

## Backdating first records of non-indigenous species in the Mediterranean: are initial findings underestimated?

Marika GALANIDI<sup>1</sup>, Eirini GRATSIA<sup>2</sup>, and Argyro ZENETOS<sup>3</sup>

<sup>1</sup> ÜEE LLC, Marine Ecology Division, Teknopark İzmir A1/49, Urla 35437, Türkiye

<sup>2</sup> Hellenic Centre for Marine Research, Institute of Marine Biology, Biotechnology and Aquaculture, 71003 Heraklion, Crete, Greece

<sup>3</sup> Hellenic Centre for Marine Research, Institute of Marine Biological Resources and Inland Waters, 19003 Anavissos, Greece

Corresponding author: Marika GALANIDI; [marika.galanidi@gmail.com](mailto:marika.galanidi@gmail.com)

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### Abstract

This work lists 75 cases of backdated non-indigenous species (NIS) first records in the Mediterranean Sea which constitute 7.6% of the total marine NIS diversity of the region. Of the backdated first records, approximately one-third belong to species of Mollusca, with the second most important group being Macrophyta, followed by Polychaeta and Crustacea. The backdating time spans in our dataset vary between 1 and 52 years with an average of approximately 8 years but considerable differences exist among taxonomic groups. Among reasons for NIS backdating delays in publishing due to a lack of taxonomic expertise emerges as a prominent factor. Backdating in Mollusca is partly attributed to shell collectors, who may delay in publishing their findings. In fish species backdating is primarily attributed to unreported findings that were only accidentally noticed. Misidentifications of species, often due to confusion with native or cryptogenic species, has also contributed to backdating, particularly in polychaetes. This challenge can be addressed by combining morphological identification with molecular analyses. A third reason for backdating is the volume of overlooked species in museums and/or private collections. In many cases, multiple factors such as misidentification and overlooked specimens in museum collections may contribute to large backdating intervals. It is expected that the number of backdated NIS will increase as overlooked specimens in museum drawers or private collections are re-examined and as new identification techniques are applied. Re-examination of older samples, using both morphological and molecular methods, may reveal even earlier entries of NIS.

**Keywords:** backdated records; NIS; marine diversity; first introduction; management; Mediterranean Sea.

### Introduction

The redistribution of global biodiversity through anthropogenic activities with the introduction of species into areas outside their natural range has been recognised as one of the major pressures on native species, habitats, and ecosystems as well as the services they provide (IPBES, 2023). Biological invasions have fascinated naturalists and scientists for almost two centuries, often regarded as biogeographical curiosities (Richardson & Pyšek, 2008). However, their potentially severe ecological and socio-economic consequences have motivated a much more systematic effort over the past five decades to research, catalogue, assess, and combat species invasions beginning with studies on their spatial and temporal patterns (Carlton, 1989).

Species checklists are increasingly recognised as invaluable tools for biodiversity studies, conservation purposes, and management strategies (Lo Brutto, 2023).

In particular, non-indigenous species (NIS) inventories provide baseline information to understand and monitor the arrival of these species in a region and to relate them to changes in vector intensity and environmental conditions (e.g., Gittenberger *et al.*, 2023; Png-Gonzalez *et al.*, 2023).

NIS inventories typically consist of the first record of each NIS in a geographic or administrative area, with the year the species was detected or/and collected, the associated publication, its ecological status (casual, established, or invasive), and the most likely pathway(s) of introduction (e.g., Çınar *et al.*, 2011; Galil *et al.*, 2021; Zenetos *et al.*, 2020). Since the actual introduction event is rarely observed, the date of first collection in any publication is often known to lag behind the actual date of introduction (Bailey *et al.*, 2020). Occasionally, later publications present findings that show that a NIS was present in an area earlier than previously documented, resulting in what is known as backdated first records of species.

Sometimes the reason can be as simple as a delay in the publication of findings (Zenetos *et al.*, 2019); on the other hand, the emergence of new information on species taxonomy and/or the (re)examination of material collected prior to the registered first record of a species can also lead to backdating of first records.

Whatever the reason may be, it is important that backdating changes are documented and examined, as they constitute a step towards a more accurate reconstruction of NIS invasion history and can help better elucidate potential introduction pathways as well as means and patterns of spread (Carlton & Schwindt, 2024). One typical example is the backdating of *Bursatella leachii* Blainville, 1817 in the Western Mediterranean from 1996 in Spain (Oliver & Terrasa, 2004) to 1969 in Naples, Italy, based on an overlooked specimen in the collections of the Stazione Zoologica Anton Dohrn by Travaglini & Crocetta (2019). The species, with a circumtropical distribution including the Red Sea, was first reported in the Mediterranean in 1940 in Israel (O'Donoghue & White, 1940) and was considered a Lessepsian migrant due to its typical east-west progression, presumably by natural dispersal (Selfati *et al.*, 2017). The overlooked Italian specimen, however, casted doubts on this hypothesis, suggesting at least the presence of simultaneous secondary vectors (Travaglini & Crocetta, 2019). Furthermore, later molecular studies indicated a possible Atlantic origin of *B. leachii* in the Mediterranean (Bazzicalupo *et al.*, 2018; 2020), with the status of the species still regarded as debatable among Mediterranean experts (Galanidi *et al.*, 2023).

Moreover, backdated records can inform NIS risk assessment and prioritisation efforts but also NIS evaluation in the framework of dedicated policy instruments at national and regional level. For example, the most widely used NIS indicator for Good Environmental Status (GES) within the framework of European Marine Strategy Framework Directive (MSFD) and Mediterranean Integrated Monitoring and Assessment Programme of the Mediterranean Sea (IMAP) policies currently relies on species first record dates to calculate temporal trends in marine NIS introduction rates (EC, 2008; 2017; UNEP/MAP, 2017). Last, but not least, backdated records can reveal gaps and deficiencies in invasion research and knowledge, and bring to light neglected and/or underexplored research areas and resources, providing critical insights for improving future monitoring, assessment, and management strategies.

In this work, we collate and present information on backdated NIS first records at the Mediterranean scale documented in the past 20 years, aiming to highlight the most common underlying reasons and discuss the implications for species' invasion histories and NIS assessments.

## Methodology

The Mediterranean NIS inventory has been periodically enriched and revised since the early 2000s (Stref-

tari *et al.*, 2005; Zenetos *et al.*, 2005; Galil, 2008), motivated by policy needs (e.g., Zenetos *et al.*, 2010, 2012; Tsiamis *et al.*, 2019, 2021; Galanidi *et al.*, 2023) and taxonomic or quality control considerations (Zenetos *et al.*, 2017; 2022a, b).

Data for this paper have been assembled during the course of approximately 20 years, starting from one of the first Mediterranean full NIS inventories with first record dates (Zenetos *et al.*, 2005), with continuous curation of the dataset, which forms part of the Hellenic Centre for Marine Research (HCMR) offline database, up until November 2024 based on published and grey literature. All first record dates in the database are accompanied by their primary reference. During the process of revision and updating, there were cases where more recent literature would demonstrate the presence of a species in the Mediterranean at an earlier time than previously documented by older literature. All these cases were recorded and annotated as “backdated” records. This applies both to new publications, e.g., published after the establishment of the first NIS inventories, and to older publications that were supposed to be available at the time of the first published inventories but were erroneously missed during the initial evaluation of the literature and came to the attention of the authors at a later time. In other words, “backdating” occurs any time more recent literature documents the first presence of a NIS in a region earlier than previously thought, based on older available literature. For the purposes of this work, the superseded first record dates are referred to as “original” first records.

In a small number of cases an accurate collection date was not provided in the publication but rather the presence of the species was reported before a certain year (e.g., < 1970); in those cases, the collection date was set as that year. Moreover, when no temporal information at all was supplied about the collection of a species, which is not uncommon in older literature cataloguing species lists of a region, the year of the publication was registered as the year of the species record.

Regarding taxonomic groups, NIS were listed under the following groups: Ascidiacea, Bryozoa, Chlorophyta, Cnidaria, Ctenophora, Crustacea, Echinodermata, Fishes, Foraminifera, Mollusca, Ochrophyta, Platyhelminthes, Polychaeta, Porifera, and Rhodophyta. Chlorophyta, Ochrophyta, and Rhodophyta were then merged under the “Macrophyta” group, while Bryozoa, Ctenophora, Platyhelminthes, and Porifera (i.e., taxa with only one backdated species in our dataset) were grouped under the category “Miscellaneous taxa”.

## Results and Discussion

This work catalogued a total of 75 cases of backdated NIS first records in the Mediterranean Sea (Table 1), with an initial detection date until 2020. This subset constitutes 7.5% of the total marine NIS diversity of the region, which amounts to 1006 valid NIS according to the latest Mediterranean NIS baseline (Galanidi *et al.*, 2023). Even though most of these backdates have been incorporated

**Table 1.** Backdated species first records in the Mediterranean NIS inventory. Group abbreviations: ASC=Ascidiacea, BRY=Bryozoa, CHL=Chlorophyta, CNI=Cnidaria, CRU=Crustacea, CTE=Ctenophora, FISH=Fishes, FOR=Foraminifera, MOL=Mollusca, OCH=Ochrophyta, PLAT=Platyhelminthes, POL=Polychaeta, POR=Porifera, RHO=Rhodophyta. The column “Changes” presents the original (top) and backdated (bottom) first record dates with the associated references. Country codes follow the internationally accepted two-letter codes for countries <https://www.worldatlas.com/aatlas/ctycodes.htm>

