

The westernmost record of *Rhopilema nomadica* (Galil, 1990) in the Mediterranean – off the Maltese Islands

Alan Deidun^{1*}, Shaun Arrigo² and Stefano Piraino³

¹IOI-Malta Operational Centre, University of Malta, Msida, Malta

²Calm Seas, Malta

³Evolutionary and Developmental Biology of Marine Invertebrates, Dipartimento Scienze e Tecnologie Biologiche ed Ambientali (DISTEBA), University of Salento, Lecce, Italy

E-mail: alan.deidun@um.edu.mt (AD), heinemann@waldonet.net.mt (SA), stefano.piraino@unisalento.it (SP)

*Corresponding author

Received: 4 July 2010 / Accepted: 12 August 2011 / Published online: 19 September 2011

Abstract

In late autumn and early winter of 2004, two individuals of the Erythrean alien *Rhopilema nomadica* were sighted at two locations off the Maltese Islands, marking the westernmost records of this species in the Mediterranean Sea. Since only two adult specimens were ever reported from Maltese waters, in the species has yet to establish a reproducing population in the Sicily Channel. The record is considered as yet another hallmark of the warming trend of the Mediterranean Sea.

Key words: *Rhopilema nomadica*, Maltese Islands, Erythrean alien, warming trend

Introduction

Rhopilema nomadica Galil, 1990, is a tropical scyphozoan which purportedly first entered into the Mediterranean Sea via the Suez Canal since the late 1970's. Since then, this planktotrophic jellyfish species has regularly formed swarms of considerable proportions (some stretching for 100km) along the Levantine coast, decimating this ultra-oligotrophic part of the Mediterranean Sea of plankton resources and impinging in a detrimental fashion on tourism, fisheries and coastal installations (Galil 2007).

Rhopilema nomadica is considered as one of the “100 worst invading species” in Europe within the Delivering Alien Invasive Species Inventories for Europe (DAISIE), this designation being justified by its rapid spread and high densities in the easternmost parts of the Mediterranean Sea. Ever since its introduction more than 30 years ago, the native Mediterranean *Rhizostoma pulmo* Macri, 1778, has ceased to be the important scyphozoan species in the Levant in terms of biomass and abundance

(Lakkis and Zeidane 2010). *Rhopilema nomadica*'s prodigious spread in the Levantine Basin is spurred by its peculiar life cycle, which features polyp asexual reproduction and resting periods via podocyst formation, and polydisc strobilation leading to liberation of multiple ephyrae from each individual polyp.

Lotan et al. (1992) conducted tests on the temperature dependence of the strobilation process of the species' polyps and concluded that the synchronisation and annual occurrence of *Rhopilema nomadica* may be controlled by seasonal variations in water temperature regimes. This jellyfish species inflicts painful stings on swimmers and fishermen, characterised by erythematous eruptions, itching and burning sensations. Systematic symptoms include fever, fatigue and muscular aches (as reviewed in Gusman et al. 1997). As early as the summer of 1987, severe jellyfish envenomations requiring hospitalization had been reported in the medical literature (Galil 2010). We report herein the first finding of adult *R. nomadica* in Maltese waters, the westernmost record of the species in the Mediterranean Sea.

Figure 1. Location of the two sightings of *Rhopilema nomadica* in the Maltese Islands.

