

Rapid Communication

Early stages of establishment of the non-indigenous ascidian *Herdmania momus* (Savigny, 1816) in shallow and deep water environments on natural substrates in the Mediterranean Sea

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Abstract

The solitary ascidian *Herdmania momus* (Savigny, 1816) was first recorded in the Eastern basin of the Mediterranean, off the coast of Israel, in 1958. Since then, *H. momus* established along the shores of Israel, albeit restricted to artificial substrates (e.g., pier pillars, artificial reefs, and shipwrecks) and deeper waters (20–30 m) in comparison to its native range. It has recently spread to natural substrates (i.e. the rocky reef) and shallow water environments (< 1 m). Field surveys, augmented by observations by recreational divers, were conducted along the Israeli Mediterranean coast on natural substrates to assess the present distribution. *H. momus* was detected on natural substrates at eleven sites, some of them at very shallow depths. This change in the distribution of *H. momus* that now includes natural substrates in shallow waters along with deep water environments may have negative impacts on the native fauna in the Eastern Mediterranean.

Key words: ascidians, marine bioinvasion, recreational divers, Lessepsian migration

Introduction

The opening of the Suez Canal in November 1869 enabled the movement of vessels between the Red Sea and the Mediterranean Sea, dramatically affecting both marine commerce worldwide and the biodiversity of the Mediterranean. There are now at least 343 species that have been introduced from the Red Sea into the Mediterranean Sea through the Suez Canal (Galil and Goren 2014). This ongoing introduction, known as the "Lessepsian migration" (Por 1978), or "Eritrean invasion" (Galil 2006), is one of the most extensively documented phenomena of marine bioinvasions, featuring species from many taxonomic groups (Galil and Zenetos 2002). One of the invertebrate "Lessepsian species" is the solitary ascidian *Herdmania momus* (Savigny, 1816).

Common in the Red Sea, *H. momus* can be found in the Gulfs of Suez, Aqaba and Aden. It was first recorded in the Suez Canal in 1924 (Harant 1927), and later along the Eastern

Mediterranean shores of Israel (Pérès 1958), Cyprus (Nishikawa 2002), Turkey (Çinar et al. 2006) and Lebanon (Bitar et al. 2007). Although *H. momus* populations have become well established along the Mediterranean coast of Israel, until recently its distribution was restricted to artificial substrates such as cement structures, wharves, and submerged vessels and at greater depths (20–30 m) than those occupied by the native Red Sea population (Shenkar and Loya 2008). This restriction of *H. momus* to man-made habitats in the Mediterranean suggests that it is a non-indigenous ascidian in its initial stages of invasion or a species that is continuing to spread. The previous absence of this tropical species from shallow waters (< 1 m) has been explained by the stronger wave exposure that characterizes the Mediterranean Sea (Shenkar and Loya 2008). This also reinforces the hypothesis that *H. momus* is an invader in its primary stages of establishment and has not yet fully adjusted to its new environment. The first evidence for spread to more shallow depths was found in February

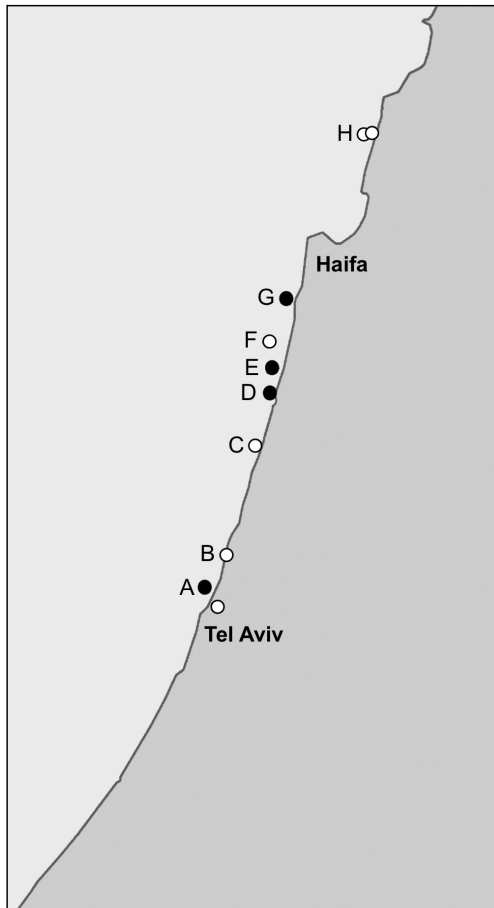


Figure 1. Map with locations of *Herdmania momus* on natural substrate. White dots denote where *H. momus* were recorded by scientific divers, while black dots denote records made by recreational divers. See more information in Annex 1 (The base maps were generated on <http://www.planiglobe.com>).