| Group | Species                                                                                      | Changes                                                                                                                                     |
|-------|----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| CRU   | <i>Actaea savignii</i> (H. Milne Edwards, 1834)                                              | 2010: Karhan <i>et al.</i> , 2013 (IL);<br>2006: Crocetta <i>et al.</i> , 2015 (LB)                                                         |
| MOL   | <i>Afrocardium richardi</i> (Audouin, 1826)                                                  | 1997: Bogi & Galil, 1999 (IL);<br>1991: Zenetos <i>et al.</i> , 2024 (TR)                                                                   |
| MOL   | <i>Alveinus miliaceus</i> (Issel, 1869)                                                      | 2016: Steger <i>et al.</i> , 2018 (IL);<br>2009: Albano <i>et al.</i> , 2024 (IL)                                                           |
| MOL   | <i>Anadara kagoshimensis</i> (Tokunaga, 1906)                                                | 1969: Ghisotti, 1973 (IT);<br>1966: Parenzan, 1976 (IT)                                                                                     |
| CNI   | <i>Aurelia solida</i> Browne, 1905                                                           | 2002: Scorrano <i>et al.</i> , 2016 (FR);<br>1994: Gueroun <i>et al.</i> , 2020 (TN)                                                        |
| POL   | <i>Branchiomma bohollense</i> (Grube, 1878)                                                  | 1933: Monro 1937 (EG);<br>1927: Fauvel, 1955 (IL)                                                                                           |
| CRU   | <i>Callinectes sapidus</i> Rathbun, 1896                                                     | 1949: Giordani Soika, 1951 (IT);<br>1947: Serbetis, 1959 (GR)                                                                               |
| CNI   | <i>Calyptospadix cerulea</i> Clarke, 1882                                                    | 1978: Morri, 1979 (IT);<br>1977: Gili, 1986 (ES)                                                                                            |
| RHO   | <i>Caulacanthus okamurae</i> Yamada                                                          | 2004: Mineur <i>et al.</i> , 2007 (FR);<br>2002: Petrocelli <i>et al.</i> , 2020 (IT)                                                       |
| CHL   | <i>Caulerpa cylindracea</i> Sonder                                                           | 1990: Nizamuddin, 1981 (LY);<br>1985: Hamza, 1995 (TN)                                                                                      |
| CHL   | <i>Caulerpa racemosa</i> var. <i>lamourouxii</i> f. <i>requienii</i> (Montagne) Weber Bosse  | 1954: Huve, 1957 (SY);<br>1951: Rayss & Edelstein, 1960 (IL)                                                                                |
| CHL   | <i>Caulerpa scalpelliformis</i> (R.Brown ex Turner) C.Agardh                                 | 1930: Hamel, 1930 (IL);<br>1929: Carmin, 1934 (SY, LB)                                                                                      |
| CHL   | <i>Caulerpa taxifolia</i> var. <i>distichophylla</i> (Sonder) Verlaque, Huisman & Procaccini | 2006: Çevik <i>et al.</i> , 2007 as <i>C. taxifolia</i> (TR);<br>2003: Bitar, 2010 misidentified as a dwarf form of <i>C. mexicana</i> (SY) |
| BRY   | <i>Celleporaria brunnea</i> (Hincks, 1884)                                                   | 2004: Koçak, 2007 (TR);<br>2003: Harmelin, 2014 (LB)                                                                                        |
| RHO   | <i>Chondria curvilineata</i> F.S.Collins & Hervey                                            | 1981: Boudouresque <i>et al.</i> , 1983 (FR);<br>1980: Athanasiadis, 1987 (GR)                                                              |
| RHO   | <i>Chondria pygmaea</i> Garbary & Vandermeulen                                               | 1991: Cormaci <i>et al.</i> , 1992 (IT);<br>1974: Kashta & Pizzuto, 1995 (AL)                                                               |
| MOL   | <i>Circenita callipyga</i> (Born, 1778)                                                      | 1980: Barash & Danin 1986 (IL);<br>1972: Mienis, 2000 (IL)                                                                                  |
| RHO   | <i>Colaconema codicola</i> (Børgesen) H.Stegenga, J.J.Bolton, & R.J.Anderson                 | 1973: Meñez & Mathieson, 1981 (TN);<br>1952: Bidoux & Magne, 1989 (FR)                                                                      |
| OCH   | <i>Colpomenia peregrina</i> Sauvageau                                                        | 1956: Méndez-Domingo, 1957 (FR);<br>1939: Blackler, 1967 (IT);<br>1918: Ville, 1968 (FR)                                                    |
| MOL   | <i>Crepidula fornicata</i> (Linnaeus, 1758)                                                  | <1970: Parenzan, 1970 (IT);<br>1957: Clanzig, 1989 (FR)                                                                                     |
| MOL   | <i>Cycloscala hyalina</i> (G. B. Sowerby II, 1844)                                           | 1992: Cecalupo & Quadri, 1994 (TR);<br>1986: Slieker <i>et al.</i> , 2023 (TR)                                                              |
| CRU   | <i>Cymodoce fuscina</i> Schotte & Kensley, 2005                                              | 2015: Ulman <i>et al.</i> , 2017 (GR);<br>2002: Castelló <i>et al.</i> , 2020 (LB)                                                          |
| MOL   | <i>Dendostrea folium</i> (Linnaeus, 1758)                                                    | 1993: Çeviker, 2001 (TR);<br>1989: Zenetos <i>et al.</i> , 2024 (TR)                                                                        |
| OCH   | <i>Dictyota acutiloba</i> J. Agardh                                                          | 2014: Katsanevakis <i>et al.</i> , 2020 (IL);<br>2010: Galil <i>et al.</i> , 2021 (IL)                                                      |
| OCH   | <i>Dictyota cyanoloma</i> Tronholm, De Clerck, Gomez Garreta & Rull Lluch                    | 1987: Rull Lluch <i>et al.</i> , 2007 (ES);<br>1935: Steen <i>et al.</i> , 2016 (HR)                                                        |

*Continued*

Table 1 continued

| Group | Species                                                                     | Changes                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASC   | <i>Didemnum perlucidum</i> Monniot F., 1983                                 | 2019: Novak & Shenkar, 2020 (IL);<br>2018: Karahan <i>et al.</i> , 2023 (TR)                                                                                                      |
| MOL   | <i>Dikoleps micalii</i> Agamennone, Sbrana, Nardi, Siragusa & Germanà, 2020 | 2016: Agamennone <i>et al.</i> , 2020 (GR);<br>2015: Albano <i>et al.</i> , 2021 (IL)                                                                                             |
| MOL   | <i>Divalinga arabica</i> Dekker & Goud, 1994                                | 1976: Mienis, 1979 (IL);<br>1956: Barash & Danin, 1986 (EG)                                                                                                                       |
| POL   | <i>Dorvillea similis</i> (Crossland, 1924)                                  | 2005: Çınar, 2009 (TR);<br>2002: Toso <i>et al.</i> , 2024 (LB)                                                                                                                   |
| MOL   | <i>Elysia nealae</i> Ostergaard, 1955                                       | 2019: Manousis <i>et al.</i> , 2020 (GR);<br>2018: Trainito <i>et al.</i> , 2022 (IT)                                                                                             |
| MOL   | <i>Ervilia scaliola</i> Issel, 1869                                         | 2013: Zenetos & Ovalis, 2014 (TR);<br>2011: Albano <i>et al.</i> , 2024 (IL)                                                                                                      |
| CNI   | <i>Eudendrium carneum</i> Clarke, 1882                                      | 1983: Gili, 1986 (ES);<br>1950: Schuchert, 2008 (FR)                                                                                                                              |
| CNI   | <i>Eudendrium merulum</i> Watson, 1985                                      | 1984: Bavestrello & Piraino, 1991 (IT);<br>1977: Marques <i>et al.</i> , 2000 (TR)                                                                                                |
| POL   | <i>Ficopomatus enigmaticus</i> (Fauvel, 1923)                               | 1927: Seurat, 1927 (TN);<br>1919: Lindegg, 1934 (IT)                                                                                                                              |
| FISH  | <i>Fistularia commersonii</i> Rüppell, 1838                                 | 2000: Golani, 2000 (IL);<br>1975: Bariche <i>et al.</i> , 2014 (LB)                                                                                                               |
| MOL   | <i>Gari pallida</i> (Deshayes, 1855)                                        | 2017: Lubinevsky <i>et al.</i> , 2018 (IL);<br>2016: Albano <i>et al.</i> , 2021 (IL)                                                                                             |
| MOL   | <i>Goniobranchus annulatus</i> (Eliot, 1904)                                | 2004: Daskos & Zenetos, 2007 (GR);<br>2000: Bitar, 2013 (LB)                                                                                                                      |
| CRU   | <i>Gonioinfradens giardi</i> (Nobili, 1905)                                 | 2010: Corsini-Foka <i>et al.</i> , 2010 as<br><i>Gonioinfradens paucidentatus</i> (GR);<br>2009: Karhan & Yokeş, 2012 (TR)                                                        |
| MOL   | <i>Hemiliostraca clandestina</i> (Mifsud & Ovalis, 2019)                    | 2014: Mifsud & Ovalis, 2019 (TR);<br>1999: Crocetta <i>et al.</i> , 2020 as <i>Sticteulima clandestina</i> (LB)                                                                   |
| POL   | <i>Iphione muricata</i> (Lamarck, 1818)                                     | 2015: Goren <i>et al.</i> , 2017 (IL);<br>2010: Boudaya <i>et al.</i> , 2019 (TN)                                                                                                 |
| MOL   | <i>Isognomon bicolor</i> (C. B. Adams, 1845)                                | 2015: Mienis <i>et al.</i> , 2016 as <i>I. legumen</i> (IL);<br>1997: Crocetta, 2018 (LY), correctly identified<br>by Garzia <i>et al.</i> , 2022 and Albano <i>et al.</i> , 2024 |
| RHO   | <i>Kapraunia schneideri</i> (Stuercke & Freshwater) Savoie & G.W.Saunders   | 2016: Wolf <i>et al.</i> , 2018 (IT);<br>2014: Ragkousis <i>et al.</i> , 2023 (IL)                                                                                                |
| CRU   | <i>Laticorophium baconi</i> (Shoemaker, 1934)                               | 2018: Gouillieux & Sauriau, 2019 (ES);<br>2010: Guerra-García <i>et al.</i> , 2023 (IT)                                                                                           |
| MOL   | <i>Lioberus ligneus</i> (Reeve, 1858)                                       | 1999: Crocetta <i>et al.</i> , 2013 (LB);<br>1993: Delongueville & Scailet, 2023 (TR)                                                                                             |
| PLAT  | <i>Maritigrella fuscopunctata</i> (Prudhoe, 1978) Newman & Cannon, 2000     | 2014: Crocetta <i>et al.</i> , 2015 (MT);<br>2013: Velasquez <i>et al.</i> , 2018 (IL)                                                                                            |
| CRU   | <i>Metapenaeopsis mogiensis consobrina</i> (Nobili, 1904)                   | 1996: Galil, 1997 (IL);<br>1995: Kevrekidis <i>et al.</i> , 1998 (GR)                                                                                                             |
| CRU   | <i>Micippa thalia</i> (Herbst, 1803)                                        | 1994: Enzenross & Enzenross, 1995 (TR);<br>1993: Hasan & Noel, 2008 (SY)                                                                                                          |
| MOL   | <i>Microcirce consternans</i> P. G. Oliver & Zuschin, 2001                  | 2012: Ovalis & Mifsud, 2013 (TR);<br>2011: Van Aartsen <i>et al.</i> , 2015 (IL)                                                                                                  |
| CTE   | <i>Mnemiopsis leidyi</i> A. Agassiz, 1865                                   | 1992: Uysal & Mutlu, 1993 (TR);<br>1990: Shiganova <i>et al.</i> , 2001 (GR)                                                                                                      |
| CRU   | <i>Paracaprella pusilla</i> Mayer, 1890                                     | 2011: Ros <i>et al.</i> , 2013 (ES);<br>2010: Lo Brutto <i>et al.</i> , 2019 (IL)                                                                                                 |
| CRU   | <i>Paracartia grani</i> Sars G.O., 1904                                     | 1978: Rodríguez & Vives, 1984 (ES);<br>1975: Bradford-Grieve, 1999 (ES)                                                                                                           |
| POR   | <i>Paraleucilla magna</i> Klautau, Monteiro & Borojevic, 2004               | 2001: Longo <i>et al.</i> , 2004 (IT);<br>2000: Frotscher & Uriz, 2008 (ES)                                                                                                       |

