OPEN ACCESS
Freely Available Online

INTERNATIONAL MARINE SCIENCE JOURNAL
ISSN NO: 2643-0282

Research Article
DOI: 10.14302/issn.2643-0282.imsj-18-2514

First Geographical Record of *Corymorpha bigelowi* (Cnidaria: Hydrozoa, Corymorphidae) in the Northern Red Sea Coast of Egypt, Based on Morphological Description

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Abstract

The Anthomedusae species, *Corymorpha bigelowi* Maas, 1905 (Cnidaria: Hydrozoa, Corymorphidae), was recorded in the northern Red Sea fauna, representing it "first invasion" in Egypt. A fact proven by past studies that this species is endemic in the Indo-Pacific region, which is mainly located in southern coast of Japan and Indian Ocean. The specimens were collected from an area located off Hurghada city, and between latitudes 27° 14.427´and 27° 10.816´N, and longitudes 33° 51.085´and 33° 51.603´E using plankton net (350 µm mesh). In total, six mature medausae of *C. bigelowi* were caught in December 2014 and February 2015 (4 and 2 medusae, respectively). Following this, the captured species medusa of *C. bigelowi* was photographed and morphological characteristics described in details. As well as, further discussions of biogeographical distribution and morphological speciation of the present species were provided. This work makes a noteworthy contribution to clarify the migration route of *C. bigelowi* from southern Red Sea to the Mediterranean Sea.

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Keywords: Hydromedusae, *Corymorpha bigelowi*, Red Sea, biogeographic distribution, gelatinous zooplankton

Received: Nov 30, 2018 **Accepted:** Jan 07, 2019 **Published:** Jan 29, 2019

Editor: Adela J, The Swire Institute of Marine Science and School of Biological Sciences, the University of Hong Kong, Pokfulam, Hong Kong, China.

Introduction

A hydromedusae species, *Corymorpha bigelowi* Maas, 1905 was first described and identified as *Euphysora bigelowi* from Indonesian waters during the Siboga Expedition [1]. *C. bigelowi* is one of the 20 medusan species of *Euphysorai* Maas, 1905 that belongs to family Corymorphidae (Cnidaria, Hydrozoa, Anthomedusae) [2-4]. *C. bigelowi* is widely distributed in the Indo-Pacific region and a common species in the southeastern coast of Japan and Indian Ocean [5-9].

Although studies on the gelatinous zooplankton of the Red Sea started at the beginning of 20th century [10], our information is still inadequate and scattered. All records of plankton that collected irregularly from various localities of the Red Sea; Gulf of Suez and Gulf of Aqaba earlier to 1969 were reviewed and a list included one species of chondrophores, 25 siphonophores and 15 schyphomedusans was concluded [11]. The first intensive study on Hydromedusae of the Red Sea and adjacent water was conducted in 1973 by Schmidt [12]. He examined about 500 plankton samples collected from the entire Red Sea and Gulf of Aden by various expeditions and his own collections near Eilat throughout a long period (1956 – 1969). Of them, only 25 samples were taken from the northern Red Sea. He recorded 72 species from the entire Red Sea and found that there is an eightfold increase in the number of species from north to south. He recorded six specimens of *C. bigelowi* in the southern region only of the Red Sea.

The most recent studies on gelatinous zooplankton in the Egyptian coast of the Red Sea were carried out during a survey on board R/V Meteor in February 1999 [13, 14]. These studies recorded 16 Hydromedusae, 11 Siphonophorae, two species of Schyphomedusae and one species of Ctenophora from Gulf of Aqaba and the northern Red Sea. A fact proven by all previous studies that *C. bigelowi* did not record from the northern Red Sea and the two Gulfs, Aqaba and Suez. The present study corroborates the occurrence of a Hydromedusae species, C. bigelowi, for the first time in the northern Red Sea. Also the study clarifies its migration route from southern Red Sea to the Mediterranean Sea.

