The first *Pelagia noctiluca* outbreak off the Syrian coast (the eastern Mediterranean Sea), five years after its first appearance

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Abstract

The blooms of mauve stinger Pelagia noctiluca (Forskål, 1775) (Scyphozoa, Semaeostomeae, Pelagiidae) in the Mediterranean Sea were generally restricted to the western basin and the Adriatic Sea. The occurrence and distribution of this species in the Levantine Basin has not been investigated adequately and is still far from being satisfactory.

The present study reports the first documented outbreak of P. noctiluca five years after its first appearance off the Syrian coast (the eastern Mediterranean Sea). It also provides an additional scientific knowledge of the P. noctiluca blooms in the Mediterranean Sea, and will extend the region limits of the above species blooms to the Levantine Basin.

Keywords *Pelagia noctiluca, mauve stinger, jellyfish, Scyphozoa, Syrian coast, Mediterranean Sea, Levantine.*

I. INTRODUCTION

Jellyfish bloom is a natural population event in the marine ecosystem. This phenomenon is not new, but the increasing incidence and frequency worldwide, and their potential impacts on marine ecosystem and their dramatic socio-economic implications, like fishing, aquaculture, tourism industries, power and desalination plants, has become a topic of recent scientific and public interest. Therefore, several workshops about jellyfish blooms were held, and a number of reports were issued ([1], [2], [3], [4], [5], [6], [7]). Even though, the ecological studies on jellyfish blooms are still insufficient ([8]).

Recent studies have suggested that jellyfish blooms may have increased in response to the cumulative effects of anthropogenic impacts, such as climate changes, environmental degradation, eutrophication, overfishing, pollution, species invasions, and coastal development ([9], [10], [11], [12], [13], [8]).

The Mediterranean Sea has been largely affected by several scyphozoan jellyfish species. Among them *Rhoplima nomadica* in the Eastern Mediterranean Sea ([14], [15]) and *Pelagia noctiluca* in the Western and Central Mediterranean Sea ([16], [17], [18], [19], [20], [21], [7]).

The mauve stinger *Pelagia noctiluca* (Forskål, 1775) (Scyphozoa, Semaeostomeae, Pelagiidae) has a holoplanktonic life cycle. It reproduces sexually by direct development without a benthic polyp stage, thus it can survive and reproduce in a wide range of environmental conditions. It has the ability to form large blooms starting from hundreds of individuals within a short time ([22], [19]). *P. noctiluca* is an important predator of zooplankton, fish eggs and larvae, their coastal aggregations can exert significant impact on food webs and fish reproduction ([11], [22], [23], [24], [25], [26]).

P. noctiluca can be found in the Atlantic Ocean, Pacific Ocean and the Mediterranean Sea. Records of *P. noctiluca* in the Mediterranean Sea began in the 1700s, motivated by its painful stings and its costal dense aggregations ([16], [3], [18]). All the published work on *P. noctiluca* blooms in the Mediterranean Sea were generally restricted to the western basin and the Adriatic Sea, while the occurrence and distribution of this species in the Levantine basin has not been investigated adequately and is still far from being satisfactory ([3], [27]).

Since 2010, surveys of jellyfish have been carried out in the Syrian coastal waters (eastern Mediterranean Sea), with monitoring being carried out bimonthly. New arrivals of non-indigenous jellyfish of the following species *Rhopilema nomdica, Aequorea globosa*, *Phyllorhiza punctata*, *Cassiopea andromeda*, *Marivagia stellate*, and *Porpita porpita* were recorded for the first time, and they are mostly of Indo-Pacific and Red Sea origin, introduced through the Suez Canal ([15], [28], [29], [30], [31], [32]).

The first records of *P. noctiluca* on the coast of Syria was on 14 June 2014, about 3 km North West of Lattakia Port ([33]). Since then, this species has been noticed and sampled twice closed to where it was first recorded.

During the period between the second and the twelfth of May 2019, coastal and offshore swarms of *P. noctiluca* were observed for the first time at various locations off the Syrian coast. This abnormal outbreak happened five years since *P. noctiluca* was first recorded. Therefore, the present study provides

an additional scientific knowledge about the *P. noctiluca* blooms in the Mediterranean Sea, and how it will extend the region limits of the above species blooms to the Levantine Basin.