Continued

Table 1 continued

| Group | Species                                                                     | Changes                                                                                                            |
|-------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| FISH  | <i>Paranthias furcifer</i> (Valenciennes, 1828)                             | 2011: Dulčić & Dragičević, 2012 (HR);<br>2007: <i>et al.</i> , 2015 (LB);<br>2003: Çinar <i>et al.</i> , 2021 (TR) |
| RHO   | <i>Phrix spatulata</i> (E.Y.Dawson) M.J.Wynne, M.Kamiya & J.A.West          | 1992: Sartoni & Boddi, 1993 (IT);<br>1988: Clavell & Polo, 1998 (ES)                                               |
| POL   | <i>Polycirrus twisti</i> Potts, 1928                                        | 2005: Çinar, 2009 (TR);<br>1983: Simboursa, 2011 (GR)                                                              |
| POL   | <i>Polydora cornuta</i> Bosc, 1802                                          | 1990: Tena <i>et al.</i> , 1991 (ES);<br>1986: Çinar <i>et al.</i> , 2005 (TR)                                     |
| POL   | <i>Prionospio depauperata</i> Imajima, 1990                                 | 2005: Dağlı & Çinar, 2009 (TR);<br>2000: Dağlı <i>et al.</i> , 2011 (TR)                                           |
| FOR   | <i>Hauerina diversa</i> Cushman, 1946                                       | <1997: Avşar, 1997 (TR);<br>1993: Yanko <i>et al.</i> , 1998 (IL)                                                  |
| FOR   | <i>Pseudomassilina reticulata</i> (Heron-Allen and Earland, 1915)           | <1993: Yanko <i>et al.</i> , 1993 (IL);<br>1988: Avşar <i>et al.</i> , 2001 (TR)                                   |
| FOR   | <i>Pyrgo denticulata</i> (Brady, 1884)                                      | 1996: Hyams, 2000 (IL);<br>1994: Samir <i>et al.</i> , 2003 (EG)                                                   |
| MOL   | <i>Rugalucina angela</i> (Melvill, 1899)                                    | 2016: Steger <i>et al.</i> , 2018 (IL);<br>2013: Albano <i>et al.</i> , 2024 (IL)                                  |
| MOL   | <i>Sabia conica</i> (Schumacher, 1817)                                      | 1980: Barash & Danin, 1986 (IL);<br>1954: Mienis, 2004 (IL)                                                        |
| FISH  | <i>Saurida lessepsianus</i> (Russell, Golani and Tikochinski, 2015)         | 1952: Ben Tuvia, 1953 (IL);<br>1951: Ben Tuvia, 1966 (TR)                                                          |
| FISH  | <i>Scarus ghobban</i> Forsskål, 1775                                        | 2001: Goren & Aronov, 2002 (IL);<br>1999: Bariche & Saad, 2005 (LB)                                                |
| MOL   | <i>Smaragdia souverbiana</i> (Montrouzier in Souverbie & Montrouzier, 1863) | 1989: Buzzurro & Greppi, 1994 (TR);<br>1987: Rothman & Mienis, 2011 (IL)                                           |
| POL   | <i>Streblospio gynobranchiata</i> Rice & Levin, 1998                        | 2003: Çinar <i>et al.</i> , 2005 (TR);<br>2000: Dağlı <i>et al.</i> , 2011 (TR)                                    |
| POL   | <i>Syllis cf. crassicirrata</i> (Treadwell, 1925)                           | 2020-21: Chatzigeorgiou <i>et al.</i> , 2022 (GR);<br>2002: Toso <i>et al.</i> , 2024 (LB)                         |
| ASC   | <i>Symplegma brakenhielmi</i> (Michaelsen, 1904)                            | 1999: Bitar & Kouli-Bitar, 2001 (LB);<br>1975: Zenetos <i>et al.</i> , 2017 (IL)                                   |
| FISH  | <i>Synanceia verrucosa</i> Bloch & Schneider, 1801                          | 2010: Edelist <i>et al.</i> , 2011 (IL);<br>2008: Abd Rabou <i>et al.</i> , 2023 (Palestine Authority)             |
| MOL   | <i>Syrnola fasciata</i> Jickeli, 1882                                       | 1963: van Aartsen, 1977 (TR);<br>1949: van Aartsen <i>et al.</i> , 1989 (IL)                                       |
| MOL   | <i>Turbonilla cangeyrani</i> Ovalis & Mifsud, 2017                          | 2016: Ovalis & Mifsud, 2017 (TR);<br>2014: Öztürk <i>et al.</i> , 2023 (TR)                                        |
| CHL   | <i>Ulva ohnoi</i> M.Hiraoka & S.Shimada                                     | 2011: Armeli Minicante <i>et al.</i> , 2014 (IT);<br>2002: Krupnik <i>et al.</i> , 2018 (IL)                       |
| CHL   | <i>Uronema marinum</i> Womersley                                            | 2008: Sfriso <i>et al.</i> , 2014 (IT);<br>1989: Zenetos <i>et al.</i> , 2017 (FR)                                 |
| MOL   | <i>Zafra savignyi</i> (Moazzo, 1939)                                        | 1958: van Aartsen, 1963 (IL);<br>1954: Mienis, 1972 (IL);<br>1952: Mienis, 1976 (IL)                               |
| MOL   | <i>Zafra selasphora</i> (Melvill & Standen, 1901)                           | 1989: Palazzi, 1993 (TR);<br>1980: Tringali & Villa, 1995 (TR);<br>1976: van Aartsen, 1997 (IL)                    |

into published regional inventories (e.g., Zenetos *et al.*, 2017, 2022b), several stem from very recent publications and are herein collectively presented for the first time. Of the 75 species, it is worth highlighting four that had their first records revised on two separate occasions during the total investigation period; these are the macrophyte *Colpomenia peregrina* Sauvageau, with a remarkable back-

dating interval of 38 years, the fish *Paranthias furcifer* (Valenciennes, 1828), and the two congeneric gastropods *Zafra savignyi* (Moazzo, 1939) and *Z. selasphora* (Melvill & Standen, 1901).

Furthermore, there is some uncertainty regarding the backdating accuracy of five species' first records, where no precise collection date was mentioned in the original

publication. Two of these species are the foraminiferans *Hauerina diversa* Cushman, 1946 and *Pseudomassilina reticulata* (Heron-Allen and Earland, 1915), backdated by 1 and 5 years, respectively. Both species are native to the Indo-Pacific (Stulpinaite *et al.*, 2020) and have been detected in Israel and Türkiye (see details in Table 1) such that Lessepsian migration is a plausible pathway of introduction and spread (e.g., Çinar *et al.*, 2021). In that case their presence in Israel would precede records in Türkiye; nevertheless, Foraminifera can also be transported through shipping vectors, thus a first record in Türkiye is not out of the question.

Two more cases of uncertainty in backdating first records belong to the polychaete *Ficopomatus enigmaticus* (Fauvel, 1923) and the green alga *Caulerpa scalpelliformis* (R. Brown ex Turner) C. Agardh, both documented in the older literature, which is often lacking collection dates. *Caulerpa scalpelliformis* is an Indo-Pacific species, most likely having arrived via the Suez Canal, thus backdating its introduction by 1 year (backdated record in 1929 by Carmin, 1934 (Lebanon, Syria); the original first record regarded as 1930 in Hamel, 1930 (Israel)) could be a result of imprecise information in the latter publication. On the other hand, *Ficopomatus enigmaticus* is native to the Indo-West Pacific/Australasian region (Styan *et al.*, 2017; Tsiamis *et al.*, 2018) and a typical fouling species, transported with vessels throughout the world (Pernet *et al.*, 2016); consequently, an 8-year backdating interval from Tunisia (1927 by Seurat, 1927) to Italy (1919 by Lindegg, 1934) could indicate a true earlier introduction despite the lack of collection date information in Seurat (1927). Finally, an exact collection date was not provided for *Crepidula fornicata* in Italy by Parenzan (1970), and thus, the first introduction was assumed in 1970, attributed to shipping vectors by Servello *et al.* (2019). However, the 13-year backdating interval by the French record (1957 by Clanzig, 1989, at La Seyne-sur-mer lagoon) and the known association of the species with oyster farming strongly support an earlier introduction in Mediterranean France from the French Atlantic coast, where the species was already present (Zenetos *et al.*, 2004).

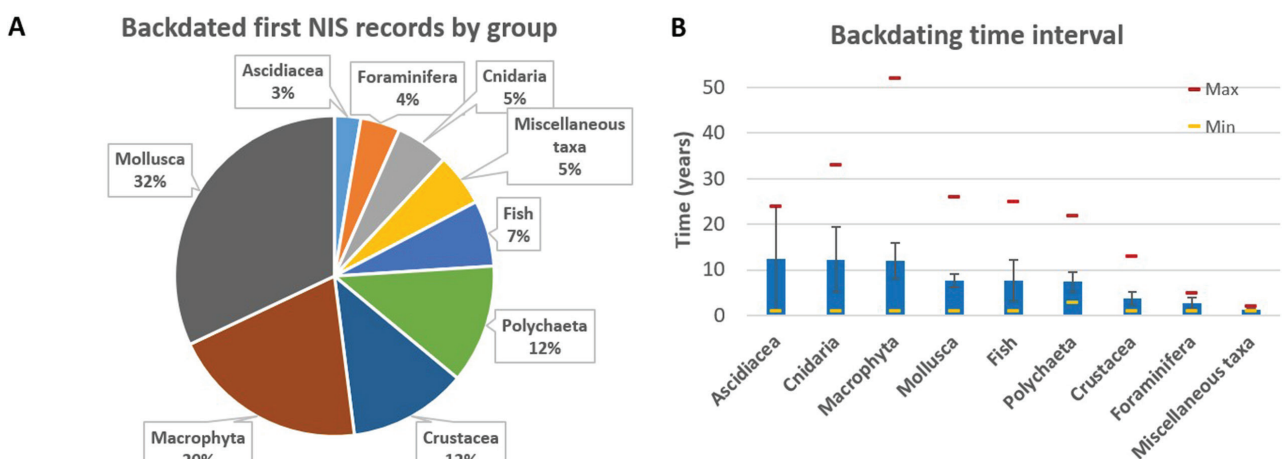
Approximately one third of backdated first records

belong to species of Mollusca, with the second most important group being Macrophyta, followed by Annelida and Crustacea (Fig. 1A). The backdating time spans in our dataset varied between 1 and 52 years, with an average of approximately 8 years but with considerable differences among taxonomic groups. Ascidiaceans, cnidarians, and macrophytes were characterised by the longest backdating intervals (more than 12 years), with polychaetes, molluscs, and fishes displaying backdating intervals of 7.5–8 years, while the other categories showed smaller gaps (Fig. 1B).

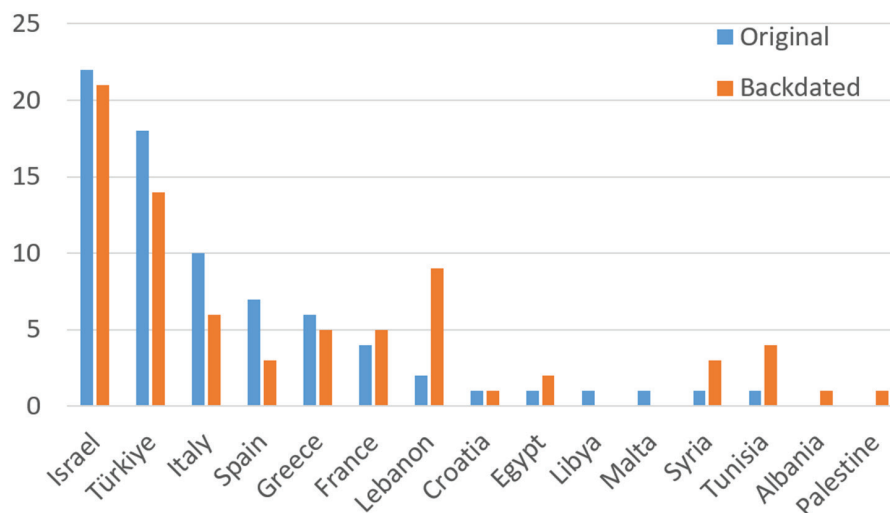
Regarding the country of first record of the backdated species, it can be seen in Figure 2 that the majority of the “original” first records were observed in Israel, Türkiye, Italy, Spain, and Greece. However, most of the backdated records are not from the same country as the original records and appear to be more evenly distributed among Mediterranean countries, with countries in North Africa (Tunisia, Egypt) and the Middle East (Lebanon, Syria) emerging more frequently as gateways of introduction.

Backdating intervals generally increase with time of original first record up until approximately 1970, after which they start gradually decreasing (Fig. 3A), meaning that in more recent years less time passes until the discovery of an earlier first record of a NIS. This likely indicates a faster emergence of new taxonomic information and more concerted efforts to utilise this information in the context of NIS management (Martínez-Laiz *et al.*, 2020; Golo *et al.*, 2023). At the same time, backdating of first records results in increased time lags between the collection date of a specimen and the publication of the finding (Fig. 3B). Specifically, time lags of the original first records in our dataset are generally lower than four years with an average value of 2.8 years. On the other hand, the time lags of the backdated first records are on average 19 years, with a maximum of 81 years. However, it should be pointed out that for many of the backdated records (with the exception of cases of misidentification), their presence in the Mediterranean basin was already known to the scientific community for quite some time already.

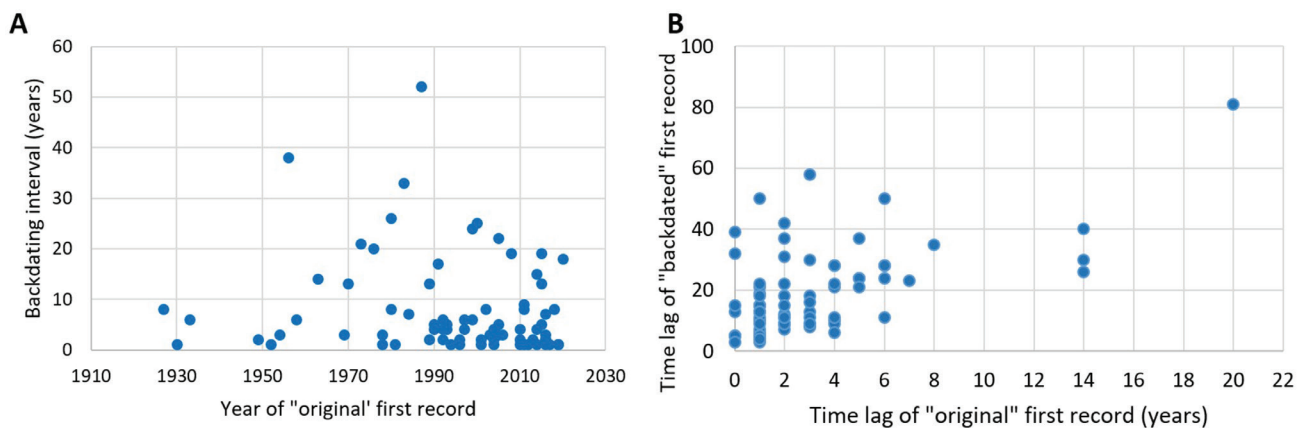
On looking at the causes of NIS backdating, delay in



**Fig. 1:** Number of backdated species by taxon group (A) and average backdating interval per group (B). Bars in B indicate Standard Errors, red and yellow dashes are maximum and minimum values, respectively.



