

Preliminary evidence of a potential reproductive aggregation area of the common stingray *Dasyatis pastinaca* (Linnaeus, 1758) (Chondrichthyes – Dasyatidae) in the Central Mediterranean Sea

Desirée GRANCAGNOLO¹, Carlo CATTANO^{2,3}, Federico QUATTROCCHI^{1,3} and Marco MILAZZO^{1,3}

¹ Università degli Studi di Palermo, Dipartimento di Scienze della Terra e del Mare (DiSTeM), Università di Palermo, Via Archirafi 20- 22, I-90123 Palermo, Italy

² Stazione Zoologica Anton Dohrn, Department of Integrative Marine Ecology, Sede Interdipartimentale della Sicilia, Lungomare Cristoforo Colombo (complesso Roosevelt) 90149 Palermo, Italy

³ NBFC, National Biodiversity Future Center, Palermo, Italy

Corresponding author: Desirée GRANCAGNOLO; desiree.grancagnolo@community.unipa.it

Contributing Editor: Francesco TIRALONGO

Received: 07 June 2023; Accepted: 30 September 2023; Published online: 21 November 2023

Abstract

Shallow and coastal aggregations of batoids are poorly documented in the Mediterranean Sea, despite being likely threatened by multiple anthropogenic pressures. We report the first observations of a potential summer reproductive aggregation of the common stingray (*Dasyatis pastinaca*). The recurrent presence in previous years of several pregnant females, a mature male and a female with fresh bite wounds was recorded in shallow waters by recreational scuba divers and scientists in Scilla Bay (Strait of Messina, Italy), a location with unique oceanographic features in the Central Mediterranean Sea. These observations suggest that the area could be used as a parturition and mating site in early summer, and this is significant for the conservation of this Vulnerable species.

Keywords: Batoid aggregation; reproductive area; scuba diving; small-scale fishery; Strait of Messina.

The identification of spatio-temporal patterns of distributions of critical life stages of threatened elasmobranchs is key to their effective conservation and potential recovery from direct and indirect effects of human activities (e.g., Hyde *et al.*, 2022). This is particularly true within the Mediterranean Sea, a known hotspot of extinction risk for sharks and rays with a concerning decline of its elasmobranch populations and no signs of improvement in their conservation status for many years (Dulvy *et al.*, 2014; Dulvy *et al.*, 2016; Milazzo *et al.*, 2021). Rays have received less scientific attention compared to other vertebrate groups (Aschliman *et al.*, 2012; Bräutigam *et al.*, 2016), with most studies assessing their status using fishery-dependent approaches and often not properly evaluating their actual abundance and distribution, particularly in shallow waters (Ismen, 2003; Morey *et al.*, 2006; Ismen *et al.*, 2007; Geraci *et al.*, 2021; Ruiz-García *et al.*, 2023).

Field surveys using direct underwater observations led to the description of a massive seasonal aggregation of the common eagle ray *Myliobatis aquila* in Western Sicily (Grancagnolo & Arculeo, 2021). High relative abundances of the common stingray *D. pastinaca* have been reported during late spring and early summer off the

Balearic Islands and along the Israeli coast, with a balanced sex ratio of mature individuals, evidence of courtship behaviours and the presence of gravid females and juveniles (Morey *et al.*, 2006; Chaikin *et al.*, 2020).

This study reports on the first characterization of a potential reproductive area of the common stingray *D. pastinaca* in the Strait of Messina (Central Mediterranean Sea), an important migration route for several cartilaginous fishes with a high frequency of records of Critically Endangered species (Canese *et al.*, 2011; Malara *et al.*, 2021; Bargnesi *et al.*, 2022). Here, we specifically refer to the definition of reproductive areas proposed by Hyde *et al.* (2022) for elasmobranchs “...areas where a regular or predictable presence of mature sharks and rays has been recorded for mating, and/or where pregnant females aggregate”.