2013 when a large population (5 individuals per m^2) of *H. momus* was observed in the Rosh Haniqra marine nature reserve, Israel (10–13 m depth), on natural rocky substrate. This observation led to the hypothesis that the *H. momus* invasion is in a transitional stage, and that it may have the capacity to colonize natural substrates. If this hypothesis is correct, then we have a rare opportunity to observe and study this process.

Methods

To document the spread and establishment of *H. momus* on natural substrate along the Mediterranean coast of Israel, we conducted a series of underwater field surveys from March to November 2013. Specimens of *H. momus* were located and counted during every dive. The Israeli coastline

is approximately 105 km long, with many areas closed to the public. Closed military areas, as well as ports for civil and military use, block general access to many shores. To date, populations from natural rocky substrate have been documented by scientific divers at four locations – Herzliyya (10 m depth), Mikhmoret (6.5 m), Dor nature reserve (2–4 m), and Akhziv shallow lagoon, in depth of <1 m (exact waypoints appear in Annex 1).

To expand our database, we needed to increase the number of surveying divers; therefore, we sought the involvement of the public, seeking assistance from recreational divers and the military marine and naval units of the Israel Defence Forces. Informative posters were distributed at dive centers and military bases to help raise awareness of the introduction of *H. momus* (Annex 2). The poster presented information on invasive species, various ascidians, and *H. momus*. In addition, we gave popular science lectures on the same topic. Divers were asked to inform us by e-mail about the specific location, depth, and substrate type (artificial/natural) where they observed *H. momus*, and to attach a photo if possible. In addition, separate surveys were carried out monthly at the Rosh Haniqra marine nature reserve by SCUBA divers beginning in May 2013 to document seasonal changes in the *H. momus* population, and population dynamics. The surveys were performed between 20 to 25 meters depth, using a 10 m measuring tape. All specimens of *H. momus* counted in a distance of 1 m above the measuring tape were recorded.

Results and discussion

Between June and November 2013, we received eight reports of *H. momus* as a result of our public campaign. Six of the reports contained photos that enabled us to confirm the identification of *H. momus* and provided information about six new locations: Gordon reef: (4–8 m deep), Sedot Yam (5 m and 30 m), Jisr Ez Zarqa (30 m), Atlit (20–30 m), Akhziv caves (3–5 m) and the military zone of Rosh Haniqra (12 m). Several scientific dives were subsequently conducted to verify the data received in these reports (Figure 1; Annex 1).

Monthly survey in the Rosh Haniqra marine nature reserve showed an average of 2.85 individuals per m^2 between May and November 2013, when *H. momus* typically formed aggregates of 3–6 individuals on the natural rocky reef (Figure 2). Seasonal differences will be examined after completing monitoring period of 24 months.



Figure 2. *Herdmania momus* aggregation in Rosh Haniqra marine nature reserve on natural rocky reef. July 2013. Photo: M. Gewing.

Our field surveys and recreational diver reports helped us describe a non-indigenous ascidian that is increasing its ability to colonize natural substrates along the Mediterranean coast of Israel, and expanding its habitat range by establishing in shallower waters (< 10 m).

An examination of any differences in genetic diversity and structure between *H. momus* from natural and artificial substrates in the Mediterranean and the Red Sea, will further contribute to our understanding of the invasion process of *H. momus*. COI sequences produced from natural substrate population will be added to (Rius and Shenkar 2012) data, and reanalyzed in order to ascertain the origin of the population now colonizing natural substrates.

