

Biodiversity and frequency of occurrence of jellyfish (*cnidaria*) in Al Hoceima Bay (North coast of Morocco, Alboran Sea)

B. Benyoub^{1,*}, O. Kada², H. El Ouarghi¹, B. Mghili³, and A. Aknaf⁴

¹Research Team Environmental Management and Civil Engineering (GEGC), Laboratory of Applied Sciences (LSA). ENSAH, Abdelmalek Essaadi University. Tetouan, Morocco.

²Laboratory of halieutic resources of the Institut des Recherches Halieutiques of Nador, Morocco.

³LESCB, URL-CNRST N° 18, Abdelmalek Essaadi University, Faculty of Science, Tetouan, Morocco.

⁴Pluridisciplinary Faculty of Nador- Mohamed 1st University.

Abstract. Jellyfish are the best-known group of gelatinous zooplankton; they refer to organisms from the phylum Cnidaria, including animals with cnidocytes (stinging cells). As part of our research on jellyfish that swarm in the bay of Al Hoceima conducted during the period (2021-2022), a study of the diversity of species of jellyfish in the bay has proved to be of paramount importance because of the risks associated with their proliferation, especially in summer periods. The species composition and frequency of occurrence of the jellyfish community in Al Hoceima Bay (The northern coast of Morocco) were studied during two seasons, summer 2021 and winter 2022. Zooplankton sampling was conducted within the epilimnetic layer (between 0 and 80 m) at 9 stations. A total of 9 species of Hydromedusae and Scyphomedusae were identified in the study area. The populations of Hydromedusae are represented by Trachymedusae (4 species), Anthomedusae (2 species), and Leptomedusae (one species). The Trachymedusa *Aglaure hemistoma* was widely distributed in the bay, as it was found in six sampling stations, with a frequency of occurrence $F_i > 66\%$ during the summer period. The Anthomedusae *Pantachogon militare* was inventoried for the first time in the southwestern Mediterranean Sea. The population of Scyphomedusae is represented by two species, *Pelagia noctiluca* and *Rhizostoma Pulmo*, both species showed dense aggregations in the Bay during the summer of 2022. **Keywords:** Cnidaria, jellyfish, gelatinous zooplankton, Hydromedusae.

1 Introduction

The word "jellyfish" or "true jellyfish" refers to organisms from the cnidaria phylum, which includes animals that have cnidocytes (stinging cells). Jellyfish are important constituents of the marine ecosystem, forming a diverse group of pelagic cnidarians including Scyphozoa, Hydrozoa, and Cubozoa, as well as Ctenophores [1].

Blooms of these gelatinous organisms have been widely documented in many coastal regions of the world [1–3]. These blooms have been attributed to human-induced alterations of the marine ecosystem, such as overfishing, climate change, eutrophication, and marine constructions and developments [2–4].

Their proliferation has impacts on the functioning of pelagic ecosystems, particularly on fish fauna because jellyfish are effective competitors of pelagic fish since they are macroplankton predators that occupy the top of the food chain [3,5].

In the Mediterranean, jellyfish studies are more numerous in the northern basin [6–10].

On the other hand, on the southwest coast of the Mediterranean, at the level of the Tunisian coast, there are some qualitative and quantitative works [11,12].

Also, some studies within the Algerian coast [13,14], describe the biodiversity of gelatinous zooplankton and its quantitative distribution on the Algerian coast. For the Moroccan Mediterranean coast, studies on jellyfish, in general, and jellyfish more specifically, are almost non-existent. Recently, some studies on the jellyfish *Pelagia noctiluca* have been published by Mghili [15,16].

As part of research on all the jellyfish that swarm in the Bay of Al Hoceima (period 2021-2022), qualitative research on the jellyfish of the bay seems necessary to determine the species composition and their distribution. spatio-temporal by comparing the seasonal dynamics (summer and winter) and the frequency of

*Corresponding author: bobenyoub@gmail.com

occurrence of species in order to detect differences between the different areas of the bay.

2 Materials and methods

2.1 Study zone

The bay of AL Hoceima is a maritime part of the Mediterranean coastal area of Morocco, located in the Western Mediterranean, at the level of the Alboran Sea, About 150 km east of the Strait of Gibraltar. The depth of the bay of Al Hoceima reaches 100 m.

