemones from Key West, Florida. *Canadian Journal of Zoology* 59: 1708-1719.
- Katsanevakis, K., Thessalou-Legaki, M., Karlou-Riga, C., Lefkaditou, E., Dimitriou, E., Verriopoulos, G. (2006) Information-theory approach to allometric growth of marine organisms. *Marine Biology* 151:949-959.

López-González, P.J., Estefanía Rodríguez, E., Segonzac, M. (2005) A new species of sea anemone (Cnidaria: Anthozoa: Actiniaria) from Manus Basin hydrothermal vents, south-western Pacific. *Marine Biology Research* 1(5): 326-337.

Molea, T., Vuki, V. (2008) Pêche de subsistance et habitudes de consommation de poisson des habitants – les gens de la mer – du Lagon de Lau, Malaita (Îles Salomon): Étude de cas des habitants des îles de Funaafou et de Niuleni. HINA, les femmes et la pêche - *Bulletin de la Communauté du Pacifique* PS18: 30-34.

Nyholm, K.G. (1943) Zur Entwicklung und Entwicklungsbiologie der Ceriantharien und Aktinien. *Zoologiska bidrag från Uppsala* 22: 87-248. (Cited in: Shick, J.M. (ed.) (1991) A Functional Biology of Sea Anemones. University of Maine, London.)

Ocaña, O.O.V., Hartog, J.C. (2002) A catalogue of Actiniaria and Corallimorpharia from the Canary Islands and from Madeira Arquipelago. *Life and Marine Sciences* 19: 33-54.

Ocaña, O.O.V., Hartog, J.C., Brito, A., Moro, L., Herrera, R., Martín, J., Ramos, A., Ballesteros, E., Bacallado, J.J. (2015) A survey on Anthozoa and its habitats along the Northwest African coast and some islands: new records, descriptions of new taxa and biogeographical, ecological and taxonomical comments. Part I. *Revista de la Academia Canaria de Ciencias* 27: 9-66.

Ostrander, G.K. (2000) The Laboratory Fish. Johns Hopkins University Baltimore, MD, USA.

Ottaway, J.R. (1979) Population ecology of the intertidal anemone *Actinia tenebrosa* II. Geographical distribution, synonymy, reproductive cycle and fecundity. *Australian Journal of Zoology* 27: 273-90.

Parrinello, D., Bellante, A., Parisi, M.G., Sanfratello MA, Indelicato S, Piazzese, D., Cammarata, M. (2017) The ascidian *Styela plicata* hemocytes as a potential biomarker of marine pollution: in vitro effects of seawater and organic mercury. *Ecotoxicology and Environmental Safety* 136: 126-134.

Schäfer, W. (1984) Reproduction and development of *Anemonia sulcata* Anthozoa Actiniaria I. Reproductive cycle and oocyte structure before and after insemination. *Helgolaender Meeresuntersuchungen* 38(2): 135-148.

Schmidt, H. (1972) Prodrömus zu einer Monographie der mediterranen Aktinien. *Zoologica* 42: 1-120. (Cited in Shick, J.M. (ed.) (1991) A Functional Biology of Sea Anemones. University of Maine, London.)

Scott, A., Harrison, P.L. (2009) Gametogenic and reproductive cycle of the sea anemone, *Entacmaea quadricolor*. *Marine Biology* 156(8): 1659-1672.

Sebens, K.P. (1981) Reproductive ecology of the intertidal sea anemones *Anthopleura xanthogrammica* and *A. elegantissima*: body size, habitat, and sexual reproduction. *Journal of Experimental Marine Biology and Ecology* 54: 225-250.

Shick, J.M. (1991) A Functional Biology of Sea Anemones. University of Maine, London.

Stephenson, T.A. (1928) The British Sea Anemones, Vol. I, The Ray Society, London, 148 pp. + 14 plates. (Cited in Shick, J.M. (ed.) (1991) A Functional Biology of Sea Anemones. University of Maine, London.)

Utrilla, O., Castro-Claros, J.D., Urra, J., Navas, F.D., Salas, C. (2019) Reproduction of the anthozoan *Anemonia sulcata* (Pennant, 1777) in southern Spain: from asexual reproduction to putative maternal care. *Marine Biology* 166(8): 111.

Wallace, R.L., Taylor, W.K. (2003) Invertebrate Zoology: A Laboratory Manual, Sixth Edition. University of Central Florida, USA.

Wiedenmann, J., Kraus, P., Funke, W., Vogel, W. (2000) The relationship between different morphs of *Anemonia aff. sulcata* evaluated by DNA fingerprinting (Anthozoa, Actinaria). *Ophelia* 52(1): 57-64.