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RAZY HOFFMAN, HIROSHI KAJIHARA

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First report of *Evelineus mcintoshii* (Langerhans, 1880) (Heteronemertea, Lineidae) from the Mediterranean Sea

Razy HOFFMAN¹, Hiroshi KAJIHARA²

¹The Steinhardt Museum of Natural History, Israel National Center for Biodiversity Studies, Tel Aviv University, Tel Aviv 69978, Israel

²Faculty of Science, Hokkaido University, N10 W8 Sapporo 060-0810, Japan

Corresponding author: razyho@hotmail.com

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Abstract

The ribbon worm *Evelineus mcintoshii* is reported for the first time from the Mediterranean Sea. Observations that took place, during two algal surveys, on the intertidal abrasion platforms at the middle of the Levantine Sea of Israel indicated that this species is hiding inside a mixture of local and non-indigenous marine seaweeds. It is probably another alien species, one of many, that adopted the Levantine basin of the Eastern Mediterranean due to tropical environmental conditions that characterize this sea. We discuss the first record of this species and its possible origins as well as the first report of *Notospermus geniculatus*, the other marine nemertean species recently reported from Israel.

Keywords: *Evelineus mcintoshii*; *Notospermus geniculatus*; nemertean; Mediterranean, Levantine; Israel.

Introduction

Ribbon worms (phylum Nemertea) are unique unsegmented invertebrate creatures occurring in oceans, freshwaters, and also terrestrial environments, with 1305 described extant and fossil species, distributed in 250 genera, worldwide. The vast majority, over 99%, are marine species, some of which are key predators, detritophages, vegetarians, or parasites in oceanic ecosystems (Gibson, 1995; Norenburg *et al.*, 2020).

Review articles of nemerteans of the world and recent studies of species found on land and in waters of the Iberian Peninsula, as well as the Spanish and Portuguese islands of the Atlantic Ocean and the Mediterranean Sea, revealed approximately 400 species in Europe and ca. 200 species in the Mediterranean Sea (Gibson, 1995; Herrera-Bachiller *et al.*, 2015). Surprisingly, no studies of marine nemerteans of the eastern Levantine Sea exist and the lack of attention to this group is particularly notable. The only marine species reported, so far, from Israel is *Notospermus geniculatus* (Delle Chiaje, 1828). This impressive “long” species, that can reach one meter in length and 15 mm in width (Lipej *et al.*, 2017) was found ca. 16 years ago (first record) during an intensive survey at the northernmost Marine Protected Area (MPA) of Israel in Rosh Hanikra, by the border with Lebanon. It was observed convoluted on seaweed at the subtidal surrounding Nahli’eli Islet (Site 1, Table 1) in October 2004

at a depth between 13-28 m (Ramos-Espla & Valle-Pérez, 2004).

Although nearly 90 species of alien worms in different phyla were reported thus far from the Mediterranean seawaters, including the Levantine Sea, most of them belong to Annelida, and none to Nemertea (Galil *et al.*, 2020; Zenetos & Galanidi, 2020).

Evelineus mcintoshii (Langerhans, 1880), originally established as *Cerebratulus mcintoshii* from Madeira (Langerhans, 1880), is a marine heteronemertean species. Individuals of this species, along with closely related forms, if not conspecific, have been reported previously from the Brazil as *Evelineus tigrillus* Corrêa, 1954 (Corrêa, 1954) and *Evelineus mcintoshii* (de Almeida Alves *et al.*, 2019); India and Japan as *Lineus mcintoshii* (Takakura, 1898; Shynu *et al.*, 2015; Kajihara, 2007, 2017); and Vietnam as *Evelineus cf. mcintoshii* (Chernyshev, 2016). Whether these forms are conspecific or not should be tested with molecular data (Chernyshev, 2016). *Evelineus mcintoshii*, which is the only member of its genus, has not previously been reported from the Mediterranean Sea. Therefore, the main goal of this study is to publish the first record of *Evelineus mcintoshii* from the Mediterranean Sea.

Materials and Methods

Two algal surveys, part of an extensive ongoing second decade of the Millennium's survey of marine flora of the Israeli Levantine Sea, that focus on alien seaweeds and their impacts on the natural flora (Hoffman, 2014), revealed observation (at site 2) and collection (at site 3) of an unknown colorful species of ribbon worm that was identified as *Evelineus mcintoshii* (Table 1 and Fig. 1). Both specimens were found in the intertidal zone of the abrasion platforms of both sites. The first was observed crawling on the coralline red seaweed *Jania adhaerens* J.V. Lamouroux, growing on the southwestern edges of the abrasion platform surrounding an islet and the latter was collected entangled on branches of two other red seaweed, *Palisada cf. perforata* (Bory) K.W.Nam and *Acanthophora nayadiformis* (Delile) Papenfuss, growing in a pothole.

The specimen from site 3 was mounted on a glass slide and examined under an Olympus MVX10 Research Macro Zoom Microscope (Olympus Corp., Tokyo, Japan); images were acquired with an Olympus DP71 microscope digital camera. Figures were edited and cleaned using the graphic editor GIMP software (New-York City, USA).

Results

The specimen studied of *Evelineus mcintoshii* (from site 3) measured approximately 30 mm in length and 0.5 to 1.5 mm in width at posterior and anterior regions respectively (Fig. 2a). The head is bluntly rounded at its tip, demarcated from the neck; no eyes; the cephalic slits are noticeable (Fig. 2b). Ground color of dorsal and lateral body surfaces pale yellowish but the cephalic tip and the margins of the dorsal and ventral surfaces are pale and almost colorless. There is a flattened triangular reddish patch on the more posterior portion of the cephalic tip. From the center of this patch a distinctive single orange-red line extends along the dorsal median line to reach to the tip of the tail. On either side of this line numerous transverse dark brown to black bands are rather regularly arranged. The distal ends of the bands slightly reach the ventral surface, while the proximal ends are connected with a longitudinal dark line, which abuts on each side of the longitudinal orange line. The general shape of the band forms a triangle, which is proximally wide and distally narrow. Because the specimen was pressed on a slide the eversible proboscis was ejected, as

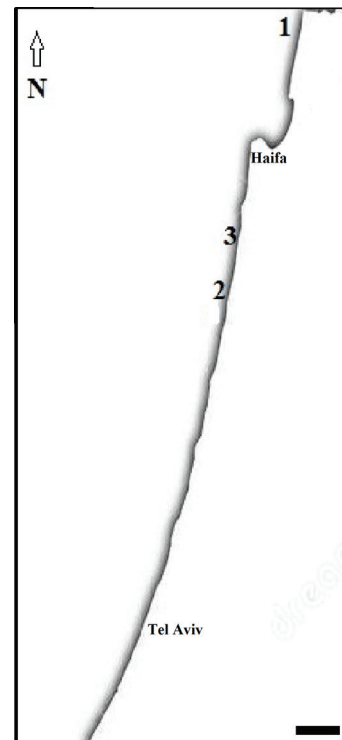


Fig. 1: Map indicating the survey sites where *Evelineus mcintoshii* were observed and collected (Scale bar = 10 km).

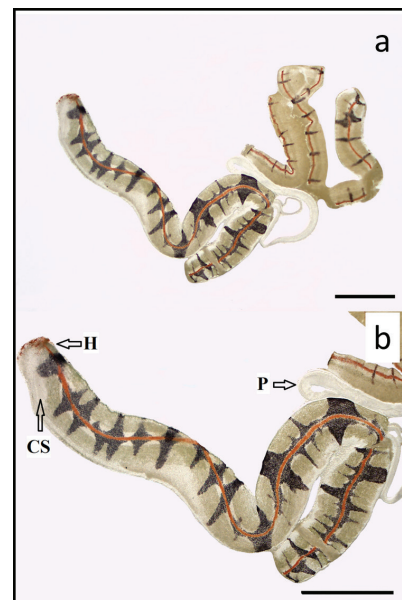


Fig. 2: Specimen of *Evelineus mcintoshii* studied. (a) General dorsal view of the specimen pressed on slide. (b) Close up showing some details of the specimen such as the eyeless head (H), cephalic slits (CS), and the eversible proboscis (P). Scale bars = 2 mm.

Table 1. List of nemertean species so far reported from Israel along with collection data.

Nemertean species	Site	Date	Coordinates	References
<i>Notospermus geniculatus</i>	1. Nahli'eli Islet, MPA Achziv	21.X.2004	33.072670° N, 35.094622° E	Ramos-Espla & Valle-Pérez (2004)
<i>Evelineus mcintoshii</i>	2. Islet in Ma'agan Michael	24.X.2014	32.556918° N, 34.903258° E	This study
<i>Evelineus mcintoshii</i>	3. MPA Habonim	27.X.2019	32.637058° N, 34.920940° E	This study

seen in Fig. 2b. These features are identical with description by Chernyshev (2016) and Takakura (1898).

Discussion

Surveys and studies of the marine worms of Israel were mostly conducted by Ben Eliahu who extensively surveyed the eastern Levantine shore as well as the Red Sea during the 20th century. Although focusing on studies of the Annelida and specifically indigenous and alien polychaetes, which arrived in the Mediterranean Sea through the Suez Canal (Ben Eliahu, 1977), she did not report any ribbon worms from the Levantine shore. *Notospermus geniculatus* is a well-known ribbon worm from the western and central Mediterranean as well as the Black Sea, with the type locality being in Naples (Italy) (Gibson, 1995; Kajihara, 2007), and therefore the species is regarded as a native species in the Mediterranean. However, although it is a long, thick and impressive marine ribbon worm with remarkable black and white bands throughout its body length, it was not reported from the Levantine shore of Israel before 2004. We therefore also recognize the report by Ramos-Espla & Valle-Pérez (2004) of *N. geniculatus*, sixteen years ago, from MPA Achzive (Site 1) as the first record of nemertean species from the region.

Evelineus mcintoshii is not a common species and therefore its biology and ecology are still unknown. However, scarce studies, including this one, indicate that it associates with seaweeds and feeds on bristle worms (Corrêa, 1954). The Levantine shore of Israel is diverse and rich in species of polychaetes and a recent study even listed 31 alien species of this group (Galil *et al.*, 2020) from this shore. We therefore assume that the tropical conditions that characterize this sea and the rich dietary sources welcomed this potentially non-indigenous species to the area. We also hypothesize that *E. mcintoshii* was introduced to the eastern Mediterranean through shipping, as a hull stowaway, because studies from Brazil indicate that nemerteans have been found associated with seaweeds as fouling organisms attached to the hulls of different vessel types (de Almeida Alves *et al.*, 2019). The fact that *E. mcintoshii* was found only at two sites (2 and 3), with a distance of only 12 km between them, might indicate a very recent arrival. This assumption is supported by the fact that RH is an algal taxonomist and ecologist who has also extensively studied, during the past 15 years, marine invasion of the fauna and flora associated with local seaweeds and seagrasses. Crustaceans as well as worms, insects, echinoderms, cnidarians and bryozoans that hide between seaweed branches, have also been collected and identified in order to monitor the marine fauna and determine new invaders. We assume that this colourful species arrived through bulk carriers conveying coal to the nearby power plant located ca. 9 km south to site 2. However, in order to solve the enigma and unravel the origins of both *E. mcintoshii* and *N. geniculatus* in Israel a comprehensive molecular study should take place, comparing gene sequences of specimens from

Israel to those of specimens collected from the oceans.

Data from Table 1 indicates that the specimens of *E. mcintoshii* and *N. geniculatus*, observed so far from the Levantine shore of Israel, were all collected at the same season and almost in the same day in October.

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