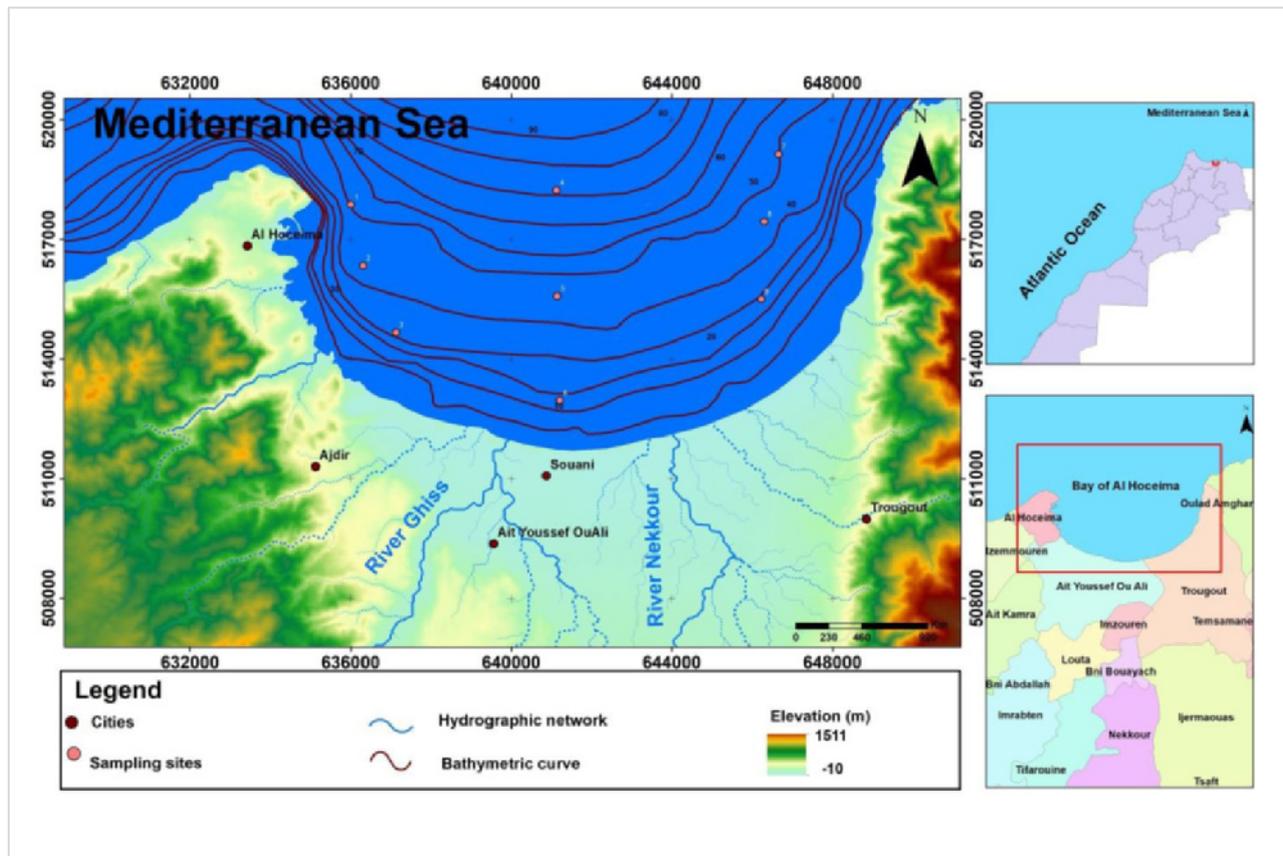


Fig. 1. Geographical location and position of the stations in the bay of Al Hoceima.

2.2 Sampling strategies

The sampling network includes nine study stations (Figure 1), which were explored during two sampling campaigns, the first in September 2021 and the second was carried out in January 2022. Sampling is carried out within the epipelagic layer (between 0 and 80 m), by vertical lines, from the bottom to the surface using a Working Party 2 (WP2) type plankton net [11].