**Fig. 2:** Number of backdated first records by Mediterranean country. In blue the number of “original” first record dates as catalogued in early Mediterranean NIS inventories, in orange the number of “backdated” first records as revealed by subsequent publications.



**Fig. 3:** Backdating interval against the year of first record as originally appearing in the literature (A); comparison of time lags (i.e., the delay in time between collection date and publication) between “original” and “backdated” first records (B).

publishing due to lack of taxonomic expertise emerges as a prominent reason. There is a shortage of taxonomists worldwide (Engel *et al.*, 2021). Taxonomic works are long-lasting and require specific skills that must be handed from one generation to the next to preserve historical knowledge and allow new generations to have a more comprehensive awareness of biological changes (Gravina *et al.*, 2020). Although molluscs, macroalgae, polychaetes, and crustaceans are among the most rich NIS taxa, taxonomic expertise varies among Mediterranean countries with some countries in North Africa and the Middle East lagging behind in the most challenging taxonomic groups (Galanidi *et al.*, 2023). The increasing collaboration among Mediterranean experts, in parallel with the emergence of new knowledge, has led to the correct identification of previously collected specimens in a number of groups, such as polychaetes (e.g., Toso *et al.*, 2024) and molluscs (e.g., Crocetta *et al.*, 2020; Albano *et al.*, 2024), and is likely another factor contributing to a more even distribution in the countries of the backdated first records in the basin (Fig. 2). A good example is that of *Caulerpa taxifolia* var. *distichophylla* (Sonder) Ver-

laque, Huisman & Procaccini, which was distinguished as a separate taxonomic entity to *C. taxifolia* only in 2013 (Jongma *et al.*, 2013). Subsequently, it was determined that the species had first been recorded in Syria in 2003, but misidentified as a dwarf form of *C. mexicana* Sonder ex Kützinger, 1849 (Bitar *et al.*, 2010, 2017).

Backdates have been reported in almost all taxonomic groups but mostly related to the phylum Mollusca. This is attributed partly to shell collectors, who may delay in publishing their findings [e.g., *Afrocardium richardi* (Audouin, 1826) was first reported from Israel (1997: Van Aartsen & Goud, 2000) and backdated from Türkiye by six years (1991: Zenetos *et al.*, 2024)] or publish their earlier findings only after the species identity has been unequivocally determined and published. Such is the case of *Lioberus ligneus* (Reeve, 1858) reported from Lebanon (Crocetta *et al.*, 2013) and backdated from Türkiye (Delongueville & Scaillet, 2023). However, in many cases amateur naturalists are those who publish first and the scientists follow (e.g., for the crab *Micippa thalia* (Herbst, 1803), the molluscs *Microcirce conster-nans* P. G. Oliver & Zuschin, 2001 and *Divalinga arabica*

Dekker & Goud, 1994).

Backdating in fish species is primarily attributed to unreported findings accidentally noticed, e.g., *Paranthias furcifer* listed in Croatia in 2011 was backdated in 2015 by four years back to 2007 via a photograph (Crocetta *et al.*, 2015). A further update of the first record was reported in 2021 from Türkiye (Çinar *et al.*, 2021). *Paranthias furcifer* was observed and photographed during scuba dives in 2003 but the finding remained unpublished until 2021 since a specimen could not be captured. Similarly, the first record of *Fistularia commersoni* has been backdated to 1975 (Bariche *et al.*, 2014) based on a dried specimen of the species found in a private collection of a fisherman in Lebanon, whilst its original invasion was presumed in 2000 in Israel (Golani, 2000), creating a remarkable time lag of 25 years.

Misidentifications of species due to their confusion with native /cryptogenic species can also lead to backdating species first records, particularly so in polychaetes. Detection of the polychaete *Dorvillea similis* (Crossland, 1924) found in 2019 in Capraia, Italy (Dragičević *et al.*, 2019) in previous surveys might have been hindered by its superficial similarity with the native *D. rubrovittata*. Indeed, recent examination of old material from Lebanon has revealed the presence of *D. similis* since 2002 (Toso *et al.*, 2024). Another example in the Mediterranean is the non-native polychaete *Polycirrus twisti* Potts, 1928 that might have been confused in the past with *Polycirrus plumosus* Wollebaek, 1912 originating in the Red Sea (Çinar, 2009). Simboura (2011) re-examined older specimens of *P. plumosus* from Greek waters and re-assigning them to *P. twisti*. Outside polychaetes, a remarkable case is that of the amphipod *Laticorophium baconi* (Shoemaker, 1934), first recorded in 2018 in Spain and already suspected to have been misidentified in the past as the cryptogenic *Apocorophium acutum* (Chevreux, 1908) (Gouillieux & Sauriau, 2019). Prompted by these findings, Guerra-García *et al.* (2023) re-examined previously collected material, in addition to collecting new samples, aiming to clarify the species' invasion history. Their research not only verified the presence of *L. baconi* in Mediterranean waters since 2010 in Italy, but also provided the first records of *L. baconi* in Morocco, Tunisia, France (Corsica), Greece, and Egypt.

Today, integrative approaches combining morphological identification with molecular analyses (DNA) enable the unambiguous assignment of non-indigenous status to specimens previously surrounded by uncertainty concerning their identity and origin. The bivalve *Isognomon bicolor* (C. B. Adams, 1845) was originally reported from Israel under the name *I. legumen* (Gmelin, 1791) by Mienis *et al.* (2016) and was subsequently backdated by 18 years based on morphological features from Libya (Crocetta, 2018). As the species identity was disputed, Garzia *et al.* (2022) performed a molecular analysis which showed that specimens morphologically similar to the records in Libya and Israel in fact belong to the Caribbean species *Isognomon bicolor*. Also worth mentioning is the case of the polychaete *Branchiommma bairdi* (McIntosh, 1885). According to morphological and genetic di-

versity of specimens from Mediterranean locations, some samples were re-designated as *Branchiommma bohollense* (Grube, 1878), another non-indigenous species originally described from Philippines (Del Pasqua *et al.*, 2018).

A third reason for backdating is the volume of overlooked species in museums and/or private collections. A sound example of this is the hydrozoan *Eudendrium carneum*. Its first record from Spain by Gili (1986) should be backdated by 33 years based on a colony from France found at the Muséum d'histoire naturelle de Genève, Switzerland, accession no. MHNG INVE39470 (Schuchert, 2008). Similarly in the case of the tunicate *Symplegma brakenhielmi*: its first record from Lebanon in 1999 (Bitar & Kouli-Bitar, 2001) should be backdated by 24 years according to museum samples at Steinhardt Museum of Natural History, Tel Aviv University, Israel (Zenetos *et al.*, 2017).

More than one reason, e.g., misidentification and museum collections, may be implicated for large backdating intervals as in the case of the brown seaweed *Dictyota cyanoloma*. The species was first reported from Spain in 1987 as *Dictyota ciliolata* by Rull Lluch *et al.* (2007). Sequence data, however, demonstrated unequivocally that the Iberian specimens were clearly distinct from *D. ciliolata* (Tronholm *et al.*, 2010). Molecular sequence information from historical herbarium samples proved the presence of *D. cyanoloma* in the Adriatic Sea as early as 1935 (Steen *et al.*, 2016).

Recent initiatives in collecting large sets of unpublished data so as to enrich spatio-temporal information on the distribution of alien, cryptogenic, and neonative species in the Mediterranean (Katsanevakis *et al.*, 2020; Ragkousis *et al.*, 2023) has brought to light some thousands of unreported records including backdating of NIS at national level but also at Mediterranean level, e.g., *Kapraunia schneideri* from Israel, two years prior to its first record from Italy (Wolf *et al.*, 2018).

Museum collections, citizen scientists, and re-examination of specimens from a new perspective may lead to the backdating of many more species. It is expected that the number of backdated NIS will increase once several overlooked specimens stored in drawers or museum collections are re-examined and /or new techniques are applied. Re-examination of older samples, not only for morphological analysis but also for molecular analyses, since also DNA recovery from formalin-preserved specimens (Palero *et al.*, 2010) is feasible, may reveal older entries of NIS. For example, the identity and distribution of native and introduced *Padina* species has recently been re-evaluated in the Mediterranean, based on more detailed morphological characters and molecular analyses (Win *et al.*, 2011). With this renewed knowledge, Pagana *et al.* (2023) re-examined herbarium material from Sicilian coasts, attributed to *P. pavonica* (Linnaeus) Thivy, 1960, and demonstrated that it belonged to five different *Padina* species. Of these, the species *Padina tetrastromatica* Hauck, 1887 is currently considered of uncertain taxonomic position due to its possible synonymy with *P. antillarum* (Wynne, 1998; Verlaque *et al.*, 2015; Zenetos *et al.*, 2022). The species was first reported in the

Mediterranean in Syria in 2004 (Mayhoub 2004) but was found to be present in Sicily already in 1966 by Pagana *et al.* (2023). This backdate is not included in our list until the taxonomic position of the species is fully resolved. Phylogenetic methods that are now applied to identify NIS and/ or cryptic species (Albano *et al.*, 2024) could also reveal backdating of species. Increased backdating will lengthen reporting time lags, as we see in Fig. 3B, alter temporal and spatial trends in NIS inventories, and may affect policy indices that only consider species introduced after 1970 for the calculation of time trends (e.g., Zenetos *et al.*, 2022c; UNEP/MAP, 2023).

In conclusion, the current work serves to showcase how the meticulous and continuous curation of NIS inventories helps increase accuracy of NIS datasets for purposes of assessment and improve our confidence in assigning pathways of introduction, which has been identified as a pressing need within the context of various policy instruments (Stæhr *et al.*, 2022). It also highlights the variable sources of NIS data and the importance of bringing them together in a framework of increased collaborations and modern methodologies in order to advance NIS research. Collaborative initiatives, such as those by Katsanevakis *et al.* (2020) and Ragkousis *et al.* (2023), have demonstrated that new data are continuously being produced that need to be validated, harmonised, and openly shared. Furthermore, journals and article series dedicated to publishing species records (e.g., Marine Biodiversity Records, Bioinvasions Records, and the Collective Series of Mediterranean Marine Science) have contributed to shorter time-lags between findings and publications (Zenetos *et al.*, 2019). Cryptogenic and questionable species are also being increasingly reported in national and regional inventories (Tsiamis *et al.*, 2021; Galanidi *et al.*, 2023), providing valuable information for future studies. In this context of increased NIS data availability, it is important to foster expert networks, promote taxonomic expertise and revisit older material in collections in order to enhance our understanding of marine bioinvasions (Ricciardi *et al.*, 2021; Guerra-García *et al.*, 2023).