Using sightings made on different visits and captured on underwater videos by recreational scuba divers or through direct observations along transects, the reproductive area was identified in the shallow waters of Scilla Bay, located on the Northern coast of the Strait of Messina (SoM, Italy; Fig. 1). The SoM is a narrow channel with an articulated bottom topography and strong tidal currents that separates Sicily Island from the Italian pen-

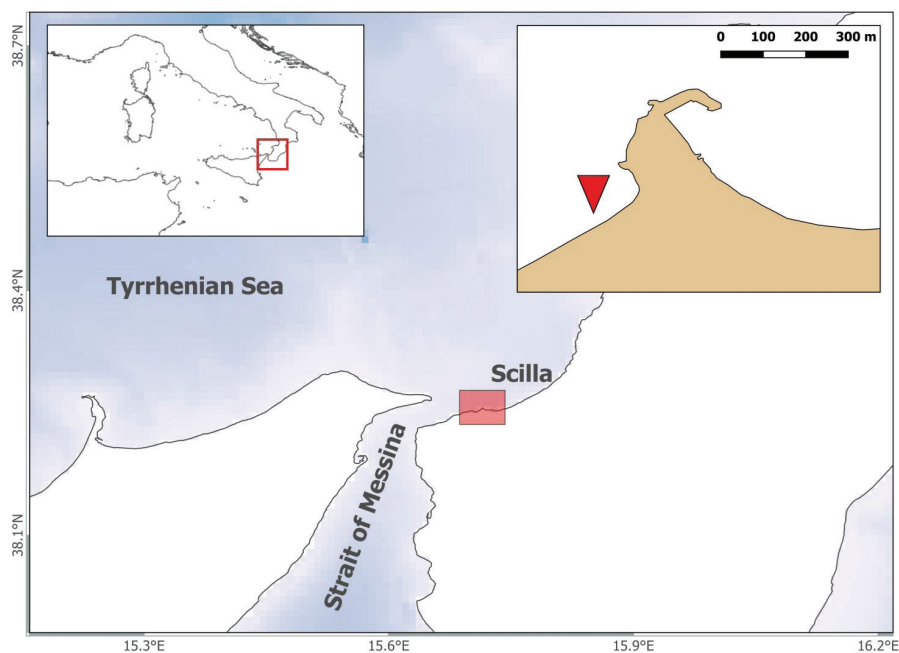


Fig. 1: Location of the shallow coastal reproductive area of the common stingray *Dasyatis pastinaca* in Scilla Bay in the Central Mediterranean Sea.

insula and connects the Tyrrhenian and the Ionian seas.

Seven species belonging to the Dasyatidae family have been reported in the Mediterranean Sea, including two similar-looking *Dasyatis* species (*D. pastinaca* and *D. tortonesei*) that lead to possible morphological misidentifications (Saadaoui *et al.*, 2016; Serena *et al.*, 2020) despite recently-confirmed genetic differences (Vella & Vella, 2021). The common stingray *D. pastinaca* is a large demersal meso-predator that inhabits sandy-muddy bottoms of the North-east Atlantic Ocean and the Mediterranean and Black Seas (Ebert & Stehmann, 2013). The species is considered Vulnerable according to the last IUCN Mediterranean and Black Sea assessment (Dulvy *et al.*, 2016) and is frequently by-caught during artisanal and commercial fishery operations, showing very high fishing mortality rates (Bradaï *et al.*, 2006; Morey *et al.*, 2006; Yeldan *et al.*, 2009; Yemissen *et al.*, 2014), which may be because its venomous caudal sting forces fishers to kill specimens to avoid injuries while freeing them from the nets (Tiralongo *et al.*, 2018). The Tortonese's stingray *Dasyatis tortonesei* Capapé, 1975 is considered endemic to the Mediterranean Sea (Froese & Pauly, 2019) and has been assessed as Data Deficient by the global IUCN Red List (Jabado & Derrick, 2020). Its distribution is mostly reported in Maltese and Tunisian waters and along the Levantine basin coast (Vella & Vella, 2021 and references therein), with recent observations in the Balearic Islands (Ramírez-Amaro *et al.*, 2021). In this study our direct observations focused on morphological aspects distinguishable by underwater visual inspection such as the differences in colour of the dorsal part of the disc (from brown to dark grey in the common stingray and brown or ochre yellow in the Tortonese's stingray; Barone *et al.*, 2022), the shape of the head and the snout (which are flatter and shorter in *D. tortonesei* than *D. pastinaca*; Saadaoui *et al.*, 2016) and the coloration of nostrils' and mouth margins (white in *D. pastinaca* and dark in *D. tortonesei*; Barone

et al., 2022). The analysis of these characteristics allowed us to attribute the observed individuals in Scilla Bay to the common stingray *D. pastinaca*. In support of our findings, scientific trawl surveys carried out in the same area in the frame of the MEDITS program only reported *D. pastinaca* over several years (Bottari *et al.*, 2014).