II. MATERIALS AND METHODS

An extraordinary abundance of variably coloured, purple to yellowish-brown, jellyfish species, with a similarly coloured mottling on the bell, were seen for the first time by local fishermen and divers at various locations off the Syrian coast, during the period between the second and the twelfth of May 2019.

A daytime cruise was conducted along one of the main coastal outbreak location, about 10 km to the north of Lattakia Port, between Raas Ibn Hani (35°35'35.15"N, 35°45'25.37"E) and The High Institute of Marine Research (35°35'34.95"N, 35°44'31.60"E), on the fifth of May 2019, as shown in Fig. 1. This location is considered as one of the most important tourist area on the Syrian coast. The coastal water depth ranges from 5 to 20 m (Fig. 2).

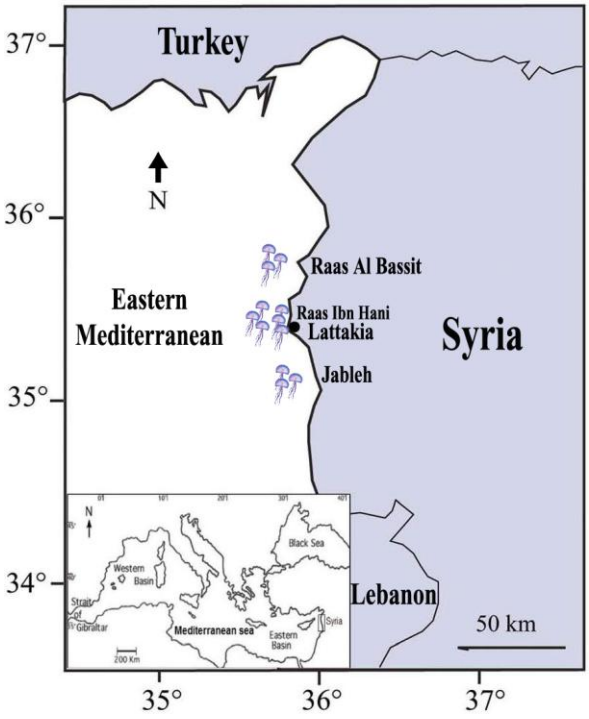

Fig 1: Locations of the observed *Pelagia noctiluca* outbreak off the Syrian Coast

The monitoring and counting process was conducted from the front of a small boat. Monitoring covered an area that could be seen to the naked eye for up to 3 m from each side of the boat, at an average speed of 5 knots, allowing good observations of the sea surface, the abundance of jellyfish species has been estimated as (individual/m^2). Random jellyfish specimens were collected using long-armed hand net (mouth diameter 60 cm and 0.5 cm mesh size). Wherever large numbers of jellyfish species were found, they were filmed under water by a professional diver at the outbreak site. The temperature at sampling time was 20 °C, while the physical properties of the water currents and wind direction were roughly estimated from the local fishermen, because the boat was not equipped for physical and hydrographical measurements.

Specimens were taken to the laboratory and were immediately examined while still alive, photographed, fixed in 4% formaldehyde and stored in the zooplankton laboratory, High Institute of Marine Research (Fig. 3).

Fig 2: *Pelagia noctiluca* (Forskål, 1775) outbreak off the Syrian Coast (Raas Ibn Hani) on the fifth of May 2019

Fig 2: *Pelagia noctiluca* (Forskål, 1775) off the Syrian Coast (Immature medusa, left photo and mature medusa right photo).

III. RESULTS AND DISCUSSION

The jellyfish specimens collected during the cruise conducted along one of the main coastline outbreak locations, on the fifth of May 2019, were identified in the laboratory by their morphology as *Pelagia noctiluca* (Forskål, 1775) (Scyphozoa, Semaeostomeae, Pelagiidae).

Two specimens of *P. noctiluca* were caught for the first time off the Syrian coast, about 3 km North West of Lattakia Port, on 14th of June 2014 ([33]). Since then, only one specimen was seen in the summer of 2018, and two specimens were seen on the 28th of March 2019, and they were sampled close to the location where they were first recorded. Larvae of *P. noctiluca* has not been recorded in any zooplankton samples on the Syrian coast. During the period between the second and the twelfth of May 2019, the first coastal outbreak of *P. noctiluca* was observed with an average density of 5 individuals/m^2,

and they formed subsurface aggregations ranging from a few to 10 m deep. This outbreak happened five years since *P. noctiluca* was first recorded off the Syrian coast.