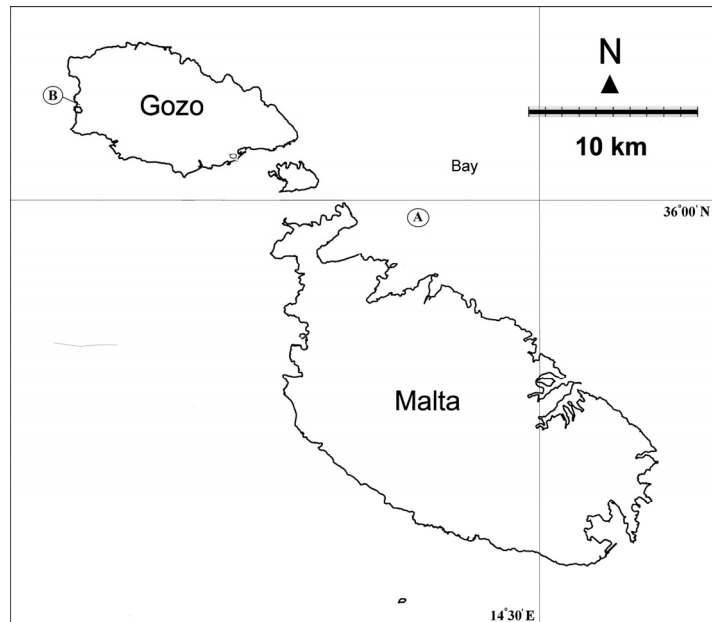


Table 1. Geographical coordinates of the two Maltese coastal sites at which *Rhopilema nomadica* individuals were filmed in 2004.

Date	Location	Coordinates	Number of <i>R. nomadica</i> individuals recorded
November 2004	Sikka l-Bajda, Malta	35°59'27"-14°23'42"	1
December 2004	Dwejra, Gozo	36°03'14"-14°11'29"	1

Materials and methods

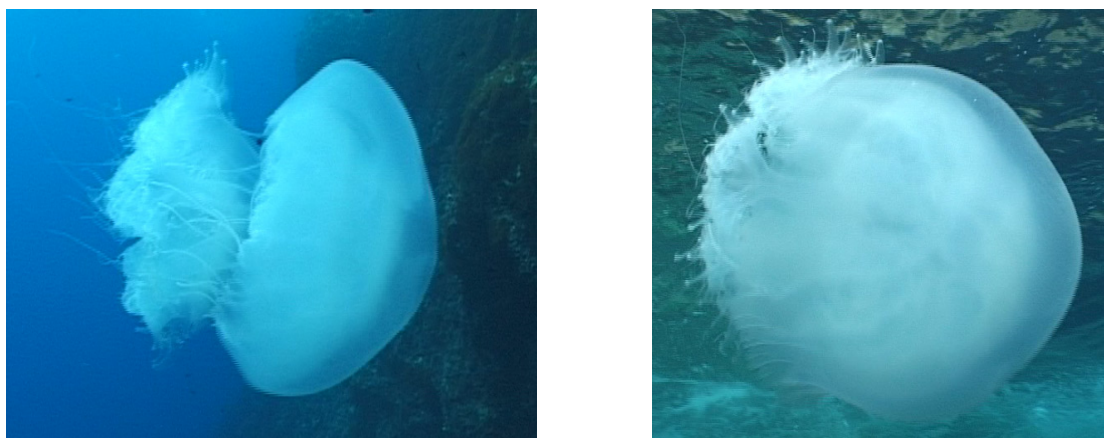
An underwater film footage was shot by Shaun Arrigo (Planet Sea) in late autumn and early winter of 2004 at shallow waters at two coastal locations in the Maltese Islands (Figure 1) using a Sony DV Camcorder PD150 fitted within an Amphibico Housing. The video footage was gleaned within the ambit of the ‘Spot the Jellyfish campaign’, a citizen science jellyfish species monitoring initiative operated by the International Ocean Institute-Malta Operational Centre of the University of Malta. Through the initiative, a number of gelatinous species were recorded for the first time from the Maltese Islands – *Porpita porpita* Linnaeus, 1758, *Aequorea* sp., *Olindias phosphorica* Delle Chiaje, 1841, *Leucothea multicornis* Quoy and Gaimard, 1824, *Beroe forskalii* Milne Edwards, 1841 and *Beroe cucumis* Fabricius, 1780 (Deidun 2010; Deidun 2011).