Citizen science contributions consisting of video recordings made by local divers confirmed the presence of aggregated common stingrays early in the summers 2021 and 2022 in a specific area of Scilla Bay. This evidence was further confirmed at the end of June 2023 when 23 common stingrays were sighted in the same area at 8–12m depth over three consecutive days with up to 15 individuals counted in a single transect. In the sample, six pregnant females were detected on the 25 June 2023 by scuba divers. Four of them were resting on patches of *Posidonia oceanica* (Linnaeus) Delile (1813), at a depth of 8 m (Fig. 2A), and two were hidden between rocks at a depth of 12 m (Fig. 2B, C). On 26 June 2023, the first author counted five pregnant females resting on sand and ten on *P. oceanica* at 8–10 m depths during a single visual census survey carried out along a 50 m linear transect. Two additional videos recorded on 27 June 2023 in the same area also documented the presence of a mature male with evident claspers longer than the pelvic fins and a large-sized female with mating scars (Fig. 2C, D). Mating interactions are supported by margin abrasions on the female body, particularly in the posterior half of the disc (Kajiura *et al.*, 2000), while advanced pregnancy can be identified by an evident posterior–dorsal swelling (Chai-kin, 2020). Seawater temperature during all observations ranged between 22 and 23°C. In all cases the divers approached the common stingray females, which showed fast body and opercular contractions and a flee distance of about 5 m from the diver (Supporting material). Other surveys conducted on the same days in surrounding areas did not record the species' presence.

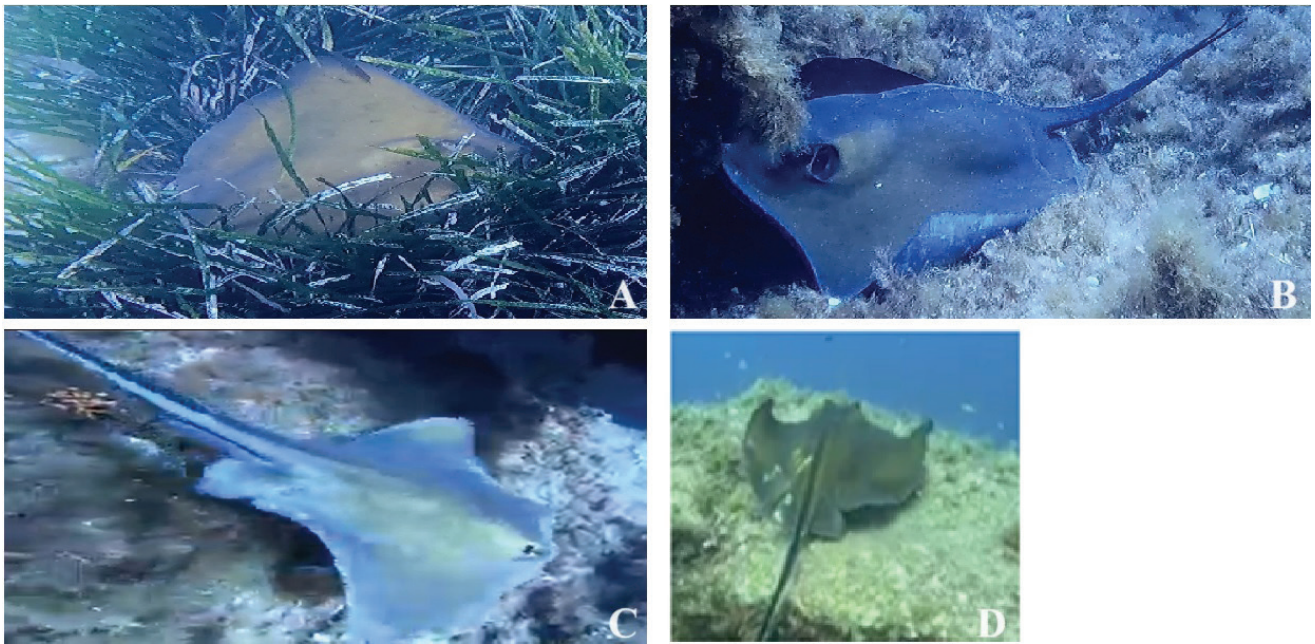


Fig. 2: Pregnant females and a mature male of the common stingray *Dasyatis pastinaca* sighted in Scilla Bay in the Central Mediterranean Sea. Panels A and B show two pregnant females resting on a Neptune seagrass meadow and algal rocky substrate; panel C shows a mature male with calcified claspers longer than his pelvic fins; panel D shows a female with mating scars on her body (Photo credits: Desirée Grancagnolo and Nunzio Bellantoni).