Materials and Methods

Specimen Collection

Four stations were selected in the coastal region of the Egyptian Red Sea off Hurghada city (1-4 from north to south), between latitudes 27° 14.427´and 27° 10.816´N, and longitudes 33° 51.085´and 33° 51.603´E as shown in Figure (1). The back shore area of station 1 is occupied by a resort. Station 2 represents the main port for sailing boats. Station 3 is rich with seagrasses and well known for hotels, tourism markets and large number of touristic boats. Station 4 is very close to the Island of Magawish. The specimens were collected monthly from four stations during August 2014-July 2015. Horizontal near surface hauls from 2m depth were conducted in the morning, before sunset, using a plankon-net (mesh size: 350 µm, diameter: 100 cm). Gelatinous organism was separated from the catch and fixed in neutralized 4% formalin for later identification. Temperature and salinity were recorded in situ using thermometer and refractometer, respectively.

Microscopic Examination

In a preserved state of specimens, the *C. bigelowi* were examined under stereomicroscope, photographed with Olympus Camera. In order to identify the captured species, the morphological characteristics depicted in detail. The identification was confirmed with regard to main features and measurements as indicated in the literature using different keys [5, 10, 15, 16].

Results and Discussion

Material Examined

Through 48 catches from the northern Red Sea coast off Hurghada at 2m depth during August 2014-July 2015, six mature medusae of *C. bigelowi* were obtained. Of them four specimens were observed at station 3 in December 2014 and two specimens recorded at station 1 in February 2015.

Systematics

Order ANTHOATHECATA Cornelius, 1992

Suborder CAPITATA Kühn, 1913

Family CORYMORPHIDAE Allman, 1872

Genus *Corymorpha* Maas, 1905

Corymorpha bigelowi Maas, 1905 (Figure 2a,b)

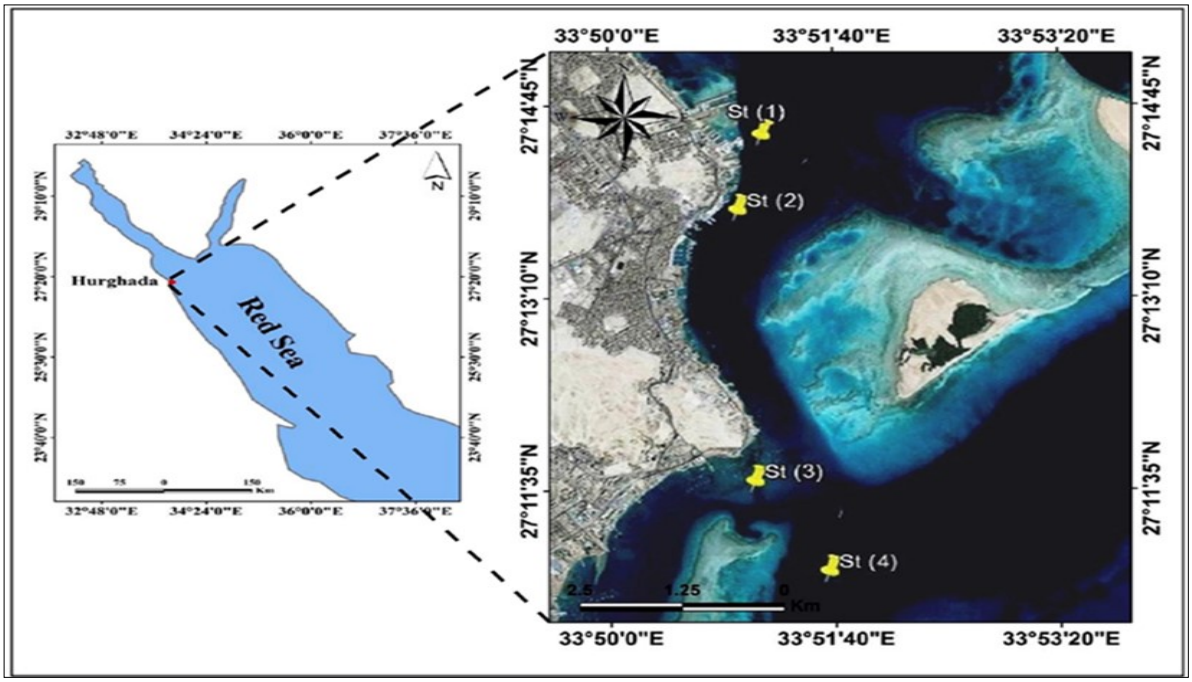

Figure 1. Locations of selected stations in the northern Red Sea of Egypt.