## References

- Abd Rabou, A.F.N., Elkahoul, K.E., Elnabris, K.J., Shurrah, H.M., Almalfoh, A.M. *et al.*, 2023. Rare records of the exotic Reef Stonefish (*Synanceia verrucosa* Bloch and Schneider, 1801) in the Mediterranean waters of the Gaza Strip, Palestine. *International Journal of Fauna and Biological Studies*, 10 (3), 24-28.
- Agamennone, F., Sbrana, C., Nardi, N., Siragusa, F., Germanà, A., 2020. *Dikoleps micalii* n. sp. (Gastropoda: Skeneidae) from the Eastern Aegean Sea. *Bollettino Malacologico*, 56 (1), 91-95.
- Albano, P.G., Steger, J., Bakker, P.A., Bogi, C., Bošnjak, M. *et al.*, 2021. Numerous new records of tropical non-indigenous species in the Eastern Mediterranean highlight the challenges of their recognition and identification. *ZooKeys*, 1010, 1-95.
- Albano, P.G., Hong, Y., Steger, J., Yasuhara, M., Bartolini, S. *et al.*, 2024. New records of non-indigenous species from the eastern Mediterranean Sea (Crustacea, Mollusca), with a revision of genus *Isognomon* (Mollusca: Bivalvia). *PeerJ*, 12, e17425.
- Arias, A., Giangrande, A., Gambi, M.C., Anadón, N., 2013. Biology and new records of the invasive species *Branchioma bairdi* (Annelida: Sabellidae) in the Mediterranean Sea. *Mediterranean Marine Science*, 14 (1), 162-171.
- Armeli Minicante, S., Genovese, G., Morabito, M., 2014. Two new alien macroalgae identified by the DNA barcoding. 45° Congresso SIBM Venezia. 19-23 maggio 2014. *Biologia marina mediterranea*, 21 (1), 70-72.
- Athanasiadis, A., 1987. A survey of the seaweeds of the Aegean Sea with taxonomic studies on species of the tribe Anthamnieae (Rhodophyta). pp. i-vii, [1]-174. Gothenburg: University of Gothenburg.
- Avşar, N., 1997. Foraminifera of the Eastern Mediterranean Coastline. Çukurova Üniversitesi Yerbilimleri (Geosound), 31, 67-81.
- Avşar, N., Meriç, E., Ergin, M., 2001. İskenderun Körfezi bentojenik sedimentlerinin foraminifer içeriği. *Hacettepe Üniversitesi Yerbilimleri*, 24, 97-112.
- Bailey, S.A., Brown, L., Campbell, M.L., Canning-Clode, J., Carlton, J.T. *et al.*, 2020. Trends in the detection of aquatic non-indigenous species across global marine, estuarine and freshwater ecosystems: A 50-year perspective. *Diversity and Distributions*, 26 (12), 1780-1797.
- Barash, A., Danin, Z., 1986. Further additions to the knowledge of Indo-Pacific Mollusca in the Mediterranean Sea. *Spixiana*, 9 (2), 117-141.
- Bariche, M., Saad, M., 2005. Settlement of the Lessepsian blue-barred parrotfish *Scarus ghobban* (Teleostei: Scaridae) in the eastern Mediterranean. *Marine Biodiversity Records*, 1 (e5): 1-3.
- Bariche, M., Kazanjian, G., Azzurro, E., 2014. A lag of 25 years: evidence from an old capture of *Fistularia commersonii* Rüppell, 1838 from Lebanon (Mediterranean Sea). *Journal of Applied Ichthyology*, 1-2 doi: 10.1111/jai.12394.
- Bavestrello, G., Piraino, S., 1991. On two *Eudendrium* (Cnidaria, Hydrozoa) species from the Mediterranean Sea. *Oebalia*, n. ser., 17, 197-207.
- Bazzicalupo, E., Crocetta, F., Estores-Pacheco, K. A., Golestani, H., Bazairi, H. *et al.*, 2018. Population genetics of *Bursatella leachii* (De Blainville, 1817) and implications for the origin of the Mediterranean population. *Helgoland Marine Research* 72, 19.
- Bazzicalupo E., Crocetta F., Gosliner T. M., Berteaux-Lecellier V., Camacho-García Y. E. *et al.*, 2020. Molecular and morphological systematics of *Bursatella leachii* de Blainville, 1817 and *Stylocheilus striatus* Quoy & Gaimard, 1832 reveal cryptic diversity in pantropically distributed taxa (Mollusca: Gastropoda: Heterobranchia). *Invertebrate Systematics*, 34 (5), 535-568.
- Ben Tuvia A., 1953. Mediterranean fishes of Israel. *Bulletin of the Sea Fisheries Research Station*, (Haifa), 8, 1-40.
- Ben Tuvia, A., 1966. Red Sea fishes recently found in the Mediterranean. *Copeia*, 2, 254-275.
- Bidoux, C., Magne, F., 1989. Étude de quelques Acrochaetiales (Rhodophyta) devant être rapportés au genre *Rhodothamniella*. *Cryptogamie, Algologie*, 10, 33-55.

- Bitar, G., 2010. La flore marine benthique introduite de la côte libanaise. Etat actuel de trois espèces envahissantes. IN-OC-Tischreen University, *International conference on Biodiversity of the Aquatic Environment*, pp. 107-114.
- Bitar, G., 2013. Les mollusques exotiques de la côte libanaise. In: *3ème Congrès Franco-Maghrebin de Zoologie et d'Ichtyologie - Marrakech 2012*. Marrakech, Morocco, p 8.
- Bitar, G., Kouli-Bitar S., 2001. Nouvelles données sur la faune et la flore benthique de la côte Libanaise. Migration Lessepsienne. *Thalassia Salentina*, 25, 71-74.
- Bitar, G., Ramos-Esplá, A.A., Ocaña, O., Sghaier, Y. R., Forcada, A. *et al.*, 2017. Introduced marine macroflora of Lebanon and its distribution on the Levantine coast. *Mediterranean Marine Science*, 18 (1), 138-155.
- Blackler, H., 1967. The occurrence of *Colpomenia peregrina* (Sauv.) Hamel in the Mediterranean (Phaeophyta, Scytosiphonales). *Blumea: Biodiversity, Evolution and Biogeography of Plants*, 15 (1), 5-8.
- Bogi, C., Galil, B.S., 1999. Nuovi ritrovamenti di immigranti lessepsiani lungo le coste israeliane. *La Conchiglia*, 31 (292), 22-29.
- Boudaya, L., Mosbahi, N., Dauvin, J. C., Neifar, L., 2019. Structure of the benthic macrofauna of an anthropogenic influenced area: Skhira Bay (Gulf of Gabès, central Mediterranean Sea). *Environmental Science and Pollution Research*, 26, 13522-13538.
- Boudouresque, C.F., Meinesz A., Pergent, G., 1983. Mesure de la Production annuelle de Rhizomes dans l'Herbier a *Posidonia oceanica*, A Port-cros (Var) et Galeria (Corse). *Rapports et procès-verbaux des réunions. Commission internationale pour l'exploration scientifique de la mer méditerranée*, 28, 135-136.
- Bradford-Grieve, J.M., 1999. Copepoda Sub-Order: Calanoida, Family: Acartiidae, Genera: *Acartia*, *Paracartia*, *Pteriacartia*. To replace Fiches d'identification du plancton no. 12. ICES Identification Leaflets for Plankton = Fiches d'identification du plancton, 181. ICES: Copenhagen, Denmark. 19 pp.
- Buzzurro, G., Greppi E., 1994. Presenza di *Smaragdia* (*Smaragdella*) *souverbiana* (Montrouzier, 1863) nel Mediterraneo orientale. *Bollettino Malacologico*, 29, 319-321.
- Carlton, J.T., 1989. Man's role in changing the face of the ocean: biological invasions and implications for conservation of near-shore environments. *Conservation biology*, 3 (3), 265-273.
- Carlton, J.T., Schwindt, E., 2024. The assessment of marine bioinvasion diversity and history. *Biological Invasions*, 26 (1), 237-298.
- Carmin, J., 1934. Algae of Palestine shores. *Bulletine de Institute Oceanographique de Monaco*. No. 653, 1-7.
- Castelló, J., Bitar, G., Zibrowius, H., 2020. Isopoda (crustacea) from the Levantine sea with comments on the biogeography of Mediterranean isopods. *Mediterranean Marine Science*, 21 (2), 308-339.
- Cecalupo, A., Quadri, P., 1994. Contributo alla conoscenza malacologica per il nord dell' isola di Cipro. *Bollettino Malacologico*, 30 (1-4), 5-16.
- Çevik, C., Yokes, M.B., Cavas, L., Erkol, L.I., Derici, O.B. *et al.*, 2007. First report of *Caulerpa taxifolia* (Bryopsidales, Chlorophyta) on the Levantine Coast (Turkey, Eastern Mediterranean). *Estuarine, Coastal and Shelf Science*, 74, 549-556.
- Çeviker, D., 2001. Recent Immigrant Bivalves in the North-eastern Mediterranean off Iskenderun. *La Conchiglia*, 298, 39-46.
- Chatzigeorgiou, G., Androulakis, D., Skouradakis, G., Rallis, I., Gratsia, E., 2022. Polychaetes and Amphipodes from major ports in Greece in 2020-2021. v1.12. Hellenic Center for Marine Research. 2022 dataset/Samplingevent. [http://ipt.medobis.eu/resource?r=alienports\\_polychaetes&v=1.12](http://ipt.medobis.eu/resource?r=alienports_polychaetes&v=1.12)
- Çınar, M.E., 2005. Polychaetes from the coast of northern Cyprus (eastern Mediterranean Sea), with two new records for the Mediterranean Sea. *Cahiers de Biologie Marine*, 46 (2), 143-160.
- Çınar, M.E., 2009. Alien polychaete species (Annelida: Polychaeta) on the southern coast of Turkey (Levantine Sea, eastern Mediterranean), with 13 new records for the Mediterranean Sea. *Journal of Natural History*, 43 (37- 38), 2283-2328.
- Çınar, M.E., Ergen, Z., Dağlı, E., Petersen, M.E., 2005. Alien species of spionid polychaetes (*Streblospio gynobranchiata* and *Polydora cornuta*) in Izmir Bay, eastern Mediterranean. *Journal of the Marine Biological Associations of the United Kingdom*, 85, 821-827.
- Çınar, M.E., Bilecenoglu, M., Ozturk, B., Katagan, T., Yokes, M.B. *et al.*, 2011. An updated review of alien species on the coasts of Turkey. *Mediterranean Marine Science*, 12 (2), 257-315.
- Çınar, M.E., Bilecenoglu, M., Yokeş, M.B., Öztürk, B., Taşkın, E. *et al.*, 2021. Current status (as of end of 2020) of marine alien species in Turkey. *Plos One*, 16 (5), e0251086.
- Clanzig, S., 1989. Invertébrés d'introduction récente dans les lagunes Méditerranéennes du Languedoc-Roussillon (France). *Bulletin de la Société Zoologique de France*, 114 (3), 151-152.
- Clavell, A., Polo, L., 1998. Estudio comparativo entre *Apoglossum gregarium* (Dawson) Wynne y *Apoglossum ruscifolium* (Turner) J. Agardh (Delesseriaceae, Rhodophyta) en las Costa Brava (Girona) y Baleares. *Algas*, 19, 3-4.
- Cormaci, M., Furnari, G., Alongi, G., Dinaro, R., Pizzuto, F., 1992. On the occurrence in Sicily of three Florideophyceae new to the Mediterranean Sea. *Botanica marina*, 35 (5), 447-450.
- Corsini-Foka, M., Pancucci-Papadopoulou, M.A., Kondylatos, G., Kalogirou, S., 2010. *Gonioinfradens paucidentatus* (A. Milne Edwards, 1861) (Crustacea, Decapoda, Portunidae): a new alien crab in the Mediterranean Sea. *Mediterranean Marine Science*, 11 (2), 331-340.
- Crocetta, F., 2018. *Malleus regula* in Libya: another case of misidentification for *Isognomon legumen*. *Triton*, 37, 4-5.
- Crocetta, F., Bitar, G., Zibrowius, H., Oliverio, M., 2013. Biogeographical homogeneity in the eastern Mediterranean Sea. II. Temporal variation in Lebanese bivalve biota. *Aquatic Biology*, 19, 75-84.
- Crocetta, F., Agius, D., Balistreri, P., Bariche, M., Bayhan, Y.K. *et al.*, 2015. New Mediterranean Biodiversity Records (October 2015). *Mediterranean Marine Science*, 16, 682-702.
- Crocetta, F., Bitar, G., Zibrowius, H., Oliverio, M., 2020. Increase in knowledge of the marine gastropod fauna of Lebanon since the 19th century. *Bulletin of Marine Science*, 96