The collected samples are immediately stored in 1 liter jars and fixed with 4% formaldehyde. The largest species encountered occasionally are co-counted on-site and photographed. In the laboratory, species identification is carried out using an Optika-SZM-2 trinocular zoom magnifier stereomicroscope. The size of the umbrellas of each individual is measured using a centimetre ruler.

The frequency of occurrence (Fr) of each species is the ratio between the number of samples containing an individual of species and the total number of samples. For each station, temperature measurements are taken in

situ in parallel with fishing operations, using a HANNA-type multiparameter.

3 Results

The water temperature of Al Hoceima Bay varied between 22.5°C and 24°C during the summer period, and between 12°C and 14°C in the winter season.

The biodiversity of jellyfish in Al Hoceima Bay, caught during the two seasons, is made up of 9 species, grouped into two classes (Hydromedusa and Scyphomedusa) and six orders. Hydromedusae populations are represented by Trachymedusae (4 species), Anthomedusae (2 species), and Leptomedusae (one species). On the other hand, the class of Scyphomedusae is represented by two orders Semaestome and Rhisostome.

Table 1. Biodiversity and Spatio-temporal distribution of species recorded during two seasons (S: Summer; W: Winter) and their frequencies of occurrence (Fi)

Class	Order	species	St1		2		3		4		5		6		7		8		9		Fi			
			S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W		
Hydromedusa	Anthomeduses	<i>Pantachogon militare</i>																				1/9		
		<i>Zanella sessilis</i>																						1/9
	Leptomeduses	<i>Mitrocomella brownei</i>																					2/9	1/9
	Trachymeduses	<i>Geryoma proboscidalis</i>																					3/9	
		<i>Aglaura hemistoma</i>																					6/9	3/9
		<i>Liriope tetraphylla</i>																					1/9	1/9
		<i>Persa incolorata</i>																						1/9
Scyphomedusa	Sameostome	<i>Pelagia noctiluca</i>																				3/9		
	Rhizotomies	<i>Rhizostoma Pulmo</i>																					3/9	

The jellyfish *Aglaura hemistoma* (Figure 2) was widely distributed in the bay, since it was found in six sampling stations, with a frequency of occurrence $Fi > 66\%$ during the summer period and a low frequency of occurrence $Fi < 11\%$ during the winter season. In addition, the occurrence frequencies Fi of the other species vary between 11% and 33%. We cite *Geryoma Proboscidalis* (Figure 5), *Pantachogon Militare* (Figure 8), *Mitrocomella*

brownie (Figure 3), and *Liriope tetraphylla* (Figure 4). For the winter season, the frequency of occurrence of the identified species was low, $Fi < 11\%$. This fauna is composed of infrequent populations; we cite *Zanlea sessilis* (Figure 6), *Mitrocomella brownei* (Figure 3), *Liriope tetraphylla* (Figure 4), and *Persa incolorata* (Figure 7).



Fig. 2. *Aglaura hemistoma* (Personnal photo)



Fig. 3. *Mitrocomella brownei* (personnal photo)



Fig. 4. *Liriope tetraphylla* (Personnal photo)



Fig. 5. *Geryoma proboscidalis* (Personnal photo)



Fig. 6. *Zanlea sessilis* (Personnal photo)



Fig. 7. *Persa incolorata* (Personnal photo)



Fig. 8. *Pantachogon militare* (Personnal photo)

The Scyphomedusa class is represented by two species, *Pelagia noctiluca* (Figure 9) which is the most common species in the Mediterranean, it has reached bloom densities, and the diameter of the umbrellas of the fished species varies between 3cm (young jellyfish) and 8cm (adult). The second species is *Rhizostoma Pulmo* (Figure 10), the latter

was not found in the net used in the sampling missions, as it was inappropriate for large jellyfish, the species are occasionally collected by a dip net or observed stranded on the beaches of Al Hoceima Bay. It is a large Scyphomedusa, the diameter of the true umbrellas between 5cm and 17cm, it is considered an endemic species of the Mediterranean [17].