Results and discussion

The footage taken in 2004, had been made available to the authors of this study only recently. The photos clearly record the first images of *Rhopilema nomadica* in Maltese waters, reported at two separate sites (Table 1, Figure 1). The identification and morphological analysis of two individuals of *R. nomadica* was made through a detailed perusal of the underwater footage. Figures 2a and 2b show the two jellyfish individuals in question, extracted as still images from the same video footage.

Both recorded jellyfish were actively swimming trailing long extended tentacle filaments, at shallow depths ranging between 1 and 5m. Bell diameter was estimated around 40 cm for both specimens. Gonad pouches were not distinguishable, suggesting both specimens had spent gonads.

From the available literature, it is possible to reconstruct a chronogeonomic map of



Figures 2. The two *Rhopilema nomadica* individuals caught on film in 2004 in Maltese coastal waters. Photos extracted from footage taken by Shaun Arrigo.

Table 2. Landmark records of *Rhopilema nomadica* for eastern Mediterranean sites (as plotted in Figure 3).

Coastal zone	Coordinates/locality	Record dates	Population status	Published reference
Israel	El Dor (30 km south of Haifa)	30.09.1976	First record (single specimen)	Galil et al 1990
Israel	Beit Yanai	June 1986	Many specimens	Galil et al 1990
Israel	Hashdod, Hahotrim, Haifa,	Summer 1989	Outbreaks	Galil et al 1990
Lebanon		1988	First record	Lakkis and Zeidane 1991
Lebanon, Syria	Jounieh, Lattakia	1991	Outbreaks	Lakkis and Zeidane 1991, Lotan et al 1994
SE Turkey	Mersin,	1995	Outbreaks	Kideys and Gücü 1995
SE Turkey	Iskenderun Bay	1996	Outbreaks	Avsak et al 1996
SW Turkey	Izmir	1998	Single specimen	Galil and Zenetos 2002
Sicily Channel	Malta waters (see Table 1)	Late autumn 2004	Two specimens	Present record
SE Turkey	Finike	2006	Single specimen	Ozturk and Isinibilir 2010
Greece	Skoutary, Lakonikos gulf	2006	Two specimens	Siokou-Frangou et el. 2006
Marmaris, SW Turkey	36°50'50.90"N, 28°16'13.29"E	June 2011	Single specimen	Gülşahin and Tarkan 2011

Rhopilema nomadica invasive dispersal. Since its entrance in the Mediterranean Sea, this jellyfish embarked on a north-eastward range expansion (Figure 3), first colonizing Israeli and Lebanese waters (Galil et al 1990, Lakkis and Zeidane 1991), being recorded successively in southeastern Turkey off the coast of Mersin (Kideys and Gücü 1995) and in Iskenderun Bay (Avsar 1996), then in 1998 westward near Izmir (Ionian coast of Turkey) (Galil and Zenetos 2002) and in Lakonikos gulf, Greece, in 2006 (Siokou-Frangou et el. 2006). Supporting information to Figure 3 is provided in Table 2.

The spread pattern of *R. nomadica*, in common with that of other Erythrean aliens, follows the Levantine current (Malanotte-Rizzoli et al. 1999), with other planktonic components, including zooplanktonic copepods, exhibiting a similar dispersal pattern within the Mediterranean Sea (Lakkis 1990; Siokou-Frangou et al. 1999).

Lotan et al. (1992, 1994) had hypothesized that the future dispersal of *R. nomadica* would be restricted to the eastern Mediterranean as a result of the sensitivity of the scyphistoma (polyp) stage to low temperatures. The findings of this



Figure 3. Hypothesized expansion route taken by *Rhopilema nomadica* throughout the Mediterranean Sea to date. Key: red years, records of outbreaks; black years: records of few individuals. Supporting information to the records reported in this figure is given in Table 1.

study may not necessarily contradict such a hypothesis as drifting jellyfish may reach the entrance to Western Mediterranean, but the full completion of the *R. nomadica* life cycle may be prevented by the low winter temperatures affecting scyphistoma or podocyst stages survival.