Non-indigenous ascidians can cause severe ecological and financial damage by competing with the local fauna (Lambert and Lambert 1998, Lambert 2001, Bullard and Carman 2009), negatively impacting aquaculture (Locke and Carman 2009, Lutz-Collins et al. 2009, Adams et al. 2011), and heavily fouling marinas, pillars, and boats (Coutts and Forrest 2007). Such negative effects have not been documented so far along the Mediterranean coast of Israel. However, the consequences of the ecological transformation by this invader, as well as the trigger behind this change, are still unknown. Further study and exclusion experiments are necessary to achieve a better understanding of *H. momus* distribution

and of how it will affect the environment and local biodiversity. Furthermore, a better understanding of the rate of spread, limits of its distribution and substrate selection will also contribute to our knowledge of the dispersal and establishment patterns of other invasive ascidians and non-indigenous sessile species in new environments.

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Supplementary material

The following supplementary material is available for this article:

Annex 1. Locations of *Herdmania momus* occurring on natural rocky substrate.

Annex 2. Informative poster for recreational divers.

Annex 1. Locations of *Herdmania momus* occurring on natural rocky substrate.

Site Mark (Map Ref.)	Location	Record coordinates		Record period	Depth (meter)	Recorder
		Latitude, °N	Longitude, °E			
A	Gordon reef	32°05'08.05"	34°45'51.70"	2009	8	Recreational diver
B	Herzliyya	32°10'18.26"	34°47'45.10"	November 2013	10	Scientific diver
C	Mikhmoret	32°23'52.21"	34°51'25.59"	July 2013	6.5	Scientific diver
D	Sedot-Yam (Main island)	32°29'27.20"	34°53'08.86"	September 2013	5	Recreational diver
D	Sedot-Yam (Deep)	32°29'27.04"	34°52'55.23"	2013	30	Recreational diver
E	Jisr Ez Zarqa	32°32'41.76"	34°53'34.45"	2013	30	Recreational diver
F	Dor	32°36'48.85"	34°54'59.25"	December 2012	2–4	Scientific diver
G	Atlit	32°41'11.51"	34°55'07.97"	2013	20–30	Recreational diver
H	Rosh Haniqra	33°02'17.38"	35°04'51.23"	February 2013	10–13	Scientific diver
H	Akhziv	33°02'20.40"	35°05'52.33"	October 2013	< 1	Scientific diver
H	Akhziv caves	33°02'29.88"	35°05'51.30"	October 2013	3–5	Recreational diver

Annex 2. Informative poster for recreational divers: printed in Hebrew. Presents information about invasive species, ascidians in general, *H. momus*, and contact information.

WANTED



הרדמניה מומוס *Herdmania momus*

☒ מהו מין פולש? מינים פולשים הם מינים של בעלי חיים, צמחים, פטריות ומיקרואורגניזמים שהיגרו לבית גידול חדש בסיוע ישיר או עקיף של האדם, שם הם התבססו והתפשטו תוך שהם גורמים לשינויים במערכת האקולוגית ונזק למינים המקומיים. למעשה, פלישת מינים היא הגורם השני בחשיבותו לירידה במגוון מינים. המדוזה חוטית נודדת שפוקדת בהמוניה את חופי הלבנט, ממזרים ועד תורכיה בצפון, היא דוגמא למין פולש שחדר לים תיכון דרך תעלת סואץ.

☒ מהו איצטלן? האיצטלנים (*Ascidians, sea-squirts*), ידועים גם כטוניקטים, הם חסרי-חוליות ישיבים הניזונים מסינון, מופיעים הן כיחידאים (סולטריים) והן בצורה מושבתית. הם מופיעים במגוון צורות, גדלים וצבעים. ניתן להותם באמצעות שני סיפונים הבולטים מנופם כלפי מעלה, כפתח כניסה ופתח יציאה.

☒ הרדמניה מומוס (*Herdmania momus*), איצטלן יחידאי הידוע גם כ"אדום-הצוואר", הוא מין פולש שהגיע לחופינו דרך תעלת סואץ. ניתן למצוא אותו מחובר למצע סלעי ומלאכותי (ספינות טבועות, למשל) בעומקים רדודים המתאימים לצלילה ספורטיבית. צבעו ורוד אדמדם בקוטר של כ-3 ס"מ והוא רך למגע. באוניברסיטת תל-אביב, במעבדתה של ד"ר נועה שנקר, מנטרים את תפוצתו לאורך החוף הים-תיכוני.



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