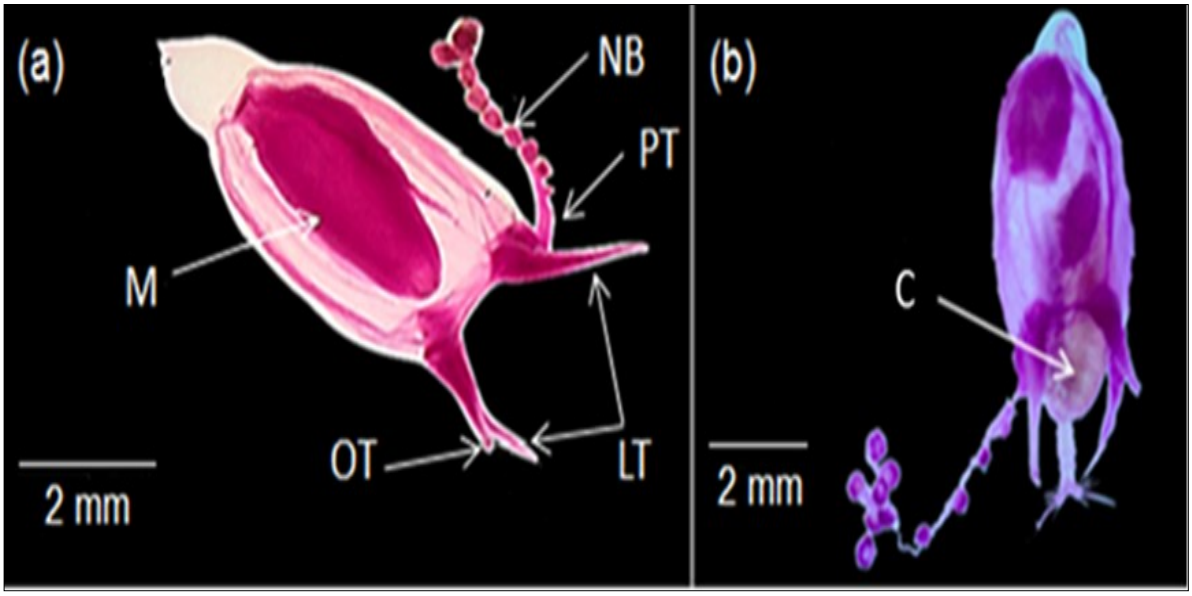

Figure 2. *C. bigelowi* in the Red Sea, Egypt; a) Adult medusa showing manubrium (M), principle long tentacle (PT), nematocyst bulbs (NB), lateral short tentacles (LT) and opposite short tentacle (OT), and b) Mature medusa eating copepod (C).

Since the erection of *C. bigelowi* by Maas in 1905 as Euphysora and up to the study of Sassaman and Rees [17], this genus had a complex taxonomic history wavering among *Euphysora*, *Euphysa* or *Corymorpha* (as *Steenstrupia*) [5, 10, 18, 19]. The polyp of *C. bigelowi* was reared in the laboratory and its nomenclature was revised on the basis of life cycle, to be a species of Corymorpha [17]. Later on, the living hydroid bearing medusa buds was first collected in the field from coastal region of Akajima Island, Kerama Islands, Okinawa, Japan [20]. In samples collected from the sea of Japan at high depths (2545–2555 m and 3340–3347 m), a larva in the form of young polyps (1 mm height) was identified as *Euphysora bigelowi* [21]. All recorded medusae in the present study were adults. However, the immature medusa of this species was recorded in Japan [8, 9].