Fig. 9. *Pelagia noctiluca* (Personnal photo)



Fig. 10. *Rhizostoma pulmo* (Personnal photo)

These two species were absent during the winter season but abundant during the summer period. Blooms of the *Pelagia noctiluca* jellyfish were noted on several beaches of the bay throughout the summer period, as well as *Rhizostoma Pulmo*, which is becoming more frequent in the bay.

4 Discussion

A total of 9 species of jellyfish have been identified for the first time in Al Hoceima Bay and on the Moroccan Mediterranean coast in general. They are divided into two classes (Hydromedusae and Scyphomedusae) and six orders. Qualitatively, for Hydromedusae populations, Trachymedusae were dominant (4 species), composed of (*G. proboscides*, *A. hematoma*, *L. tetraphylla*, *P. incolorata*), Anthomedusae (*O. maeotica*, *Z. sessilis*) and Leptomedusae (*M. brownie*). For the class Scyphomedusae, it is represented by two orders, Sameostome (*Pelagia noctiluca*) which is the most dominant, and Rhisostom (*Rhizostoma Pulmo*). This present work is the first inventory carried out in the Bay of Al Hoceima and the Moroccan Mediterranean coast. Furthermore, knowledge on the diversity and distribution of jellyfish remains fragmentary due to the lack of available studies and records. On the other hand, at the level of the Alboran Sea, 24 species have been counted [18]. On the Algerian coast, 14 species were sampled [14]. On the Tunisian coasts, about twenty species have been recorded [11,12]; In the Mediterranean, about 300 hydro jellyfish have been recorded [5,19,20]. The difference in the qualitative results of jellyfish found in Al Hoceima Bay (9 species) and the other areas (the Alboran Sea and the southern Mediterranean coast), can be explained by the sampling

period and frequency. In contrast, the species recorded in this study were previously found within adjacent regions of the Mediterranean, and the results are similar for some species. Indeed, the species *L. tetraphylla*, *A. hematoma*, *G. proboscides*, and *Zanclaea sessilis*, were already inventoried in previous studies in the Mediterranean [11,12,14,18,21]. In this study, the species *A. hematoma* was the most frequently observed in the sampling network, at stations (1, 3, 4, 5,7, 8) during the summer period and at stations (1, 3, 7) during the winter period. These stations are the deepest except for station (3). Its presence in deep stations can be explained by its oceanic character [11]. The Antomedusae *Pantachogon Militare* was found for the first time in the southwestern Mediterranean Sea. Scyphomedusae is represented by two species, *Pelagia noctiluca*, the latter dominates the population of scyphomedusae in the bay of Al Hoceima and *Rhizostoma Pulmo*, which is very common near the estuaries of Wadi Ghis and Nekkour. The jellyfish *Pelagia noctiluca* is present in the bay of Al Hoceima from the middle of spring until the end of September, the mass invasions of adults on the beaches of the bay have been observed throughout the summer period of 2022.

5 Conclusion

This work is part of a study carried out on the population of jellyfish that abound in the bay of Al Hoceima (Alboran Sea). She provided us with preliminary information on the biodiversity of jellyfish on the Moroccan Mediterranean coast and the species that abound in the bay of Al Hoceima, A total of 9 species of jellyfish have been identified. It is during the summer period when a high number of jellyfish species has been recorded qualitatively compared to the winter period. The blooms of the species of the two jellyfish (*Pelagia noctiluca* and *Rhizostoma pulmo*) which abound are also present in the bay of Al Hoceima during the summer period. The Antomedusae *Pantachogon Militare* was found for the first time in the southwestern Mediterranean Sea. The Trachymedusae *Aglaura hemistoma* was widely distributed in the bay, as it was found in six sampling stations.

Acknowledgments

We sincerely thank Mrs. Corinne BUSSI-COPIN, project manager for ocean policy at the Oceanographic Museum of Monaco, for her methodological support from the start of this work, which is being carried out within the framework of the UAE thematic project entitled: "Modelling of the proliferation of jellyfish in the western Moroccan Mediterranean Spatio-temporal location, causes, and impacts on the marine environment". We sincerely appreciate Mrs. Jacqueline Goy, a world specialist in jellyfish, who was consulted and kindly confirmed the identification of the species we collected. We would also like to thank Mr. Mohammed AKANDOUCH, the fisheries delegate in Al Hoceima.