- (1), 1-22.
- Dağlı, E., Çınar, M.E., 2009. Species of the subgenera *Aquilaspio* and *Prionospio* (Polychaeta: Spionidae: Prionospio) from the southern coast of Turkey (Levantine Sea, eastern Mediterranean), with description of a new species and two new reports for the Mediterranean fauna. *Zootaxa*, 2275 (1), 1-20.
- Dağlı, E., Çınar, M.E., Ergen, Z., 2011. Spionidae (Annelida: Polychaeta) from the Aegean Sea (eastern Mediterranean). *Italian Journal of Zoology*, 78 (sup1), 49-64.
- Daskos, A., Zenetos, A., 2007. Additions to the knowledge of alien Opisthobranchia of Greece. *Aquatic Invasions*, 2, 258-260.
- Del Pasqua, M., Schulze, A., Tover-Hernández, M., Keppel, E., Lezzi, M. *et al.*, 2018. Clarifying the taxonomic status of the alien species *Branchiomma bairdi* and *Branchiomma bohollense* (Annelida: Sabellidae) using molecular and morphological evidence. *PLoS One*, 13, e0197104.
- Delongueville, C., Scaillet, R., 2023. The genus *Lioberus* Dall, 1898 (Bivalvia—Mytilidae), some thoughts about its distribution in the Mediterranean Sea. *Novapex*, 24, 77-85.
- Dragičević, B., Anadoli, O., Angel, D., Benabdi, M., Bitar, G. *et al.*, 2019. New Mediterranean Biodiversity Records (December 2019). *Mediterranean Marine Science*, 20, 645-656.
- Dulčić, J., Dragičević, B., 2012. *Paranthias furcifer* (Perciformes: Serranidae), a new alien fish in the Mediterranean Sea. *Journal of Fish Biology*, 82 (1), 332-337.
- EC, 2008. European Commission Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union L164, 19-40.
- EC, 2011. Our life insurance, our natural capital: an EU biodiversity strategy to 2020.
- EC, 2017. European Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardized methods for monitoring and assessment, and repealing Decision 2010/477/EU. Official Journal of the European Union L125, 43-74.
- EC, 2020. EU Biodiversity Strategy for 2030. Bringing nature back into our lives. Brussels, 20.5.2020 COM(2020) 380 final.
- Edelist, D., Spanier, E., Golani, D., 2011. Evidence for the occurrence of the Indo-Pacific stonefish, *Synanceia verrucosa* (Actinopterygii: Scorpaeniformes: Synanceiidae), in the Mediterranean Sea. *Acta Ichthyologica et Piscatoria*, 41 (2), 129-131.
- Engel, M.S., Ceriaco, L. M., Daniel, G. M., Dellapé, P.M., Löbl, I. *et al.*, 2021. The taxonomic impediment: a shortage of taxonomists, not the lack of technical approaches. *Zoological Journal of the Linnean Society*, 193 (2), 381-387.
- Enzenross, R., Enzenross, L., 1995. Erstnachweise indopazifischer Brachyura (Crustacea: Decapoda) von der türkischen Mittelmeerküste. *Stuttgarter Beitrag zur Naturkunde Serie A (Biologie)*, 521, 1-4.
- Fauvel, P., 1955. Contribution à la faune des Annélides polychètes des côtes d'Israël. *Bulletin Sea Fisheries Research Station (Haifa)*, 10, 3-12.
- Frotscher, P.J., Uriz, M.J., 2008. Reproduction and life cycle of the calcarean sponge *Paraleucilla magna* in the Mediterranean Sea. In: *XV Simposio Ibe'rico de Estudios de Bentos Marino*, Funchal, Septiembre 2008, p 121.
- Galanidi, M., Aissi, M., Ali, M., Bakalem, A., Bariche, M. *et al.*, 2023. Validated Inventories of Non-Indigenous Species (NIS) for the Mediterranean Sea as Tools for Regional Policy and Patterns of NIS Spread. *Diversity*, 15, 962.
- Galil, B.S., 1997. Two Lessepsian migrant decapods new to the coast of Turkey. *Crustaceana*, 70 (1), 111-114.
- Galil, B.S. 2008. Alien species in the Mediterranean Sea. Which, when, where, why? *Hydrobiologia*, 606, 105-116.
- Galil, B.S., Mienis, H.K., Hoffman, R., Goren, M., 2021. Non-native species along the Israeli Mediterranean coast: tally, policy, outlook. *Hydrobiologia*, 848, 2011-2029.
- Garzia, M., Furfaro, G., Renda, W., Rosati, A-M., Mariottini, P. *et al.*, 2022. Mediterranean spreading of the bicolor purse oyster, *Isognomon bicolor*, and the chicken trigger, *Mallotus* sp., vs. the Lessepsian prejudice. *Mediterranean Marine Science* 23 (4), 777-788.
- Ghisotti, F., 1973. *Scapharca* cfr. *cornea* (Reeve), ospite nuova del Mediterraneo. *Conchiglie*, 9 (3-4), 68.
- Gili, J.M., 1986. *Estudio sistemático y faunístico de los cnidarios de la costa catalana*. Ph D. Thesis, Universitat Autònoma de Barcelona, Bellaterra, 565 p
- Giordani Soika, A., 1951. Il *Neptunus pelagicus* (L.) nell'alto Adriatico. *Natura*, 42, 18-20.
- Gittenberger, A., Rensing, M., Faasse, M., van Walraven, L., Smolders, S. *et al.*, 2023. Non-indigenous species dynamics in time and space within the coastal waters of the Netherlands. *Diversity*, 15 (6), 719.
- Golani, D., 2000. First record of the bluespotted cornetfish from the Mediterranean Sea. *Journal of Fish Biology*, 56, 1545-1547.
- Golo, R., Vergés, A., Díaz-Tapia, P., Cebrian, E., 2023. Implications of taxonomic misidentification for future invasion predictions: Evidence from one of the most harmful invasive marine algae. *Marine Pollution Bulletin*, 191, 114970.
- Goren, M., Aronov, A., 2002. First record of the Indo-Pacific parrot fish *Scarus ghobban* in the eastern Mediterranean. *Cybium*, 26 (3), 239-240.
- Goren, L., Shefer, S., Feldstein T., 2017. First record of the Indo-Pacific species *Iphione muricata* Savigny in Lamarck, 1818 (Polychaeta: Iphionidae) from the Mediterranean Sea, Israel. *Mediterranean Marine Science*, 18 (1), 134-137.
- Gouillieux, B., Sauriau, P.G., 2019. *Laticorophium baconi* (Shoemaker, 1934)(Crustacea: Amphipoda: Corophiidae: Corophiini): first record in European marine waters. *BioInvasions Records*, 8 (4), 848-861.
- Gravina, M.F., Bonifazi, A., Del Pasqua, M., Giampaolletti, J., Lezzi, M. *et al.*, 2020. Perception of changes in marine benthic habitats: The relevance of taxonomic and ecological memory. *Diversity*, 12 (12), 480.
- Guerra García, J.M., Revanales, T., Sáenz Arias, P., Navarro Barranco, C., Ruiz Velasco, S. *et al.*, 2023. Quick spreading of the exotic amphipod *Laticorophium baconi* (Shoemaker, 1934): another small stowaway overlooked? *Mediterranean Marine Science*, 24 (3), 644-665.
- Gueroun, S.M., Molinero, J.C., Piraino, S., Dali Yahia, M.N., 2020. Population dynamics and predatory impact of the

- alien jellyfish *Aurelia solida* (Cnidaria, Scyphozoa) in the Bizerte Lagoon (southwestern Mediterranean Sea). *Mediterranean Marine Science*, 21 (1), 22-35.
- Hamel, G., 1930. Les Caulerpes méditerranéennes. *Revue Algologique*, France, 5, 229-230.
- Hamza, A., Bradai, M.N., Ghorbel, M., Abdelmouleh, A., 1995. New mentions of *Caulerpa racemosa* (Forsskal) J. Agardh in the Gabès Gulf (Tunisia). *Bulletin de l'Institut National des Sciences et Technologie de la Mer de Salammbô*, 22, 81-87.
- Harmelin, J.G., 2014. Alien bryozoans in the eastern Mediterranean Sea—new records from the coast of Lebanon. *Zootaxa*, 3893 (3), 301-338.
- Hasan, H., Noël, P.Y., 2008. The marine decapod Crustacea of the area of Lattakia, Syria. *Crustaceana*, 81(5), 513-536.
- Huve, H., 1957. Sur une variété nouvelle pour la Méditerranée du *Caulerpa racemosa* (Forsskal) Agardh. *Recueil des travaux de la Station Marine d'Endoume*, 21, 67-73.
- Hyams, O., 2000. *Benthic foraminifera from the Mediterranean inner shelf (to 40 m) of Israel*. MSc. thesis. Ben-Gurion University of the Negev, Israel, 92 pp. (In Hebrew, English abstract).
- Hyams-Kaphzan, O., Almogi-Labin, A., Sivan, D., Benjamini, C., 2008. Benthic foraminifera assemblage change along the southeastern Mediterranean inner shelf due to fall-off of Nile-derived siliciclastics. *Neues Jahrbuch für Geologie und Paläontologie - Abhandlungen*, 248 (3), 315-344.
- IPBES, 2023. *Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and Their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* Roy, H.E.; Pauchard, A.; Stoett, P.; Renard Truong, T.; Bacher, S. *et al.* (Eds) IPBES Secretariat: Bonn, Germany. <https://doi.org/10.5281/zenodo.7430692>
- Jongma, D.N., Campo, D., Dattolo, E., D'Esposito, D., Duchi, A. *et al.*, 2013. Identity and origin of a slender *Caulerpa taxifolia* strain introduced into the Mediterranean Sea. *Botanica Marina*, 56 (1), 27-39.
- Karahan, A., Temiz, B., Öztürk, E., Douek, J., Rinkevich, B., 2023. Seven ascidian (Tunicata) species from the North Eastern Mediterranean. *Mediterranean Marine Science*, 24 (3), 545-557.
- Karhan, S.Ü., Yokeş, M.B., 2012. An earlier record of the Indo-Pacific swimming crab, *Gonioinfradens paucidentatus* (A. Milne-Edwards, 1861) (Decapoda, Brachyura, Portunidae) off the Mediterranean Coast of Turkey. *Crustaceana*, 85 (1), 117-121.
- Karhan, S.Ü., Yokeş, M.B., Clark, P.F., Galil, B.S., 2013. First Mediterranean record of *Actaea savignii* (H. Milne Edwards, 1834) (Crustacea: Decapoda: Brachyura: Xanthidae), an additional Erythraean alien crab. *BioInvasions Records*, 2 (2), 145-148.
- Kashta, L., Pizzuto, F., 1995. Sulla presenza di *Halophila stipulacea* (Forsskal) Ascherson (Hydrocharitales, Hydrocharitaceae) nelle coste dell'Albania. *Bollettino della Accademia Gioenia di Scienze Naturali (Catania)*, 28 (349), 161-166.
- Katsanevakis, S., Poursanidis, D., Hoffman, R., Rizgalla, J., Rothman, S.B.S. *et al.*, 2020. Unpublished Mediterranean records of marine alien and cryptogenic species. *BioInvasions Records*, 9 (2), 165-182.
- Kevrekidis, K., Galil, B.S., Kevrekidis, T., 1998. Three Lessepsian migrant penaeids (Decapoda) in Rhodes Island (Greece) *Crustaceana*, 71 (4), 474-478.
- Krupnik, N., Paz, G., Douek, J., Lewinsohn, E., Israel, A. *et al.*, 2018. Native, invasive and cryptogenic *Ulva* species from the Israeli Mediterranean Sea: risk and potential. *Mediterranean Marine Science*, 19 (1), 132-146.
- Koçak, F., 2007. A new alien bryozoan *Celleporaria brunnea* (Hincks, 1884) in the Aegean Sea (eastern Mediterranean). *Scientia Marina*, 71 (1), 191-195.
- Lindegg, G., 1934. La “*Mercierella enigmatica*” Fauvel nello stagno di Cabras. *Natura Milano*, 25, 135-145.
- Lo Brutto, S., Laciofano, D., Guerra García, J.M., Lubinevsky, H., Galil, B.S., 2019. Desalination effluents and the establishment of the non-indigenous skeleton shrimp *Paracaprilla pusilla* Mayer, 1890 in the south-eastern Mediterranean. *BioInvasions Records*, 8 (3), 661-669.
- Lo Brutto, S., 2023. Zoological Checklists: From Natural History Museums to Ecosystems. *Diversity*, 15, 741. <https://doi.org/10.3390/d15060741>
- Longo, C., Scalera Liaci, L., Corriero, G., 2004. Note sui poriferi del Mar Grande e del Mar Piccolo di Taranto (Mar Ionio). *Biologia Marina Mediterranea*, 11, 440-443.
- Lubinevsky, H., Galil, B.S., Bogi, C., 2018. First record of *Gari pallida* (Deshayes, 1855) (Mollusca: Bivalvia: Psammobiiidae) in the Mediterranean Sea. *BioInvasions Records*, 7 (4), 415-9.
- Manousis, T., Kontadakis, C., Zaminos, G., Zeimbekis, C., Mbazios, G. *et al.*, 2020. New records of Lower Heterobranchia (Mollusca: Gastropoda) for the Mediterranean and the Hellenic Seas. *Xenophora Taxonomy*, 30, 22-39.
- Marques, A.C., Cantero, A.L.P., Vervoort, W., 2000. Mediterranean species of *Eudendrium* Ehrenberg, 1834 (Hydrozoa, Anthomedusae, Eudendriidae) with the description of a new species. *Journal of Zoology*, 252, 197-213.
- Martínez-Laiz, G., Ros, M., Guerra-García, J.M., Marchini, A., Fernández-González, V. *et al.*, 2020. Scientific collaboration for early detection of invaders results in a significant update on estimated range: lessons from *Stenothoe georgiana* Bynum & Fox, 1977. *Mediterranean Marine Science*, 21 (2), 461-481.
- Mayhoob, H., 2004. The presence of tropical alga *Padina tetrastromatica* Hauck near Latakia (Syria). *Journal of Damascus University*, 2, 77-89.
- Meñez, E.G., Mathieson, A.C., 1981. The marine algae of Tunisia. *Smithsonian Contributions to the Marine Science*, 10, 1-59.
- Méndez-Domingo, C., 1957. Sur l'existence du *Colpomenia peregrina* (Sauv.) Hamel dans la Méditerranée. *Vie Milieu*, 8 (1), 92-98.
- Mienis, H.K., 1972. On the nomenclature and distribution of *Columbella savignyi*. *Argamon*, 3 (1-4), 17-19.
- Mienis, H.K., 1976. A further note on *Anachis (Zafra) savignyi* (Moazzo) from the Mediterranean. *Levantina*, 5, 54-55.
- Mienis, H.K., 1979. *Divaricella angulifera* (von Martens, 1880), another Red Sea species from the Mediterranean coast of Israel. *Levantina*, 18, 200.
- Mienis, H.K., 2000. Additional finds of an Indo-Pacific bivalve species: *Circenita callipyga*, on the Mediterranean coast of Israel. *Triton*, 1, 6-7.