The present observations represent the first record of a reproductive area for the common stingray in the Central Mediterranean Sea. The presence of several advanced gravid females sharing the same area and resting on *P. oceanica* and sandy patches supports the hypothesis that Scilla Bay could be used as a reproductive site in early summer. Although the bay is a relatively small and sheltered area, it may offer sufficient resting areas and a variety of habitats, such as shallow sandy and rocky bottoms and *P. oceanica* meadows, where the species can find refuge or congregate for reproductive purposes. In this regard, our observation of a mixed-sex aggregation in the same area with a large female showing evident copulatory scars is also of great interest as it may suggest that mating events may also occur in Scilla Bay. Although the information on this specific phase of the life cycle of the common stingray is presently scant, females mating within minutes or hours after parturition was previously documented for the congeneric southern stingray *Dasyatis americana* (Chapman *et al.*, 2003).

The high numbers of divers and boats visiting Scilla Bay during the summer might suggest the need to manage human recreational activities during the species' reproductive period. Ecotourism activities should be promoted and regulated to limit any potential negative effects on the species' behaviours during its congregation (Cattano *et al.*, 2021) and to develop public awareness of their conservation priority (Cattano *et al.*, 2023). In addition to frequent tourism, fishing operations in the area during the aggregation could represent an important threat since aggregating behaviour makes populations more vulnerable to overexploitation (Jacoby *et al.*, 2012). In this regard, the lower fertility rate of *D. pastinaca* compared to other species of the same genus may further threaten its resilience to fishing pressure (Saadaoui *et al.*, 2015).

Protection of shark and ray species in the overcrowded and overexploited Mediterranean Sea is considered a challenging task (Ferretti *et al.*, 2013). This study adds to previous recommendations suggesting that identifying aggregation areas for coastal rays and using non-invasive techniques to do so is crucial for the conservation of threatened species and for ensuring their population replenishment (Palacios *et al.*, 2023). In addition to this, training scuba divers and involving them as citizen scientists in this process could be a promising approach, as it would allow for wider data collection and stronger community engagement in conservation and management efforts (Tiralongo *et al.*, 2019).

Finally, this study contributes to the desirable conservation and management actions to be implemented in the recently designated Important Shark and Ray Areas (ISRA) of the "Strait of Messina" (IUCN SSC, 2023). In regard to this, we suggest that temporary fishing closures and restrictions for scuba diving activities and boating rather than permanent marine protected areas should be implemented for the specific protection of the stingray aggregation of Scilla Bay. This balanced approach would allow both local fishers and diving centres to sustainably conduct their activities and coastal rays to benefit from undisturbed periods for reproduction and parturition.

Acknowledgements

We wish to thank Dr Fabrizio Serena (CNR-IRBIM, Italy) for his precious suggestions and recommendations, the staff of the "Scilla Diving Center" for the great logistical support, Elisa and Nunzio Bellantoni for kindly sharing the recorded videos in previous years.