Morphological Description of Adult Medusae

For examined specimens in the present study, the umbrella measured up to 5.5 mm high and 2.5 mm width. The umbrella was dome shaped with apical pointed projection terminating in a patch of small papillae (Figure 2). There were four spherical radial bulbs on the bell end with four tentacles at the bell margin, one long and three short. On the tentacles: the principle one was as long as the bell and differs from others not only in size, but also in structure. It has as many as 10 (possibly nine) unilateral, adaxial nematocyst bulbs along its length and a large distinct terminal bulb. Although the remaining three tentacles were short, pointed and rudimentary, without nematocyst bulbs, the two tentacles adjacent to the principle tentacle, the lateral tentacles, were approximately twice as long as the one opposite (Figure 2a, b). Manubrium is cylindrical and approximately as long as bell cavity, with simple circular mouth. *C. bigelowi* feed on copepods as shown in Figure (2b).

In comparison, the morphological characteristics of *C. bigelowi* medusae collected from the Egyptian water of the northern Red Sea fitted with the range of variations stated in some studies and varied with others as shown in Table 1. Previous studies proved that there are three quite variable characters in *C. bigelowi* medusae; i.e the presence or absence of the apical canal, the relative lengths of the three short tentacles, and the relationship between bell height and the number of nematocyst bulbs on the principle tentacle. For the first distinguished character, it would be confused that specimens of *C. bigelowi* recorded from the Malay

Table 1. Comparing morphological characters of *C. bigelowi* recorded in the present study with those recorded in previous studies.

Reference	Location	Apical canal		Relative lengths of opposite [a] and lateral [b] tentacles			Relationship between medusa height and no. of nematocyst bulbs	
		present	absent	a<b	a>b	a=b	Medusa height (mm)	No. of bulbs
Maas 1905	Malay Archipelago	+	+					
Browne 1916	Indian Ocean off Japan		+	in large medusa		in small medusa	4	11
Uchida 1927	Japan		+				3.5	26
Kramp 1928	Sundan Strait	+	+	in small medusa	in large medusa		2.25 1.5	21 31
Sassaman & Rees 1978	Reared California specimens	+		in large medusa			5	11
Present study	Northern Red Sea		+	in large medusa			5.5	11

Archipelago [1], and from the Sunda Strait [22] included animals with and without apical canals. While other descriptions for specimens from the Indian Ocean and off Japan [19, 23] coincided with the Egyptian material in the complete absence of apical canals. In contrast, all reared California specimens, had well-developed apical canals [17].

Secondly, on the tentacles and the relative length, specimens from Sunda Strait showed that the opposite tentacle is shorter than the other two in small specimens (medusae height: 1.5 mm), but its relative length increases with medusa size and may eventually exceed the lateral tentacles in length (medusae height: 2.25-3 mm) [22]. Whereas those noted in small specimens from Indian Ocean off Japan were of equivalent length [23], but that in the larger specimen (4 mm high) the opposite tentacle was much shorter than the lateral tentacles. In the California [17] and Egyptian specimens (present study), the opposite tentacle was substantially shorter than the other two, even in the largest medusa (>5 mm high).

Concerning the third morphological feature, most observations concluded that the number of nematocyst bulbs on the principal tentacle often increase with decreasing medusa height. For example, the highest medusa recorded from the Indian Ocean (4 mm) [23], California (5 mm) [17], and the present study (5.5 mm), had 11 nematocyst bulbs, whereas a 2.25 mm medusa from the Sunda Strait had 21 nematocyst bulbs, and one individual of 1.5 mm high had 31 [22]. In other study, a 3.5 mm medusa with 26 subterminal bulbs was recorded [19].

In conclusion, a common view was that the three characters do not appear to be correlated. The observations revealed that the Egyptian specimens are more similar to those from the Indian Ocean and California with regard to the lengths of the secondary tentacles and the number of nematocyst bulbs on the primary tentacle, but resemble those from the Indian Ocean off Japan in lacking the apical canal.