References

1. L. Brotz, D. Pauly, *Acta Adriatica* **53**(2), 211-230, (2012)
2. J. Purcell, S. Uye, W. Lo, *Mar. Ecol. Prog. Ser.* **350** 153–74, (2007),
<https://doi.org/10.3354/meps07093>
3. A.J. Richardson, A. Bakun, G.C. Hays, M. J. Gibbons, *Trends in Ecology & Evolution* **24** 312–22, (2009), DOI:10.1016/j.tree.2009.01.010
4. A. Canepa, V. Fuentes, A. Sabatés, S. Piraino, F. Boero, J.M. Gili, *Sea Jellyfish Blooms* ed K A Pitt and C H Lucas (Dordrecht: Springer Netherlands) pp 237–66, (2014), DOI:10.1007/978-94-007-7015-7_11
5. J.M. Gili, F. Pagès, Jellyfish blooms Bolletí de la Societat d'Història Natural de les Balears 9–22, (2005),
<https://raco.cat/index.php/BolletiSHNBalears/article/view/170002>.
6. J. Goy, P. Morand, M. Etienne, *Deep Sea Research Part A. Oceanographic Research Papers* **36**(2), 269–79, (1989)
7. J. Goy, *Hydromedusae of the Mediterranean Sea Coelenterate Biology: Recent Research on Cnidaria and Ctenophora* Developments in Hydrobiology ed R B Williams, P F S Cornelius, R G Hughes and E A Robson (Dordrecht: Springer Netherlands) pp 351–4, (1991)
8. E. Buecher, M.J. Gibbons, Temporal persistence in the vertical structure of the assemblage of planktonic medusae in the NW Mediterranean Sea *Marine Ecology Progress Series* **189**, 105–15, (1999)
9. M. Batistić, N. Jasprica, M. Carić, D. Lučić *Journal of Plankton Research* **29**, 671–86, (2007), DOI:10.1093/PLANKT/FBM048
10. A. Sabatés, F. Pagès, D. Atienza, V. Fuentes, J.F. Purcell, J.M. Gili, *Hydrobiologia* **645**(1), 153–65, (2010)
11. M.N. Daly Yahia, J. Goy, O. Daly Yahia-Kéf, *Oceanologica Acta* **26**, 645–55, (2003),
doi:10.1016/j.oceact.2003.05.002
12. C. Touzri, H. Hamdi, J. Goy, M.N. Daly Yahia, *Mar. Ecol.* **33**, 393–406, (2012), <https://doi.org/10.1111/j.1439-0485.2012.00510.x>
13. M. Ounissi, H. Laskri, M. Khélifi-Touhami, *Medit. Mar. Sci.* **17**, 519, (2016), DOI:10.12681/mms.1474
14. A. Kherchouche, A. Hafferssas, *Medit. Mar. Sci.* **21**, 52–61, (2020),
<https://doi.org/10.12681/mms.20849>
15. B. Mghili, M. Analla, M. Aksissou, *Turk. J. Fish. Aquat. Sci.* **21**(2), 87-94, (2020),
http://doi.org/10.4194/1303-2712-v21_2_04
16. B. Mghili, M. Analla, M. Aksissou, *Aquat. Ecol.* **56**, 213–26, (2022),
<https://doi.org/10.1007/s10452-021-09910-0>
17. P.L. Kramp, *J. mar. biol. Association of the United Kingdom* **40**, 7–382, (1961),
<https://doi.org/10.1017/S0025315400007347>
18. C.E. Mills, *Sci. Mar.* **60**, 145–63, (1996)
19. F. Boero, *Biol. J. Linn. Soc.* **48**, 239–66, (1993),
<https://doi.org/10.1111/j.1095-8312.1993.tb00890.x>
20. J. Bouillon, M.D. Medel, F. Pagès, J.M. Gili, F. Boero, C. Gravili, *Sci. Mar.* **68**, 5–438, (2004)
21. C. Touzri, O.K-D. Yahia, H. Hamdi, J. Goy, M.N.D. Yahia, Spatio-temporal distribution of Medusae (Cnidaria) in the Bay of Bizerte (South Western Mediterranean Sea) 10