References

- Aschliman, N.C., Nishida, M., Miya, M., Inoue, J.G., Rosana, K.M. *et al.*, 2012. Body plan convergence in the evolution of skates and rays (Chondrichthyes: Batoidea). *Molecular Phylogenetics and Evolution*, 63 (1), 28-42.
- Bargnesi, F., Moro, S., Leone, A., Giovos, I., Ferretti, F., 2022. New technologies can support data collection on endangered shark species in the Mediterranean Sea. *Marine Ecology Progress Series*, 689, 57-76.
- Barone, M., Mazzoldi, C., Serena, F., 2022. Sharks, rays and chimaeras in Mediterranean and Black Seas – Key to identification. Rome, FAO.
- Bottari, T., Busalacchi, B., Profeta, A., Mancuso, M., Giordano, D. *et al.*, 2014. Elasmobranch distribution and assemblages in the southern Tyrrhenian Sea (Central Mediterranean). *Journal of Aquaculture Research & Development*, 5 (2), 1.
- Bräutigam, A., Callow, M., Campbell, I. R., 2016. Global priorities for conserving sharks and rays: a 2015-2025 strategy.
- Bradaï, M.N., Saidi, B., Enajjar, S., Bouaïn, A., 2006. The Gulf of Gabès: A spot for the Mediterranean Elasmobranchs. Workshop on Mediterranean cartilaginous fishes with emphasis on southern and eastern Mediterranean, 14-16 October 2006. Ataköy-Marina: Istanbul/Turkey. pp. 107-117.
- Canese, S., Cardinali, A., Romeo, T., Giusti, M., Salvati, E. *et al.*, 2011. Diving behavior of the giant devil ray in the Mediterranean Sea. *Endangered Species Research*, 14 (2), 171-176.
- Cattano, C., Turco, G., Di Lorenzo, M., Gristina, M., Visconti, G. *et al.*, 2021. Sandbar shark aggregation in the central Mediterranean Sea and potential effects of tourism. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31 (6), 1420-1428.
- Cattano, C., Calò, A., Aglieri, G., Cattano, P., Di Lorenzo, M. *et al.*, 2023. Literature, social media and questionnaire surveys identify relevant conservation areas for *Carcharhinus* species in the Mediterranean Sea. *Biological Conservation*, 277, 109824.
- Chaikin, S., Belmaker, J., Barash, A., 2020. Coastal breeding aggregations of threatened stingrays and guitarfish in the Levant. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 30 (6), 1160-1171.
- Chapman, D.D., Corcoran, M.J., Harvey, G.M., Malan, S., Shivji, M.S., 2003. Mating behavior of southern stingrays, *Dasyatis americana* (Dasyatidae). *Environmental Biology of Fishes*, 68, 241-245.
- Dulvy, N.K., Allen, D.J., Ralph, G.M., Walls, R.H., 2016. The conservation status of sharks, rays, and chimaeras in the Mediterranean Sea. *Biological Sciences Faculty Publications*, 531.
- Dulvy, N.K., Fowler, S.L., Musick, J.A., Cavanagh, R.D., Kyne, P.M. *et al.*, 2014. Extinction risk and conservation of the world's sharks and rays. *eLife*, 3, e00590.
- Ebert D.A., Stehmann, M.F.W., 2013. Sharks, batoids, and chimaeras of the North Atlantic. FAO Species Catalogue for Fishery Purposes. No. 7. FAO: Rome. 523 pp.
- Ferretti, F., Osio, G.C., Jenkins, C.J., Rosenberg, A.A., Lotze, H.K., 2013. Long-term change in a meso-predator community in response to prolonged and heterogeneous human impact. *Scientific Reports* 3 (1), 1057.
- Froese, R., Pauly, D., 2019 FishBase. <http://www.fishbase.org>
- Geraci, M.L., Ragonese, S., Scannella, D., Falsone, F., Gancitano, V. *et al.*, 2021. Batoid abundances, spatial distribution, and life history traits in the Strait of Sicily (Central Mediterranean Sea): Bridging a knowledge gap through three decades of survey. *Animals*, 11 (8), 2189.
- Grancagnolo, D., Arculeo, M. 2021. Summer aggregation of common eagle ray, *Myliobatis aquila* (Chondrichthyes: Myliobatidae), in the Marine Protected Area of the Egadi Islands (southwestern Tyrrhenian Sea). *Biogeographia—The Journal of Integrative Biogeography*, 36.
- Hyde, C.A., Notarbartolo di Sciarra, G., Sorrentino, L., Boyd, C., Finucci, B. *et al.*, 2022. Putting sharks on the map: A global standard for improving shark area-based conservation. *Frontiers in Marine Science*, 9, 968853.
- Jabado, R.W., Derrick, D., 2021. *Dasyatis tortonesei*. The IUCN Red List of Threatened Species 2021.
- Ismen, A., 2003. Age, growth, reproduction and food of common stingray (*Dasyatis pastinaca* L., 1758) in Iskenderun Bay, the eastern Mediterranean. *Fisheries Research*, 60, 169-176.
- Ismen, A., Yığın, C., Ismen, P., 2007. Age, growth, reproductive biology and feed of the common guitarfish (*Rhinobatos rhinobatos* Linnaeus, 1758) in Iskenderun Bay, the eastern Mediterranean Sea. *Fisheries Research*, 84, 263-269.
- IUCN SSC Shark Specialist Group, 2023. Strait of Messina ISRA Factsheet. Dubai: IUCN SSC Shark Specialist Group. 9 pp. <https://sharkrayareas.org/portfolio-item/strait-of-messina-isra/>
- Jacoby, D.M., Croft, D.P., Sims, D.W., 2012. Social behaviour in sharks and rays: analysis, patterns and implications for conservation. *Fish and Fisheries*, 13 (4), 399-417.
- Kajiura, S.M., Sebastian, A.P., Tricas, T.C., 2000. Dermal bite wounds as indicators of reproductive seasonality and behaviour in the Atlantic stingray, *Dasyatis sabina*. *Environmental Biology of Fishes*, 58, 23-31.
- Malara, D., Battaglia, P., Consoli, P., Arcadi, E., Longo, F. *et al.*, 2021. When opportunistic predators interact with swordfish harpoon fishing activities: shark depredation over catches in the Strait of Messina (central Mediterranean Sea). *The European Zoological Journal*, 88 (1), 226-236.
- Milazzo, M., Cattano, C., Al Mabruk, S.A.A., Giovos, I., 2021. Mediterranean sharks and rays need action. *Science*, 371 (6527), 355-356.
- Morey, G., Moranta, J., Riera, F., Grau, A. M., Morales-Nin, B., 2006. Elasmobranchs in trammel net fishery associated to marine reserves in the Balearic Islands (NW Mediterranean). *Cybium*, 30, 125-132.
- Palacios, M.D., Stewart, J.D., Croll, D.A., Cronin, M.R., Trejo-Ramírez, A. *et al.*, 2023. Manta and devil ray aggregations: conservation challenges and developments in the field. *Frontiers in Marine Science*, 10.
- Ramírez-Amaro, S., Ordines, F., Picornell, A., Ramón, C.D.L.I.B., Terrasa, B. *et al.* 2021. “*Dasyatis tortonesei*”, una especie críptica de raya látigo en las Islas Baleares. *Revista de Menorca*, 100, 191-235.
- Ruiz-García, D., Raga, J.A., March, D., Colmenero, A.I., Quattrocchi, F. *et al.*, 2023. Spatial distribution of the demersal chondrichthyan community from the western Mediterranean.