Biogeographic Distribution

This species is originally described from Malay Archipelago, Indonesia [1]. It is widely distributed in the Pacific and Indo-Malayan region, also in coastal areas of Japan and China. Additional Indo-Pacific materials are originated from Hong Kong [24], Sunda strait, Philippines [22], Amakusa and Tanabe Bay [25, 26], China [27, 28], and off Pacific Ocean; Palao Islands [29], Chile and Australia [30, 31], Indo-Malayan region [5], Kerama Islands, Okinawa [20], Nansei Islands [32]. Also, it was recorded from different localities off Indian Ocean such as; Alphonse Island [23], Bombay [33], Indian coasts [34, 35], Arabian Sea and Bay of Bengal [36]. It is extended to Gulf of Aden and southern Red Sea at Dahlak Archipelago [12].

Although *C. bigelowi* is a widespread species in the Indo-Pacific, and was frequently recorded from many locations in the Pacific and Indian oceans since its first record in 1905 [1] up to 2006 [32], its occurrence in the Red Sea was restricted to southern end. Curiously, Schmidt [12] mentioned finding specimens of Hydromedusae in the Red Sea and Gulf of Aden. He divided the area of investigation into 6 regions [Bay of Eilat (E); Gulf of Aqaba (A); northern Red Sea proper (S); southern Red Sea (R); Dahlak Archipelago (D) and Gulf of Aden (N)]. He reported five specimens of *C. bigelowi* at five sites in the southern Red Sea (R) (16° 32´N, 41° 06´E) in 1958 and 1964, and one specimen in Dahlak Archipelago (D) in 1962.

Nevertheless, *C. bigelowi* was not hitherto recorded from the northern Red Sea whereas it was recorded in the eastern Mediterranean [37]. It is worth mentioned that the presence of *C. bigelowi* in the Mediterranean is solely based on two preserved medusae from Israeli coast, without any figure or description [37]. Thus, this finding is somewhat doubtful and needs further confirmation since the identification lacks some credibility. Additionally, a limitation of Schmidt findings from samples collected in 1968 up to hitherto, no more records for this species was appeared in the Mediterranean. Despite suggestion of transporting *C. bigelowi* through the Suez Canal from the Red Sea to the Mediterranean [37], we could not confirm his suggestion due to the lack of information on the presence of this species in Suez Canal and no more findings in the Mediterranean. However, this work could help to figure the route of migration via Suez Canal, in case that his presence in the Mediterranean Sea is confirmed. Further research on tracing this species, which take genetic data into account as molecular

evidence, needs to be undertaken to better understand of the introduction route of *C. bigelowi* to the Mediterranean.

Environmental Assessments

The environmental factors are driving the geographical fauna distribution. In this attempt, the temperature and salinity were assessed. In the present study, *C. bigelowi* was recorded in the northern Red Sea in winter (December and February) when surface water temperature and salinity were ~18.4 °C and ~40 ‰, respectively. Earlier records indicated that *C. bigelowi* is a high temperature species being widely distributed in equatorial and tropical areas of the Pacific, Indo-Pacific and Indian Oceans [5], giving a tolerant temperature range between 24 and 28 °C [36]. Moreover, *C. bigelowi* is considered a euryhaline species with an optimal salinity of ~ 33‰, and a tolerate range of 31.9-36‰ [36]. The presence of *C. bigelowi* in the temperate-subtropical conditions of the northern Red Sea could be explained according to one of two assumptions. One of these could be that *C. bigelowi* broadened its tolerance range for temperature to the extent that it succeeded to occur in such lower temperature than its tolerance range. The second could be related to the climate change which makes the conditions in the northern Red Sea more suitable for C. bigelowi. Finally, it could likely reflect the scarcity of knowledge of Hydrozoa in the Red Sea due to lack of study rather than absence of species.

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