On the other hand, the invasiveness of *Rhopilema nomadica* might be determined by acclimation processes requiring one to several years. The progressive expansion toward the Israeli, Lebanese, and southeastern Turkish coasts, with initial occurrence of a few pioneer individuals followed by large outbreaks, demonstrated that the establishment of large established populations may occur in a few years.

The fact that *Rhopilema nomadica* was filmed within Maltese coastal waters and within the Sicily Channel in 2004, and that no further sightings of the species were made in the Sicily Channel or in the western basin suggests that the species has not established any reproductive populations in the Sicily Channel and that it is still strictly restricted to the eastern half of the

Mediterranean Sea, particularly to the Levantine Basin.

The occurrence within Maltese coastal waters of *R. nomadica* follows the recording in 2009 of another alien jellyfish species - *Cassiopea andromeda* Forskall, 1775 (Schembri et al. 2009). Similarly, Boero et al (2009) recorded the isolated record of *Phyllorhiza punctata* Von Lendenfeld, 1884, off Sardinia, suggesting that the conditions of the Mediterranean Sea are becoming increasingly conducive to the spread of species of warm water affinity. The recording of *R. nomadica* in Maltese waters may be considered as another hallmark of the current warming trend of the Mediterranean Sea.

Acknowledgements

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement No. 266445 for the project Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors (VECTORS) and by the Euromediterranean Center for Climate Changes – CMCC (Italy-Israel Cooperation Programme on Environment Research and Development, funded by the Italian Ministry of Environment and Territory) (SP).