- an trawl bycatch. *Frontiers in Marine Science*, 10, 1145176.
- Saadaoui, A., Saidi, B., Elglid, A., Seret, B., Bradai, M.N., 2016. Taxonomic observations on stingrays of the genus *Dasyatis* (Chondrichthyes: Dasyatidae) in the Gulf of Gabès (South-eastern Mediterranean Sea). *Zootaxa*, 4173 (2), 101-113.
- Saadaoui, A., Saidi, B., Enajjar, S., Bradai, M.N., 2015. Reproductive biology of the common stingray *Dasyatis pastinaca* (Linnaeus, 1758) off the Gulf of Gabès (Central Mediterranean Sea). *Cahiers de Biologie Marine*, 56, 389-396.
- Serena, F., Abella, A.J., Bargnesi, F., Barone, M., Colloca, F. *et al.*, 2020. Species diversity, taxonomy and distribution of Chondrichthyes in the Mediterranean and Black Sea. *The European Zoological Journal*, 87, 1, 497-536.
- Tiralongo, F., Messina, G., Lombardo, B.M., 2018. Discards of elasmobranchs in a trammel net fishery targeting cuttlefish, *Sepia officinalis* Linnaeus, 1758, along the coast of Sicily (central Mediterranean Sea). *Regional Studies in Marine Science*, 20, 60-63.
- Tiralongo, F., Lillo, A.O., Tibullo, D., Tondo, E., Martire, C.L. *et al.*, 2019. Monitoring uncommon and non-indigenous fishes in Italian waters: One year of results for the AlienFish project. *Regional Studies in Marine Science*, 28, 100606.
- Vella, N., Vella, A., 2021. Characterization and comparison of the complete mitochondrial genomes of two stingrays, *Dasyatis pastinaca* and *Dasyatis tortonesei* (Myliobatiformes: Dasyatidae) from the Mediterranean Sea. *Molecular Biology Reports*, 48 (1), 219-226.
- Yeldan, H., Avsar, D., Manasirli, M., 2009. Age, growth and feeding of the common stingray (*Dasyatis pastinaca*, L., 1758) in the Cilician coastal basin, northeastern Mediterranean Sea. *Journal of Applied Ichthyology*, 25, 98-102.
- Yemiskem, E., Dalyan, C., Eryilmaz, L., 2014. Catch and discard fish species of trawl fisheries in the Iskenderun Bay (Northeastern Mediterranean) with emphasis on lessepsian and chondrichthyan species. *Mediterranean Marine Science*, 15 (2), 380-389.