- Mienis, H.K., 2004. New Data Concerning the Presence of Lessepsian and other Indo-Pacific Migrants among the Molluscs in the Mediterranean Sea with Emphasize on the Situation in Israel. In Öztürk, B. & Salman, A. (Eds): Proceedings First National Malacology Congress, 1-3 September 2004, Izmir. *Turkish Journal of Aquatic Life*, 2 (2), 117-131.
- Mienis, H.K., Rittner, O., Shefer, S., Feldstein, T., Yahel, R., 2016. First record of the Indo pacific *Isognomon legumen* from the Mediterranean coast of Israel (Mollusca, Bivalvia, Isognomidae). *Triton*, No 33, p 9-11.
- Mifsud, C., Ovalis, P., 2019. Two new species of *Sticteulima Laseron*, 1955 (Gastropoda: Eulimidae) from Turkey, Eastern Mediterranean. *Bollettino Malacologico*, 55, 68-71.
- Mineur, F., Belsher, T., Johnson, M.P., Maggs, C.A., Verlaque M., 2007. Experimental assessment of oyster transfers as a vector for macroalgal introductions. *Biological Conservation*, 137, 237-247.
- Monro, C.C.A., 1937. The John Murray Expedition 1933-34. Polychaeta. *Scientific Reports, Zoology*, 4 (8), 243-321.
- Morri, C., 1979. Osservazioni su due idrozoi launari italiani. *Bollettino Zoologico*, 46 suppl., 160-161.
- Ni-Ni-Win, Hanyuda, T., Draisma, S.G.A., Furnari, G., Meinesz, A. *et al.*, 2011. *Padina ditristromatica* sp. nov. and *Padina pavonicoides* sp. nov. (Dictyotales, Phaeophyceae), two new species from the Mediterranean Sea based on morphological and molecular markers. *European journal of phycology*, 46 (4), 327-341.
- Nizamuddin, M., 1981. Contribution to the marine algae of Libya. Dictyotales. *Bibliotheca Phycologica*, 54, 1-122.
- Novak, L., Shenkar, N., 2020. Occurrence of *Didemnum perucidum* Monniot F., 1983 on artificial substrates along the Mediterranean coast of Israel. *Mediterranean Marine Science*, 21 (2), 386-392.
- O'Donoghue, C.H., White, K.M., 1940. A collection of marine molluscs, mainly opisthobranchs, from Palestina. *Proceedings of the Malacological Society of London*, 24, 92-96.
- Oliver, J.A., Terrasa, J., 2004. Primera cita de *Bursatella leachi* (de Blainville, 1817) (Mollusca, Opisthobranchia) a Mallorca. *Bolletí de la Societat d'Història Natural de les Balears*, 47, 37-42.
- Ovalis, P., Mifsud C., 2013. Another alien Lessepsian bivalve in the Eastern Mediterranean. *Triton*, No 27 March 2013.
- Ovalis, P., Mifsud, C., 2017. A new species of *Turbonilla* (Risso, 1826) from SE Turkey (Pyramidellidae: Turbonillinae). *Triton*, 35, March 2017.
- Öztürk, B., Türkçü, N., Bitlis, B., 2023. New records of gastropods (Caenogastropoda and Heterobranchia) from the Turkish coasts with observations on some poorly known species. *Turkish Journal of Zoology*, 47 (3), 135-146.
- Pagana, I., Marroccia, G., Marletta, G., Alongi, G., 2023. Re-examination of the distribution and species diversity of the genus *Padina* (Dictyotales, Phaeophyceae) in the Mediterranean Sea. *Phytotaxa*, 619 (3), 205-218.
- Palazzi, S., 1993. Ci sono due *Zafra* in Mediterraneo, ma come si chiamano? *Notiziario del CISMA*, 14, 13-18.
- Palero, F., Hall, S., Clark, P.F., Johnston, D., Mackenzie-Dodds, J. *et al.*, 2010. DNA extraction from formalin-fixed tissue: new light from the deep sea. *Scientia Marina*, 74 (3), 465-470.
- Parenzan, P., 1970. *Carta d'Identità delle Conchiglie del Mediterraneo*. Bios Taras Ed, Taranto, 283 pp., 53 pls.
- Parenzan, P., 1976. *Carta d'identità delle conchiglie del Mediterraneo*, Vol. III, Bivalvi, parte seconda. Bios Taras (Eds), Taranto, 281-546.
- Pernet, B., Barton, M., Fitzhugh, K., Harris, L. H., Lizárraga, D. *et al.*, 2016. Establishment of the reef-forming tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923) (Annelida: Serpulidae) in southern California. *BioInvasions Records*, 5 (1), 13-19.
- Petrocelli, A., Wolf, M.A., Cecere, E., Sciuto, K., Sfriso, A., 2020. Settlement and spreading of the introduced seaweed *Caulacanthus okamurae* (Rhodophyta) in the Mediterranean Sea. *Diversity*, 12 (4), 129.
- Png-Gonzalez, L., Comas-González, R., Calvo-Manazza, M., Follana-Berná, G., Ballesteros, E. *et al.*, 2023. Updating the national baseline of non-indigenous species in Spanish marine waters. *Diversity*, 15 (5), 630.
- Ragkousis, M., Zenetos, A., Ben Souissi, J., Hoffman, R., Ghanem, R. *et al.*, 2023. Unpublished Mediterranean and Black Sea records of marine alien, cryptogenic, and neontative species. *BioInvasions Records*, 12 (2), 339-369.
- Rayss, T., Edelstein T., 1960. Deux caulerpes nouvelles sur les côtes méditerranéennes d'Israel. *Revue Générale de Botanique*, 67, 602-620, pl. xxii.
- Ricciardi, A., Iacarella, J.C., Aldridge, D.C., Blackburn, T.M., Carlton, J.T. *et al.*, 2021. Four priority areas to advance invasion science in the face of rapid environmental change. *Environmental Reviews*, 29 (2), 119-141.
- Richardson, D.M., Pyšek, P., 2008. Fifty years of invasion ecology—the legacy of Charles Elton. *Diversity and distributions*, 14 (2), 161-168.
- Rodríguez, V., Vives, F., 1984. Copepodos de las aguas portuarias de Málaga. *Investigaciones Pesqueras*, 48 (2), 235-254.
- Ros, M., Vázquez-Luis, M., Guerra-García, J. M., 2013. The tropical caprellid amphipod *Paracaprella pusilla*: a new alien crustacean in the Mediterranean Sea. *Helgoland Marine Research*, 67 (4), 675-685.
- Rothman, B.S., Mienis, H.K., 2011. *Smaragdia souverbiana*: not only the first record from Israel, but also the oldest record from the Mediterranean Sea (Gastropoda, Neritidae). *Triton*, 24, 9-10.
- Rull Lluch, J., Ballesteros, E., Barcelo, M.C., Gomez Garreta, A., Ribera Siguan, M. A., 2007. *Dictyota ciliolata* Sonder ex Kützing (Phaeophyceae, Dictyotales) in the Mediterranean Sea. *Cryptogamie, Algologie*, 28 (1), 89-97.
- Samir, A.M., Abdou, H.F., Zazou, S.M., El-Menhawey, W.H., 2003. Cluster analysis of recent benthic foraminifera from the northwestern Mediterranean coast of Egypt. *Revue de Micropaléontologie*, 46, 111-130.
- Sartoni, G., Boddi, S., 1993. *Apoglossum gregarium* (Delesseriaceae, Rhodophyta), a new record for Mediterranean algal flora. *Botanica Marina*, 36 (4), 297-302.
- Schuchert, P., 2008. The European athecate hydroids and their medusae (Hydrozoa, Cnidaria): Filifera Part 4. *Revue Suisse de Zoologie*, 115 (4), 677-757.
- Scorrano, S., Aglieri, G., Boero, F., Dawson, M.N., Piraino, S., 2016. Unmasking Aurelia species in the Mediterranean Sea: an integrative morphometric and molecular approach. *Zoological Journal of the Linnean Society*, 180 (2), 243-267.
- Selfati, M., Ouamari, N.E., Crocetta, F., Mesfioui, A., Boissery,