References

- Avsar D, Çevik C, Türeli C (1996) İskenderun Körfezi için yeni bir tür olan (*Rhopilema nomadica*)'nın biyometrisi ve Yumurtalık Koyundaki bulunurluğu. XIII. Ulusal Biyoloji Kongresi, 17–20 Eylül 1996 İstanbul. Düzenleyen Kuruluş: İ.Ü. Fen Fakültesi, Biyoloji Bölümü
- Boero F, Putti M, Trainito E, Prontera E, Piraino S, Shiganova T (2009) First records of *Mnemiopsis leidyi* (Ctenophora) from the Ligurian, Thyrrenian and Ionian Seas (Western Mediterranean) and First Record of *Phyllorhiza punctata* (Cnidaria) from the Western Mediterranean. *Aquatic Invasions* 4(4): 675-680.
- Deidun A (2010) Notes on the recent occurrence of uncommon pelagic “jellyfish” species in Maltese coastal waters. *Naturalista Siciliano* S. IV, XXXIV (3-4): 375-284
- Deidun A (2011) A collection of recent ctenophore sightings from Maltese waters. *Journal of the Black Sea/Mediterranean Environment* 17(1): 4-13.
- Galil B, Spanier E, Ferguson W (1990) The Scyphomedusae of the Israeli Mediterranean coast, including two Lessepsian migrants to the Mediterranean. *Zoologische Mededlingen* 64(7): 95–105
- Galil B, Zenetos A (2002) A sea change – exotics in the Eastern Mediterranean Sea. In: Leppakoski E, Gollasch S, Olenin S (eds) Invasive aquatic species in Europe. Distribution, impacts and management, edited by Dordrecht, Boston, London. Kluwer Academic Publishers, pp 325–336
- Galil B (2007) Seeing Red: Alien species along the Mediterranean coast of Israel. *Aquatic Invasions* 2: 281–312, <http://dx.doi.org/10.3391/ai.2007.2.4.2>
- Galil B (2010) The price of change: jellyfish outbreaks along the Mediterranean coast of Israel In: Report of the workshop on Algal and Jellyfish Blooms in the Mediterranean and the Black sea Istanbul, Turkey 6-8 October 2010. General Fisheries Council for the Mediterranean (GFCM), pp 3–4
- Gülşahin N, Tarkan AN (2011) The first confirmed record of the alien jellyfish *Rhopilema nomadica* Galil, 1990 from the southern Aegean coast of Turkey. *Aquatic Invasions* 6, Suppl. 1: S95–97, <http://dx.doi.org/10.3391/ai.2011.6.S1.022>
- Gusman L, Avian M, Galil B, Patriarca P, Rottini G (1997) Biologically active polypeptides in the venom of the jellyfish *Rhopilema nomadica*. *Toxicology* 35: 637–648
- Kideys AE, Gucu AC (1995) *Rhopilema nomadica*: A Lessepsian scyphomedusan new to the Mediterranean coast of Turkey. *Israel Journal of Zoology* 41(4): 615–617
- Lakkis S (1990) Composition, diversite et successions de copepodes planctoniques des eaux libanaises (Mediterranee orientale). *Oceanologica acta* 13 (4): 489–501
- Lakkis S, Zeidane R (1991) Jellyfish swarm along the Lebanese coast (Abstract) Lebanese Association for the Advancement of Science 11th Science Meeting American University of Beirut
- Lakkis S, Zeidane R (2010) Jellyfish bloom in the Lebanese seawaters: is it a sequence of the “Tropicalization” of the Levantine Basin? In: Report of the workshop on Algal and Jellyfish Blooms in the Mediterranean and the Black sea Istanbul, Turkey 6-8 October 2010. General Fisheries Council for the Mediterranean (GFCM), pp 3–4
- Lotan A, Ben-Hillel R, Loya Y (1992) Life cycle of *Rhopilema nomadica*: a new immigrant scyphomedusan in the Mediterranean. *Marine Biology* 112: 237–242, <http://dx.doi.org/10.1007/BF00702467>
- Lotan A, Fine M, Ben-Hillel R (1994) Synchronization of life cycle and dispersal pattern of the tropical invader scyphomedusan *Rhopilema nomadica* is temperature dependent. *Marine Ecology Progress Series* 109: 59–65, <http://dx.doi.org/10.3354/meps109059>
- Malanotte-Rizzoli P, Manca BB, D'Alcala MR, Theocharis A, Bergamasco A, Bregant D, Budillon G, Civitarese G, Georgopoulos D, Michelato A, Sansone E, Scarazzato P and Souvermezoglou E (1997) A synthesis of the Ionian Sea hydrography, circulation and water mass pathways during POEM-Phase 1. *Progress in Oceanography* 39(3): 153–204, [http://dx.doi.org/10.1016/S0079-6611\(97\)00013-X](http://dx.doi.org/10.1016/S0079-6611(97)00013-X)
- Ozturk B, Isinibilir M (2010) An alien jellyfish *Rhopilema nomadica* and its impacts to the Eastern Mediterranean part of Turkey. *Journal Black Sea/Mediterranean Environment* 16(2): 149–156
- Schembri PJ, Deidun A, Vella P (2009) The first record of *Cassiopea andromeda* (Scyphozoa: Rhizostomeae: Cassiopeidae) from the central Mediterranean Sea. *Journal of the Marine Biological Association of the UK* 2 (3), [doi:10.1017/S1755267209990625](http://dx.doi.org/10.1017/S1755267209990625)
- Siokou-Frangou I, Gotsis-Skretas O, Christou ED, Pagou K (1999) Plankton characteristics in the NW Levantine Sea and the adjacent areas. In: Malanotte-Rizzoli P, Eremeev VN (eds), “The Eastern Mediterranean as a laboratory basin for the assessment of contrasting ecosystems”, Kluwer Academic Publishers, pp 205–223
- Siokou-Frangou I, Sarantakos K, Epaminondas DC (2006) First record of the scyphomedusa *Rhopilema nomadica* Galil 1990 (Cnidaria: Scyphozoa: Rhizostomeae) in Greece. *Aquatic Invasions* 1: 194–195, <http://dx.doi.org/10.3391/ai.2006.1.3.17>