P. noctiluca individuals were each assigned to one of five size classes using measurements of bell diameter: <1.0 cm; 1.0 to < 3.5 cm (immature medusae); 3.5 to < 6.0 cm (pre mature); 6.0 to < 8.5 cm (mature); and class >8.5 cm bell diameter ([17]). The bell diameters of *P. noctiluca* along the outbreak site ranged between 2 and 6.5 cm, with a marked chromatic difference observed between the immature medusae bell (< 3.5 cm diameter), which was yellowish-brown in colour, and that of premature and mature (> 3.5 cm diameter), which assumed a purple or pink colour.

According to this classification, approximately 80% of counted and examined *P. noctiluca* individuals had a small bell size (2-2.5 cm diameter), and were determined as an immature medusa, while approximately 15% were determined as a premature medusa, and 5% as a mature medusa.

Local fishermen have also seen an offshore patches swarm about 2 to 3 km away from the coast, many kilometers in length, with thousands of specimens involved, at different locations off the Syrian coastal waters, mainly at Raas Al Bassit and Jableh which are located about 30 Km to the north and south of Raas Ibn Hani, respectively (Fig 1.).

P. noctiluca offshore swarms were observed at night-time, whereas, the spotting of Raas Ibn Hani swarms offshore and in the coastal waters occurred at both day and night. All the swarms of *P. noctiluca* off the Syrian coast have been noticed swimming with the help of an irregular surface current which was coming down from the north-west, whereas, the direction of the prevailing current is usually south-west.

Based on historical data from the Mediterranean Sea, the most described blooms of *P. noctiluca* indicate a trend to cover the entire western Mediterranean basin, with a significant periodic outbursts of about 12 years, This trend began to deviate in the late 1990s, where blooms occurred quasi annually ([1], [16], [19], [20], [21], [7]), while in the Aegean Sea, the trend was maintaining the aforementioned 12-year periodicity ([19]). *P. noctiluca* in the Adriatic Sea was rare until 1977, then blooming became frequent for about 10 years, until 1987 afterwards it virtually disappeared for more than a decade, however, in 2004, blooms of *P. noctiluca* began to appear again until 2007 ([34], [19], [22]).

Physical forces such as wind, tidal effects, current direction and velocity, have been the main drivers for *P. noctiluca* coastal aggregations in the western Mediterranean Sea, Adriatic Sea and Maltese waters over a long period of time. It is for this reason, *P. noctiluca* has been considered an indicator of climate variability in the Mediterranean Sea ([1], [16], [2], [17], [35], [6]).

The origins and the mechanisms leading to an abnormal offshore outbreak of *P. noctiluca* off the Syrian coastal water is still unknown. However, the coastal outbreak observed off Raas Ibn Hani may have resulted from the transport of the existing offshore population inshore by specific hydrodynamic conditions, such as incoming surface currents accompanied by a strong north-west wind, which led to an offshore population pushed inshore. This claim can be supported by the sight of a random and divergent proliferation of *P. noctiluca* swarms at different locations of the Syrian coastal waters.

The reason for the uncertainty in explaining the outbreak can be attributed to a lack of observations of the annual *P. noctiluca* distribution and abundance data in the Eastern Mediterranean Sea. The most important questions to ask are: will *P. noctiluca* outbreak occur again? And when? In order to fill the knowledge gap, and to answer the above questions, a jellyfish regional monitoring network in the Eastern Mediterranean Sea should be established, in order to monitor and identify large temporal and spatial scale distribution and fluctuation of *P. noctiluca*, and the prevailing hydrodynamic conditions, to predict the conditions conducive to their outbreak in the Levantine basin.

IV. CONCLUSION

The present study reports the first documented outbreak of *P. noctiluca* five years after its first appearance off the Syrian coast (the eastern Mediterranean Sea). The origins and mechanisms leading to an abnormal offshore outbreak of *P. noctiluca* off the Syrian coastal water is still unknown, while the coastal outbreak observed off Raas Ibn Hani may result from the transport of the permanent offshore population inshore by specific hydrodynamic conditions. A jellyfish regional monitoring network in the Eastern Mediterranean Sea should be established, to predict the conditions conducive to *P. noctiluca* outbreak in the Levantine basin.

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