- P. *et al.*, 2017. Closing the circle in the Mediterranean Sea: *Bursatella leachii* Blainville, 1817 (Mollusca: Gastropoda: Anaspeidea) has reached Morocco. *BioInvasions Records*, 6, 129-134.
- Serbetis, C., 1959. Un nouveau crustacé comestible en mer Egée *Callinectes sapidus* Rath. (Decapod brach.). *General Fisheries Council for the Mediterranean (GPMC) Proceedings and Technical Papers*, 5, 505-507.
- Servello, G., Andaloro, F., Azzurro, E., Castriota, L., Catra, M., Chiarore, A. *et al.*, 2019. Marine alien species in Italy: A contribution to the implementation of descriptor D2 of the marine strategy framework directive. *Mediterranean Marine Science*, 20, 1-48.
- Seurat, L.G., 1927. Sur la presence d'une serpule *Mercierella enigmatica* Fauvel dans une riviere de la Tunisie, *Comptes Rendus des séances hebdomadaires de l'Académie des Sciences Paris*, 185, 549-550.
- Sfriso, A., Buosi, A., Sfriso A.A., 2014. On the occurrence of *Uronema marinum* Womersley (Chaetophorales, Chlorophyta) in the north-western lagoons of the Adriatic Sea, Mediterranean Sea (Italy). *Mediterranean Marine Science*, 15 (1), 101-105.
- Shiganova, T.A., Mirzoyan, Z.A., Studenikina, E.A., Volovik, S.P., Siokou-Frangou, I. *et al.*, 2001. Population development of the invader ctenophore *Mnemiopsis leidyi* in the Black Sea and other seas of the Mediterranean basin. *Marine Biology*, 139, 431-445.
- Simboura, N., 2011. An overlooked alien species present on the coasts of Greece (Eastern Mediterranean): the polychaete *Polycirrus twisti* Potts (Polychaeta: Terebellidae). *Mediterranean Marine Science*, 12 (1), 239-246.
- Sliker, F.J.A., van der Es, H., Andeweg, R., Langeveld, B.W., Schnörr, S., 2023. Natural History Museum Rotterdam - Specimens. Version 1.44. Natural History Museum Rotterdam.
- Stæhr, P.A.U., Carbonell, A., Guerin, L., Kabuta, S.H., Tidbury, H. *et al.*, 2022. Trends in New Records of Non-Indigenous Species (NIS) Introduced by Human Activities. In: OSPAR, 2023: The 2023 Quality Status Report for the Northeast Atlantic. OSPAR Commission, London.
- Steger, J., Stockinger, M., Ivkić, A., Galil, B.S., Albano, P.G., 2018. New records of non-indigenous molluscs from the eastern Mediterranean Sea. *BioInvasions Records*, 7 (3), 245-257.
- Steen, F., Aragay, J., Zuljevic, A., Verbruggen, H., Bunker, F. *et al.*, 2016. Tracing the introduction history of the brown seaweed *Dictyota cyanoloma* (Phaeophyta, Dictyotales) in Europe. *European Journal of Phycology*, 52 (1), 31-42.
- Streftaris, N., Zenetos, A., Papathanassiou, E., 2005. Globalisation in marine ecosystems - The story of non indigenous marine species across European Seas. *Oceanography and Marine Biology: An annual Review*, 43, 419-453.
- Stulpinaite, R., Hyams-Kaphzan, O., Langer, M.R., 2020. Alien and cryptogenic Foraminifera in the Mediterranean Sea: A revision of taxa as part of the EU 2020 Marine Strategy Framework Directive. *Mediterranean Marine Science*, 21 (3), 719-758.
- Styan, C.A., McCluskey, C.F., Sun, Y., Kupriyanova, E.K., 2017. Cryptic sympatric species across the Australian range of the global estuarine invader *Ficopomatus enigmaticus* (Fauvel, 1923)(Serpulidae, Annelida). *Aquatic Invasions*, 12 (1), 53-65.
- Tena, J., Capaccioni-Azzati, R., Porras, R., Torres-Gavilá, F.J., 1991. Cuatro especies de poliquetos nuevas para las costas mediterráneas españolas en los sedimentos del antepuerto de Valencia. *Miscellanea Zoológica, Barcelona*, 15, 29-41.
- Toso, A., Putignano, M., Fumarola, L.M., Bariche, M., Giangrande, A. *et al.*, 2024. A revised inventory of Annelida in the Lebanese coastal waters with ten new aliens for the Mediterranean Sea. *Mediterranean Marine Science*, 25 (3), 715-731.
- Trainito, E., Doneddu, M., Furfaro, G., 2022. Aliens in changing seascapes: a newly reported non-native sacoglossan (Mollusca, Heterobranchia) in the western Mediterranean Sea. *Check List*, 18 (3), 545-551.
- Travaglini, A., Crocetta, F., 2019. Natural History Collections and Alien Species: an Overlooked Sample of *Bursatella leachii* Blainville, 1817 (Mollusca: Gastropoda: Aplysiida) Backdates its Confirmed Presence in Italy. *Thalassas*, 35, 137-141.
- Tringali, L., Villa, R., 1995. On the identity of the Lessepsian species of the genus *Anachis* H. & A. Adams, 1853, subgenus *Zafra* A. Adams, 1860 found in the Levant Sea. *La Conchiglia*, 274, 15-19.
- Tronholm, A., Steen, F., Tyberghein, L., Leliaert, F., Verbruggen, H. *et al.*, 2010. Species delimitation, taxonomy, and biogeography of Dictyota in Europe (Dictyotales, Phaeophyceae). *Journal of Phycology*, 46, 1301-1321.
- Tsiamis, K., Zenetos, A., Deriu, I., Gervasini, E., Cardoso, A.C., 2018. The native distribution range of the European marine non-indigenous species. *Aquatic Invasions* 13, 187-198.
- Tsiamis, K., Palialexis, A., Stefanova, K., Gladan, Ž.N., Skejić S. *et al.*, 2019. Non-indigenous species refined national baseline inventories: A synthesis in the context of the European Union's Marine Strategy Framework Directive. *Marine Pollution Bulletin* 145, 429-435.
- Tsiamis, K., Palialexis, A., Connor, D., Antoniadis, S., Bartilotti, C. *et al.*, 2021. Marine Strategy Framework Directive Descriptor 2, Non-Indigenous Species, Delivering solid recommendations for setting threshold values for non-indigenous species pressure on European seas. Publications Office of the European Union, Luxembourg; 2021, EUR 30640 EN
- Ulman, A., Ferrario, J., Occhpinti-Ambrogi, A., Arvanitidis, C., Bandi, A. *et al.*, 2017. A massive update of non-indigenous species records in Mediterranean marinas. *PeerJ*, 5, e3954.
- UNEP/MAP, 2017. Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria; UN Environment/MAP: Athens, Greece, 2017; Available online: [https://wedocs.unep.org/bitstream/handle/20.500.11822/17012/\\_imap\\_2017\\_eng.pdf?sequence=5&isAllowed=y](https://wedocs.unep.org/bitstream/handle/20.500.11822/17012/_imap_2017_eng.pdf?sequence=5&isAllowed=y) (accessed on 28 October 2024).
- UNEP/MAP. 2023. The 2023 Mediterranean Quality Status Report and a Renewed Ecosystem Approach Policy in the Mediterranean. UNEP/MAP, Athens, 2023. UNEP/MED IG.26/Inf.10; Available online: <https://medqsr2023.info-rac.org/wp-content/uploads/2024/07/MEDQSR-full-englis.pdf> (Accessed on 6 December 2024)
- Uysal, Z., Mutlu, E., 1993. Preliminary note on the occurrence

- & biometry of Ctenophoran *Mnemiopsis leidyi* finally invaded Mersin Bay. Doğa, *Turkish Journal of Zoology*, 12, 229-236.
- Van Aartsen, J.J., 1963. Overpeinzingen bij een regenachtige zomer. *Correspondentieblad van de Nederlandse Malacologische Vereniging*, 107, 1115-1116.
- Van Aartsen, J.J., 1977. European Pyramidellidae: 1. Chrysallida. *Bolletino Malacologico*, 13, 49-64.
- Van Aartsen, J.J., 1997. *Anachis* in the Mediterranean: a note on distribution. *La Conchiglia*, 282, 29.
- Van Aartsen JJ, Goud J. 2000. European marine Mollusca: Notes on less well-known species. XV. Notes on Lusitanian species of *Parvicardium* Monterosato, 1884, and *Afrocardium richardi* (Audouin, 1826) (Bivalvia: Heterodonta: Cardiidae). *Basteria*, 64, 171-186.
- van Aartsen, J.J., Barash, A., Carrozza, F., 1989. Addition to the knowledge of the Mediterranean Mollusca of Israel & Sinai. *Bollettino Malacologico*, 25 (1-4), 63-76.
- Van Aartsen, J.J., Galil, B., Bogi, C., 2015. Two alien venerid bivalves from the Eastern Mediterranean. *Marine Biodiversity Records*, 8, e83.
- Velasquez, X., Bolaños, D.M., Benayahu, Y., 2018. New records of cotylean flatworms (Platyhelminthes: Polycladida: Rhabditophora) from coastal habitats of Israel. *Zootaxa*, 4438 (2), 237-260.
- Verlaque, M., Ruitton, S., Mineur, F., Boudouresque, C.F., 2015. *CIESM atlas of exotic species in the Mediterranean: 4. Macrophytes*. CIESM Publications, Monaco, 364 pp.
- Ville, J., 1968. *Le genre Colpomenia (Scytosiphonales, Iso-génératée, Phéophycée) dans la région de Sète*. Thèse Biologie végétale. Faculté des sciences de Montpellier, Montpellier.
- Wynne, M.J., 1998. A study of *Padina antillarum* (Kützting Piccone and a comparison with *P. tetrastromatica* Hauck (Dictyotales, Phaeophyta). *Cryptogamie Algologie*, 4, 271-289.
- Wolf, M.A., Buosi, A., Juhmani, A.-S.F., Sfriso, A., 2018. Shellfish import and hull fouling as vectors for new red algal introductions in the Venice Lagoon. *Estuarine, Coastal and Shelf Science*, 215, 30-38.
- Yanko, V., Avsar, N., Sanvoisin, R., Spezzaferri, S., Meric, E. *et al.*, 1993. Foraminiferal study: Taxonomy, distribution, density and diversity. Benthic foraminifera as indicators of heavy metal pollution -A new kind of biological monitoring for the Mediterranean. Task 9.
- Yanko, V., Ahmad, M., Kaminski, M., 1998. Morphological deformities of benthic foraminiferal tests in response to pollution by heavy metals: implications for pollution monitoring. *Journal of Foraminiferal Research*, 28, 177-200.
- Zenetos, A., Ovalis, P., 2014. Alien Mollusca in the Levantine Sea: an update. Occurrence of *Ervilia scaliola* Issel, 1869 along the Levantine coast of Turkey. *Cahiers de Biologie Marine*, 55 (4), 507-510.
- Zenetos, A., Çinar, M.E., Crocetta, F., Golani, D., Rosso, A. *et al.*, 2017. Uncertainties and validation of alien species catalogues: the Mediterranean as an example. *Estuarine Coastal & Shelf Science*, 191, 171-187.
- Zenetos, A., Çinar, M.E., Pancucci-Papadopoulou, M.A., Harmelin, J.G., Furnari, G. *et al.*, 2005. Annotated list of marine alien species in the Mediterranean with records of the worst invasive species. *Mediterranean Marine Science*, 6 (2), 63-118.
- Zenetos, A., Gofas, S., Russo, G., Templado, J., 2004. CIESM Atlas of Exotic Species in the Mediterranean, Volume 3: Molluscs. F. Briand (Ed.), CIESM Publishers Monaco. 376 pp.
- Zenetos, A., Gofas, S., Verlaque, M., Çinar, M.E., García Raso, J.E. *et al.*, 2010. Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. *Mediterranean Marine Science*, 11 (2), 381-493.
- Zenetos, A., Gofas, S., Morri, C., Rosso, A., Violanti, D. *et al.*, 2012. Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine strategy framework directive (MSFD). Part 2. Introduction trends and pathways. *Mediterranean Marine Science*, 13 (2), 328-352.
- Zenetos, A., Gratsia, E., Cardoso, A.C., Tsiamis, K., 2019. Time lags in reporting of biological invasions: the case of Mediterranean Sea. *Mediterranean Marine Science*, 20 (2), 469-475.
- Zenetos, A., Karachle, P.K., Corsini-Foka, M., Gerovasileiou, V., Simboura, N. *et al.*, 2020. Is the trend in new introductions of marine non-indigenous species a reliable criterion for assessing good environmental status? The case study of Greece. *Mediterranean Marine Science*, 21 (3), 775-793.
- Zenetos, A., Albano, P.G., Garcia, E.L., Stern, N., Tsiamis, K. *et al.*, 2022a. Established non-indigenous species increased by 40% in 11 years in the Mediterranean Sea. *Mediterranean Marine Science*, 23 (1), 196-212.
- Zenetos, A., Albano, P., Garcia, E.L., Stern, N., Tsiamis, K. *et al.*, 2022b. Corrigendum to the Review Article (Medit. Mar. Sci. 23/1 2022, 196-212): Established non-indigenous species increased by 40% in 11 years in the Mediterranean Sea. *Mediterranean Marine Science*, 23 (4), 876-878.
- Zenetos, A., Tsiamis, K., Galanidi, M., Carvalho, N., Bartilotti, C. *et al.*, 2022c. Status and Trends in the Rate of Introduction of Marine Non-Indigenous Species in European Seas. *Diversity*, 14 (12), 1077.
- Zenetos, A., Delongueville, C., Scaillet, R. 2024. An overlooked group of Citizen Scientists in Non Indigenous Species (NIS) Information: Shell Collectors and their contribution to molluscan NIS xenodiversity. *Diversity*, 16, 299.