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Research Article

Occurrence, Bycatch Patterns, and Associated Risks of Mediterranean Electric Rays (*Torpedo marmorata* Risso, 1810 and *Torpedo torpedo* Linnaeus, 1758) in the Gaza Strip, Palestine

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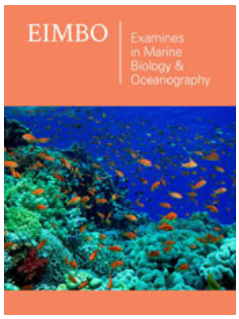

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Abstract

Mediterranean electric rays (Marbled Electric Ray *Torpedo marmorata* Risso, 1810 and Common or Eyed Electric Ray *Torpedo torpedo* Linnaeus, 1758) are benthic elasmobranchs that are widely distributed but poorly studied in the southeastern Mediterranean. This study examines the occurrence, bycatch patterns,

and risks of electric rays in the Gaza Strip's coastal waters. Data were gathered through repeated visits to landing sites and fish markets, supported by observations, specimen measurements, and consultations and discussions with fishermen and fisheries authorities, along with local media sources. Results indicate that both species are regularly encountered as non-target bycatch in artisanal fisheries, with Marbled Electric Rays more frequently recorded than Common Electric Ray. Specimens ranged from 12 to 45cm in total length, with a predominance of juveniles, suggesting that nearshore waters may function as nursery habitats. Bycatch arises mainly from bottom trawls, gillnets, and trammel nets, reflecting gear non-selectivity and species vulnerability. Although of low market value and typically discarded, their use has increased under recent food scarcity following the October 7, 2023 Israeli war. Handling poses occupational risks from electric shocks, though incidents are rare, minor, and non-fatal. Ecologically, electric rays play roles as benthic predators, but frequent juvenile capture raises sustainability concerns. The study underscores the need for improved bycatch monitoring, safer handling practices, and integration of bycatch management into local fisheries.

Keywords: Mediterranean electric rays; Marbled electric ray; *Torpedo marmorata*; Common Electric ray; *Torpedo torpedo*; Bycatch; Artisanal fisheries; Electric discharge; risk, Consumption; Conservation; Gaza Strip; Palestine; Southeastern mediterranean

Introduction

Electric rays (Order: *Torpediniformes*; Family: *Torpedinidae*) are a specialized group of elasmobranch fishes distinguished by their ability to generate electric discharges through modified muscle-derived organs [1,2]. These discharges are primarily used for prey capture and defense, making them unique among marine vertebrates [3]. The family is widely distributed across temperate and tropical seas [4], including the Mediterranean basin, where species inhabit benthic environments ranging from shallow coastal areas to deeper offshore zones [1,5]. In the Mediterranean Sea, electric rays are mainly represented by three species: The Marbled Electric Ray or Marbled Torpedo or Spotted Torpedo or Common Crampfish (*Torpedo marmorata* Risso, 1810), the Common or Eyed or Ocellate Electric Ray (*Torpedo torpedo* Linnaeus, 1758), and the Atlantic or Great Torpedo or Short-tail Torpedo Ray (*Tetronarce nobiliana* Bonaparte, 1835) [6]. These bottom-dwelling fishes are typically associated with sandy and muddy substrates and can produce electric discharges reaching 170-220 volts for predation and defense [5,7]. They are generally solitary and nocturnal predators. Despite their broad distribution, electric rays are not targeted commercially and are mostly captured incidentally as bycatch in demersal fishing gears such as bottom trawls and trammel nets [8,9]. Their low market value is attributed to soft flesh, handling difficulties, and limited consumer demand [5,10].

Mediterranean electric rays remain insufficiently studied, although numerous investigations across Mediterranean countries have addressed various aspects, including life-history traits, distribution, updated checklists, morphology, biology, and ecology [11-24]. The coastal waters of the Gaza Strip, located in the southeastern Mediterranean, support a small-scale artisanal fishery operating under conditions of high exploitation and environmental stress. In fact, before, during and even after the Israeli war of genocide (2023-2025), the fisheries sector suffered widespread weakening and systematic destruction by the Israeli occupation, exacerbating poverty, unemployment and food insecurity among the population of Gaza Strip [25]. This fishery depends on a limited range of gears targeting both demersal and pelagic species [26]. Within this context, elasmobranchs, including sharks and rays, are frequently recorded as bycatch, although their diversity and ecological roles remain insufficiently studied [27]. Recent local studies and faunal surveys have confirmed the presence of the Marbled Electric Ray and the Common Electric Ray in the Gaza Strip marine waters, where they are regularly but unintentionally captured by fishermen [27].

Although electric rays have little direct economic importance in the Gaza Strip, their occurrence provides valuable insight into coastal biodiversity and ecosystem structure. As benthic predators, they contribute to regulating fish and invertebrate populations and may serve as indicators of environmental conditions in the eastern Mediterranean [8]. However, like many elasmobranchs, they are vulnerable to overexploitation due to slow growth, low reproductive rates, and habitat specificity [3]. Given the limited research on non-target bycatch species in Palestinian marine waters, documenting the occurrence, composition, and ecological significance of electric rays is essential. This study aims to investigate their occurrence, bycatch patterns, and associated risks within the Gaza Strip's coastal fisheries.

Methodology

This descriptive study involved repeated field visits to fisheries landing sites in Gaza City and fish markets throughout the Gaza Strip, where cartilaginous, bony, and invertebrate species are openly sold (Figure 1). On occasion, field measurements were taken, including length, disc width, and weight. Data and photographic records were collected to document the Marbled Electric Ray (*Torpedo marmorata* Risso, 1810) and the Common or Eyed Electric Ray (*Torpedo torpedo* Linnaeus, 1758), both of which are incidentally caught in the coastal waters of the Gaza Strip, Palestine. Additional information was gathered through consultations with the General Directorate of Fisheries at the Ministry of Agriculture, as well as with local fishermen. Relevant data were also obtained by reviewing local news outlets and social media sources. The Gaza Strip, situated along the southeastern Mediterranean coast, extends approximately 42km, covers around 365km^2, and supports a population exceeding 2.4 million inhabitants. Fisheries are a critical sector for food security, employment, and socio-economic stability, involving over 4,500 fishermen operating more than 1,800 predominantly small-scale vessels. A variety of fishing gears-including trammel nets, gillnets, longlines, handlines, trawlers, and small purse seines-are employed to target small pelagic fishes, demersal teleosts, cephalopods, and crustaceans [26]. Cartilaginous fishes, including sharks and batoids, are also captured, primarily as bycatch but occasionally as targeted species.

Figure 1: Repeated field visits to fish markets were conducted to identify common sharks and rays targeted or incidentally caught in the Gaza Strip marine ecosystem.

Result

Electric ray species of the Gaza Strip

Electric rays recorded in the Gaza Strip are limited to two species: The Marbled Electric Ray (*Torpedo marmorata* Risso, 1810) (Figure 2) and the Common or Eyed electric ray (*Torpedo torpedo* Linnaeus, 1758) (Figure 3). Both species are non-target catches with little to no commercial value and are therefore typically discarded or, less frequently, used for low-value purposes. Despite their limited economic importance, these rays are regularly observed in local fish markets throughout the Gaza Strip. They are often displayed on the ground-as commonly seen in Gaza City's main fish market "Al-Hisba Market" near the principal fishing port-or placed in crates alongside other cartilaginous and bony fishes. On 27 January 2026, a Facebook activist from the Gaza Strip posted a short video documenting the retrieval of a Marbled Electric Ray specimen from fishing net (https://www.facebook.com/watch/?v=1257819879550247) (Figure 3D & 3E). He humorously remarked that the electric ray could be used to generate electricity for the Gaza Strip.

Figure 2: Marbled Electric Ray (*Torpedo marmorata* Risso, 1810): (A-C) Bycaught specimens displayed in Gazan fish markets; (D,E) Screenshots from a short video showing retrieval of a bycaught specimen from fishing net

Figure 3: Specimens of the Common or Eyed Electric Ray (*Torpedo torpedo* Linnaeus, 1758).

Description of the bycaught electric rays

The Marbled Electric Ray is frequently caught as bycatch in shallow coastal waters of the Gaza Strip, with individuals ranging from 15 to over 45cm in length. Its dorsal surface exhibits a marbled pattern of brown and yellow spots, while the ventral surface is paler. It has medium-sized eyes with posterior spiracles and a small ventral mouth adapted for benthic feeding. Most recorded specimens were juveniles, indicating frequent coastal capture. In contrast, the Common (Eyed) Electric Ray is less abundant but regularly recorded as bycatch, with individuals ranging from 12 to over 40cm in length. It is distinguished by its rounded disc and prominent dorsal eyes. Specimens of this species are readily identifiable by the presence of five distinctive blue eye-like spots (ocelli). Its dorsal coloration varies from brown to olive-brown, with a lighter ventral surface. The ventral mouth reflects benthic feeding habits. Most specimens were immature, suggesting that the Gaza Strip's coastal waters may serve as nursery grounds. Marbled and Common (Eyed) Electric Rays lack a venomous tail spine but possess specialized electric organs in their pectoral discs, capable of generating shocks to stun prey or deter predators. These discharges can reach up to 220 volts and pose a hazard to fishermen, with the Common (Eyed) Electric Ray producing the stronger shock. Both species have a relatively short, thick tail, with a small caudal fin that is rounded or slightly triangular. Table 1 summarizes the main differences between the two species.

Table 1: The main differences between the Marbled Electric Ray (*Torpedo marmorata*) and the Common or Eyed Electric Ray (*Torpedo torpedo*).

Feature	Marbled Electric Ray (*Torpedo marmorata*)	Common Electric Ray (*Torpedo torpedo*)
Dorsal Pattern	Irregular brown/yellow marble pattern	Distinctive round dark spots (eye-like spots)
Coloration	Camouflage and speckled appearance	More contrasting with clear markings
Body Appearance	More mysterious and blended with the seabed	More visually distinctive
Eyes	Medium-sized	Larger
Spiracles	Posterior to eyes	Posterior to eyes, more prominent
Dorsal fins	Usually smaller and set closer together	Larger and more separated
Tail length	Relatively short and thick	Longer and more slender
Electric Shock Strength	Moderate	Stronger
Risk to Humans	Moderate shock risk	Higher shock risk (up to 220 Volts)
Habitat/Depth in the Gaza Strip	Shallow coastal waters	Shallow to moderately deep waters
Bycatch Frequency in the Gaza Strip	Frequent	Less frequent

Occurrence patterns and size distribution

Observations from landing sites and fish markets in the Gaza Strip show that both species (*Torpedo marmorata* and *Torpedo torpedo*) are consistently captured as bycatch in nearshore fisheries. Recorded individuals range from 12cm to over 45cm in total length, with juveniles predominating. The Marbled Electric Ray is encountered more frequently, although both species constitute only a small fraction of mixed catches. Their recurring presence in markets suggests opportunistic retention rather than targeted fishing. No reliable published statistics are available on electric ray catches in the Gaza Strip. These species are not commercially targeted and are typically taken incidentally, particularly in trawl fisheries. Nevertheless, fishermen report that several hundred individuals are caught annually as bycatch using various local gears, a pattern supported by repeated observations in fish markets and landing sites across the region. There is no evidence of the third species of electric fish, the Atlantic or Great Torpedo Ray

(*Tetronarce nobiliana* Bonaparte, 1835), being accidentally caught off the coast of the Gaza Strip. It is unknown whether any will be caught in the future, despite the extreme rarity of this species in the eastern Mediterranean.

Bycatch methods of electric rays in the Gaza Strip

Electric rays (*Torpedo marmorata* and *Torpedo torpedo*) are primarily captured incidentally within multispecies coastal fisheries. Their benthic, slow-moving behavior and flattened body shape, combined with the non-selective nature of fishing gear, make them highly vulnerable to bycatch. Consequently, they are usually discarded or only opportunistically consumed. Bycatch occurs mainly through the following methods:

Bottom trawling: A major source of bycatch, as nets dragged along the seabed collect benthic organisms. Electric rays, often resting or partially buried in sandy substrates, are easily swept into the net and retained in the codend.

Gillnets: These nets act as vertical barriers, entangling rays rather than gilling them due to their broad bodies. Limited swimming ability reduces escape once contact occurs.

Trammel nets: The three-layered structure traps rays in inner mesh pockets during attempted passage, leading to immobilization. This method frequently captures non-target species, including electric rays.

Bottom longlines: They are less common, but may incidentally capture rays when they bite baited hooks or are hooked during foraging. Bycatch rates are generally lower than in net-based fisheries.

Risks associated with electric rays for Gazan fishermen and fish sellers

Electric rays (*Torpedo marmorata* and *Torpedo torpedo*) in the Gaza Strip present occupational hazards during capture, handling, and marketing due to their ability to generate electric shocks. