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Rapid Communication

First record of *Epitonium* (*Parviscala*) *vaillanti* (Jousseaume, 1912) (Mollusca: Gastropoda: Epitoniidae) in the Mediterranean Sea

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Abstract

Epitonium (Parviscala) vaillanti (Jousseaume, 1912), a species previously known only from the Red Sea and Gulf of Aden, is recorded for the first time in the Mediterranean Sea. This new Erythrean alien was found in the course of examination of unidentified specimens from Mediterranean coast of Israel, showed morphological features unknown to any previously recorded Mediterranean epitonid species. To confirm identification, morphological comparison with the syntypic serie of *Avalitiscala vaillanti* Jousseaume, 1912, stored in the Museum d'Histoire Naturelle de Paris (MNHN) was performed and some remarks of the taxonomy of the species are discussed.

Key words: bioinvasion, Erythraean alien, Suez Canal, Levantine Basin

Introduction

The Suez Canal is the main pathway of penetration of marine organisms from the Red Sea to the Mediterranean Sea; the rate of this migration, so called Lessepsian migration, is probably destined to increasing as result of the recent enlargement of the canal that improves chances for Erythraean biota to flow through the canal until the Mediterranean basin (Zenetos et al. 2012; Steger et al. 2018), although some studies tend to reconsider the influence of the widening of the channel on the increase in immigration rate (Zenetos 2017).

Because of its geographical position, prevailing surface currents and environmental conditions, the increasing presence of non-indigenous species (NIS) of Lessepsian origin is particularly evident along the Mediterranean coast of Israel and in the Levantine sea (Galil 2007, 2008, 2009; Tzomos et al. 2012; Galil et al. 2016; Steger et al. 2018). The ecological dynamics triggered by these alien hosts on indigenous ecosystems concerns the scientific community; many studies evidenced as the NIS may have serious environmental, social, economic and public health consequences. (Wallentinus and Nyberg 2007; Ehrenfeld 2010; Galil 2007, 2017; Guarnieri

et al. 2017; Pyšek and Richardson 2010; Simberloff et al. 2013; Steger et al. 2018; Mazza et al. 2014). Therefore a continuous monitoring process is required, which allows to detect at an early stage the presence of NIS in Mediterranean waters, in order to understand very early their potential impact and to define environmental strategies useful to limit their dispersion and any potential damages on indigenous ecosystems and human activities (Crooks 2005; Simberloff et al. 2013; Katsanevakis et al. 2014).

In this paper we report the finding, along the Mediterranean coast of Israel, of yet another Erythraean alien gastropod molluscs: *Epitonium* (*Parviscala*) *vaillanti* (Jousseaume, 1912), a species considered endemic of the Red Sea and Gulf of Aden (Dekker and Orlin 2000; Brown and Neville 2015).

Many immature specimens, with soft parts, and one empty adult shell, have been found in various samples collected in different years; that may mean that this species is already established along the southern and central Mediterranean coast of Israel.

Epitonium (*Parviscala*) *vaillanti* is the second Erythrean alien epitoniid known for the Mediterranean Sea. In the mid-90s, Cecalupo and Quadri (1994) reported, from North Cyprus, *Cycloscala hyalina* (G.B. Sowerby II, 1844), a species, distributed in the Red Sea, Indian Ocean, and throughout the Tropical Western Pacific (Kilburn 1985); the species was subsequently reported also from Southern Turkey (Engl and Çeviker 1999) (https://www.ciesm.org/atlas/Cycloscala hyalina.html) and this seems to confirm that many NIS, originally reported from the Mediterranean coast of the Israel, disperse very quickly mainly towards the Levantine sea, where they probably meet more favorable environmental conditions respect to the West Mediterranean basin, (Tringali and Villa 1990; Buzzurro and Greppi 1997; van Aartsen 2006; Bogi and Galil 2006; Gökoğlu and Özgür 2008; Galil et al. 2009b; Gökoğlu and Julian 2016; Erguden et al. 2018).

Materials and methods

A survey of the shallow soft bottoms along the central Mediterranean coast of Israel was made aboard the Research Vessels "ETZIONA" and "MED EXPLORER" in September 2015, October 2017, May 2018 and October 2018. Surface sediments were collected using a Van Veen grab (KahlSico, WA265/SS214, 32 × 35 cm, volume 20 L). Samples were preserved in 99% ethanol upon collection, and within days were sieved on a 250 µm mesh. The retained molluscan material was preserved in 70% alcohol and tinted with eosin dye.

The specimens originate from North Haifa Bay were collected in coarse sand (ALA – September 2015), from Southern part of Israel (Via Maris – September 2015, May 2018, October 2018, APM – October 2017, 2018 and Sorek – October 2018) were collected in sandy bottom with small silt-clay component; they are all immature and complete with soft parts. The empty shell from off Atlit, South Haifa Bay, was collected, in sandy bottom, in the

context of the project "Historical ecology of Lessepsian migration" funded by the Austrian Science Fund (FWF) P28983-B29 (PI: P.G. Albano).

Descriptions and measurements are based on shells oriented in the traditional way, spire up with the aperture facing the viewer. SEM micrographs were taken using a Jeol 5200; optical micrographs were taken using a reflex camera Canon Eos 400D.

The macro photography of *Avalitiscala vaillanti* Jousseaume, 1912 originate from http://mediaphoto.mnhn.fr/media/1528992784154qyGc9IzLvpud3mNC (accessed on 20 January 2019).

Abbreviations:

MNHN – Muséum National d'Histoire Naturelle, Paris, France.
MZUB – Museo di Zoologia, Università di Bologna, Italy.
NHMW – Naturhistorisches Museum, Wien, Austria.
SMNHMO – Steinhardt Museum of Natural History, Tel Aviv University, Israel.
BCC – Cesare Bogi private collection, Livorno, Italy.

Results and discussion

Family Epitoniidae Berry, 1910 (1812)
Genus *Epitonium* Röding, 1798
Type species (s.d. Suter, 1913) *Turbo scalaris* Linnaeus,1758
Subgenus *Parviscala* de Boury, 1887: 11
Parviscala de Boury, 1887: 11. Type species (o.d.) *Scalaria algeriana* Weinkauff, 1866.

Epitonium (*Parviscala*) *vaillanti* (Jousseaume, 1912)

(Figure 1A–N; Figure 2A-O; Figure 3A–I)

Avatiliscala vaillanti Jousseaume, 1912: 223, pl. 7, figs 6, 28–36, 40–44, 58.
Type material: MNHN (14 syntypes MNHN-IM-2000-4346). Type locality: Aden, Djibouti, Suez.
Epitonium vaillanti; Kaicher, 1981: 3048.
Epitonium vaillanti; Singer, 1998: 19.
Epitonium (Parviscala) vaillanti; Weil et al., 1999: 76, fig. 222.
Epitonium vaillanti; Dekker and Orlin, 2000: 26.
Epitonium (Laeviscala) vaillanti; Abubakr, 2004
Epitonium vaillanti; Brown and Neville, 2015: 156.

Material examined: see Table 1.

Description (specimens)

Shell small, slender, acuminate with the whorls increasing regularly in size, separated by a rather deep but not fenestrated suture (Figure 1A–C). Dimensions comprising between 0.8 and 5,5 mm. Protoconch polygyrate, conical, of about 4 slightly convex whorls (Figures 1B–D, 3A–B) with fine, incised axial striae which show four tiny indentations regularly spaced from each other; the first two are more pronounced than the later ones (Figure 3A, C). Basal diameter 0.35 mm. Teleoconch sculpture of 8-9 prosocline

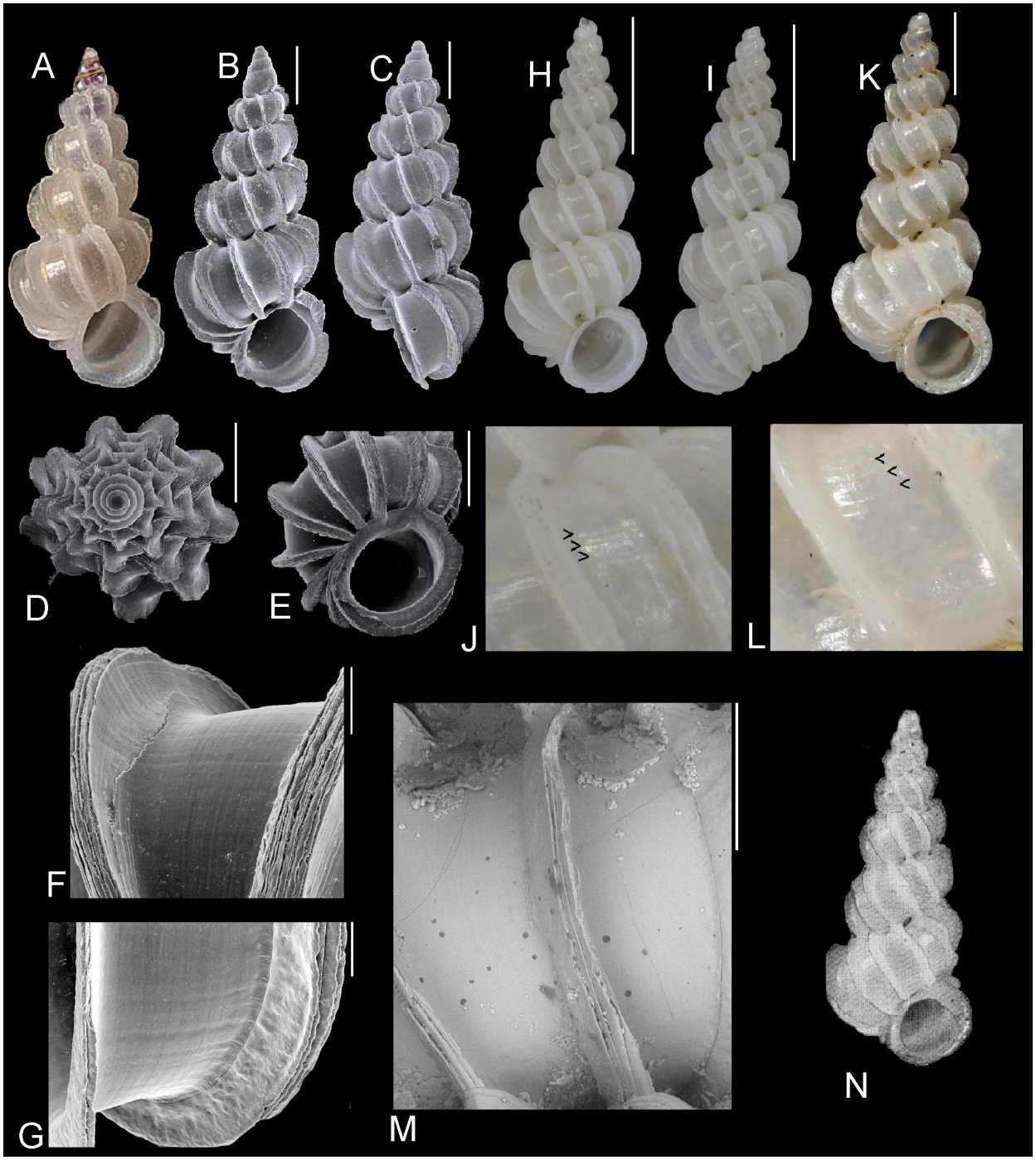

Figure 1. A–N. *Epitonium* (*Parviscala*) *vaillanti* (Jousseaume, 1912). A–G. Specimen from Mediterranean Sea. Israel, North Haifa Bay, 32.89640000; 35.06545000, 12,5 m deep. A. Macro photography, 2,8 mm. B–G. Sem micrographs of the previous specimen. B–D. Ventral, lateral and apical views, scale bar 500 µm; E. Aperture, scale bar 500 µm. F–G. Details of the teloconch surface, scale bar 100 µm. H–J. Shell from the Mediterranean Sea, Israel, off Atlit, 32.7416N; 34.9178E, 30 m deep (sample NG30_7, NHMW 112930/LM/0171) (photo Jan Steger, University of Vienna; Projet: Historical ecology of Lessepsian migration, PI: P.G. Albano). H–I Ventral and dorsal views, 5,5 mm. J. Close-up of the teleoconch surface. K–N. Largest syntype of *Avalitiscala vaillanti* Jousseaume, 1912, (MNHN-IM-2000-4346) (photo Manuel Caballer – 2018 MNHN Project: RECOLNAT (ANR-11-INBS-0004). K. Ventral view, 4,6 mm L. Close-up of the teleoconch surface. M. Details of the teloconch surface of the syntype Fig. 2E, scale bar 200 µm. N. The same syntype as presented on Kaicher's card (Kaicher, 1981; pack 30: 3048).

axial ribs, running whorl to whorl, slightly reflexed on shoulder, bearing a very low coronation (Figure 1A–D). Intervals with faint spiral scratches sometime obsolete (Figure 1F–G). Aperture ovate, peristome thin, base auriculate, umbilicus narrowly fenestrate (Figure 1E). White in colour.

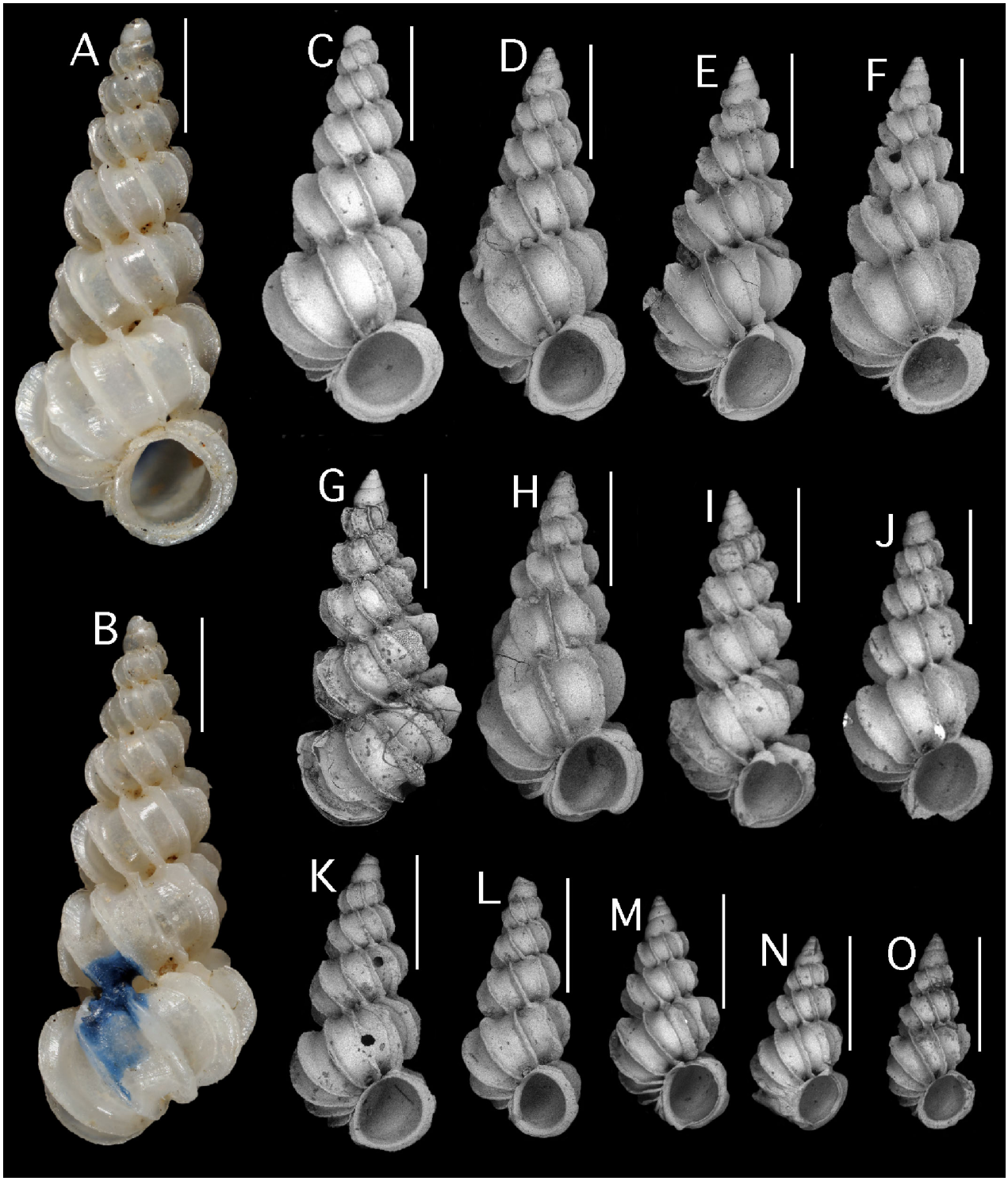

Figure 2. A–O. *Avatiliscala vaillanti* Jousseaume, 1912, syntypes (MNHN-IM-2000-4346), scale bar 1mm. A–B Largest syntype of *Avalitiscala vaillanti* Jousseaume, 1912, (photo Manuel Caballer – 2018 MNHN Project: RECOLNAT (ANR-11-INBS-0004). C-O. SEM micrographs of the typical specimens (photos by Philippe MAESTRATI, MNHN).

Remarks

The specimens do not match to any Mediterranean epitonids species but closely resembling, in morphological features, with *Epitonium (Parviscala) vaillanti* (Jousseaume, 1912), a rare species considered endemic of the Red Sea and Gulf of Aden (Dekker and Orlin 2000; Brown and Neville 2015).

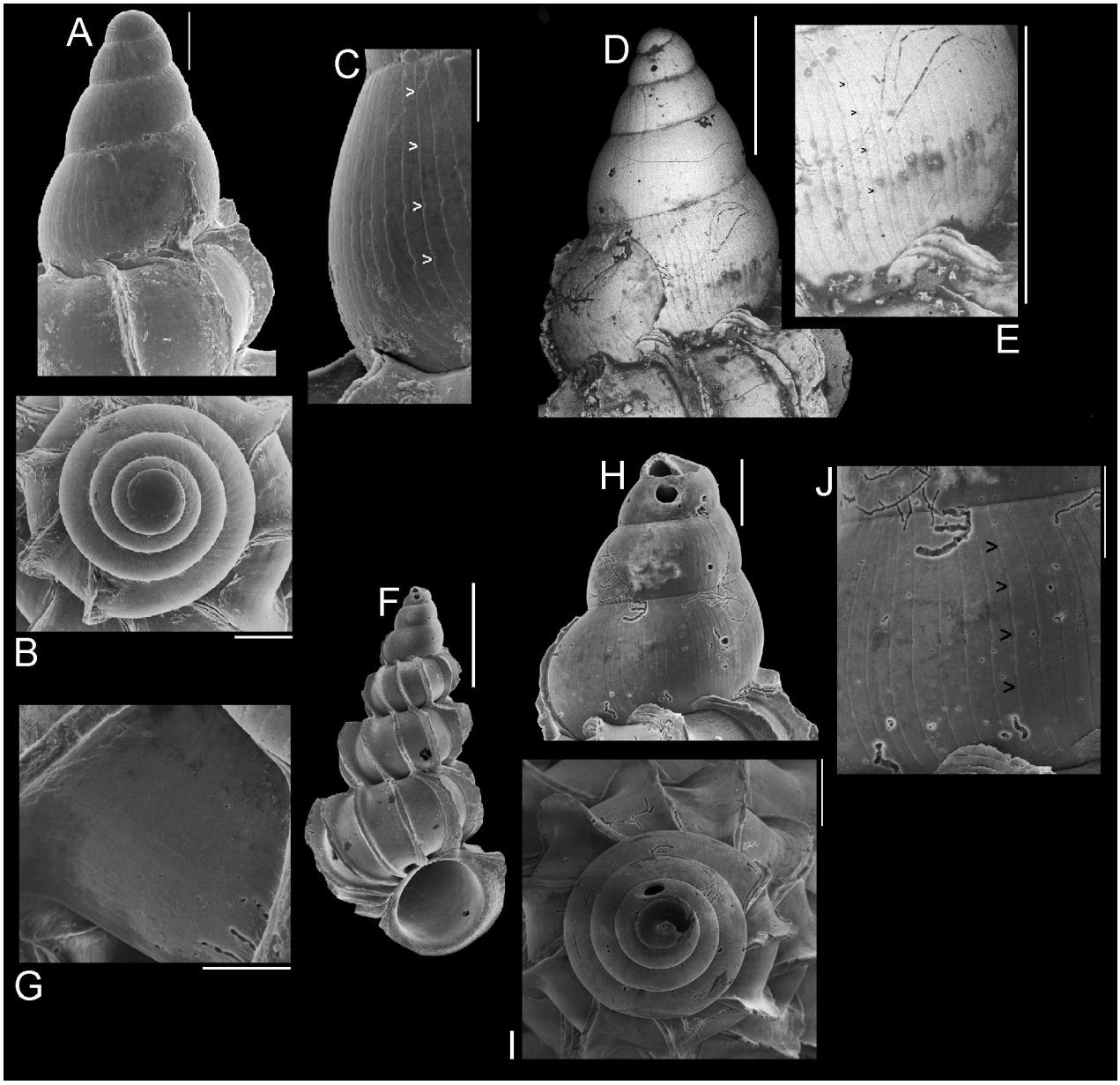

Figure 3. A–I. *Epitonium* (*Parviscala*) *vaillanti* Jousseaume, 1912. A–C. Protoconch of the specimen from the Mediterranean Sea. Israel, North Haifa Bay, 32.89640000; 35.06545000, 12,5 m deep. A–B. Frontal and apical view, scale bar 100 µm. C. Details of the axial threads with indentations, scale bar 50 µm. D–E. Protoconch of the syntype Fig. 2E and details of the axial threads with indentations, scale bar 200 µm (photo Philippe Maestrati, MNHN). F–J. Specimen from southern South Red Sea, off Yemen, 76 m depth. F. Ventral view, scale bar 600 µm. G. Details of the teleoconch surface, scale bar 40 µm. H–I. Protoconch, scale bar 100 µm. J. Details of the axial threads with indentations, scale bar 60 µm.

Avalitiscala vaillanti was originally described on 16 specimens collected from Suez, Aden and Djibouti (Jousseaume, 1912: 223, pl. VII, fig. 6, 28–36, 40–44, 58) (bathymetry unspecified). Although the species was reported from the Gulf of Aqaba (Singer 1998: 19) and from the Yemeni coasts of the Red Sea (Abubakr 2004: 69), no further information exist.

We have compared our specimens with the type specimens of *Avalitiscala vaillanti* Jousseaume, 1912, stored in the MNHN; the empty shell has a greater length than the largest syntype (5,5 mm instead to 4,8 mm) but they fit perfectly in shape, number of axial ribs (9) and ornamentation of the interspaces (Figure 1H–J, K–L). To the examined syntypes comfortably

Table 1. Mediterranean sampling sites of *Epitonium* (*Parviscala*) *vaillanti*.

Locality	Date of collection	Latitude [decimal deg]	Longitude [decimal deg]	Depth [m]	# of individuals	Site of deposition*
Southern part of Israel	18/09/2019	31.93888075	34.68645283	20.0	1	BCC
Southern part of Israel	22/10/2017	31.5328195	34.67348388	35.2	1	BCC
Southern part of Israel	23/10/2017	31.53214865	34.64661331	36.4	1	BCC
Agan	16/10/2017	31.89191667	34.65963333	21.0	1	SMNHMO
Agan	16/10/2017	31.86670000	34.65460000	13.8	1	SMNHMO
Agan	16/10/2017	31.87515000	34.65128333	21.0	1	BCC
Agan	16/10/2017	31.86693333	34.64181667	25.4	1	BCC
Agan	16/10/2017	31.86948333	34.64663333	24.1	5	BCC
Agan	16/10/2017	31.86326667	34.61083333	22.1	1	BCC
Agan	16/10/2018	31.86675000	34.65303333	22.1	8	BCC
Agan	16/10/2017	31.89191667	34.65963333	15.1	1	BCC
Agan	16/10/2017	31.86686667	34.64131667	25.8	2	BCC
Agan	16/10/2018	31.87491667	34.65180000	20.3	5	BCC
Agan	16/10/2017	31.87475000	34.64555000	25.5	7	BCC
Agan	16/10/2017	31.89133333	34.65931667	21.1	7	BCC
Agan	16/10/2018	31.86945000	34.64646667	23.3	1	BCC
Palmahim	20/09/2016	31.93651667	34.68310000	20.7	1	BCC
Palmahim	20/09/2016	31.93923333	34.68610000	20.1	1	BCC
Palmahim	14/10/2018	32.56523333	35.14401667	18.8	1	BCC
Sorek	14/10/2018	32.56871667	35.15583333	12.8	1	BCC
Sorek	14/10/2018	32.57086667	35.14441667	19.3	1	BCC
Northern part of Israel – Atlit	25/04/2017	32.74160000	34.91780000	30.0	1 (empty shell)	NHMW
North Haifa Bay	08/09/2015	32.89640000	35.06545000	12.5	1	BCC
North Haifa Bay	08/09/2015	32.90040000	35.06516667	12.3	1	MZUB
Aden, Djibouti, Suez	–			–	14 Syntypes	MNHN

match also all living specimens that are comparable mainly with the smaller specimens of the type serie, with some of which they share fewer axial ribs per whorl (8 instead 9), probably due to their not complete development, as their dimensions seem to demonstrate.

The direct study of type series of *Avalistiscala vaillanti*, performed by one of us (AB) on the original specimens to MNHN, and the analyzes of the macro photo of the largest syntype and the SEM micrographs of 13 other specimens that were provided to us by the MNHN (Figure 2A–O), allows us to make some considerations about the uncertain systematic relationships of the taxon. The genus *Avalistiscala* de Boury in Jousseaume, 1912 was erected on *Avalitiscala avalites* Jousseaume, 1912 (type species by virtual tautonomy (s.d. Wenz 1940)). This taxon is no longer in use: Kilburn (1985) and Weil et al. (1999) consider it as synonym of *Sodaliscala* de Boury, 1909 while Brown and Neville (2015) a junior subjective synonym of *Epitonium* Röding, 1798.

The genus *Avalitiscala* was characterized by the combination of interspaces spirally lirate, umbilicus closed or narrowly fenestrate and costae more or less peaked. Most of these morphological features are shared with the subgenus *Parviscala* de Boury, 1887, that differs from *Sodaliscala* de Boury, 1909 only in its peaked costae (Kilburn 1985; Weil et al. 1999).

The taxa originally described by Jousseaume (1912) (*Avalitiscala avalites*, *A. gradilis* and *A. vaillanti*) are currently considered to belonging those two

subgenera of *Epitonium*: because of its not peaked costae and closed umbilicus, *A. avalites* is placed in the subgenus *Sodaliscala* (Kilburn 1985; Weil et al. 1999), while the peaked axial ribs and the open umbilicus that characterize the other two species justify their placement in the subgenus *Parviscala* (Weil et al. 1999).

A photograph of the largest syntype of *Avalitiscala vaillanti* has been published by Kaicher (1981: 3048); the same specimens is figured in Figure 1K, N and Figure 2A–B. It probably is the specimen to which Jousseaume refers to the maximum size of the species (4.5 mm).

In the Kaicher's photo the specimen seems to have interspaces conspicuously spirally lirate (Figure 1N); in reality, this feature is not so evident, as confirms the macro photo of the same syntype (Figure 1I–L) and the analyses performed directly on the specimen at the MNHN. In the original diagnosis Jousseaume does not mention the presence of a spiral sculpture between the ribs, while in other descriptions this character is mentioned even when it is not very noticeable, as when he describes *Graciliscala agitabilis* Jousseaume, 1912, whose intervals "*...sont si finement striés qu'ils paraissent lisses* (...whose intervals are streaked so lightly that they seem smooth)". The photo given by Kaicher has been clearly retouched to enhance a morphological feature not so evident in the figured specimen and even fainter or absent in other specimens of the type series (Figure 1M). This feature is shared whit the studied Mediterranean specimens, that have the intervals sculptured by very feeble spiral lines. The 13 syntypes here presented (Figure 2A–O) show remarkable morphological variability in the shape of the shell that may represent intraspecific variation or indicate the existence of several similar species. The features shared by all the syntypes are the presence of 8–9 erect axial ribs running whorl to whorl, suture fenestrate, narrow umbilicus, protoconch of about 4 whorls. The axials ribs can be more or less lamellate and winged at the shoulder; this may account for some of the apparent variability in the shell shape. Based on these features, we found no differences that would allow for a separation between different morpho-species within the type serie or to consider the studied Mediterranean specimens belonging to a different species or even a new Mediterranean taxon.

A comparison performed between the protoconchs of the studied specimen (Figure 3A–C) and the protoconch of a syntype G (Figure 3D–E) seems to provide additional elements of similarity. The two protoconchs fit perfectly in shape (conical), number of whorls (about 4: one embryonic whorl and about 3 larval whorls) and in the ornamentation, with about 11–12 axial threads in 100 μm (on penultimate protoconch whorl) incised by 4 indentations placed in same position along the thread (Figure 3C, E).

All these morphological features are shared by one specimen of epitonid found in a sediment sample from Red Sea (Figure 3F). This specimen has the protoconch lacking the nucleus but clearly originally formed of about 4

whorls and with a maximum diameter of 0,32 mm; the larval whorls have ornamented by the same number of the axial threads (10–11 in 100 mm on penultimate protoconch whorl), incised by the same number of the indentations placed in the same way and with the first two more evident than the posterior ones (Figure 3H–J). The teloconch shows 9 erect ribs whit interspace very slightly spirally lirate, suture fenestrate and narrow umbilicus (Figure 3F–G). In our opinion this specimen can be considered conspecific with the Mediterranean specimens and also ascribable to the Jousseaume's species.

Singer (1998) states that there are not many elements to separate *Epitonium (Parviscala) vaillanti* from *E. (Laeviscala) fucatum* (Pease, 1861), to the point that one could hypothesize a probable synonymy. This supposed synonymy does not seem to be justified by the comparison of type specimens. The micro-sculpture of the interspaces of syntype of *Epitonium fucatum* was illustrated by Bonfitto (2018). In *fucatum* the interspaces are sculptured by axial and spiral treads that produce a chessboard micro-sculpture with obvious granulations at the points of the intersections; this justifies its collocation in the subgenus *Laeviscala* de Boury, 1909. In *E. (Parviscala) vaillanti* the interstices show faint spiral striae, even fully obsolete, and not axial ones; under magnification, they may appear very slight axial growth lines but they never produce the typical reticulate pattern of the subgenus *Laeviscala*.

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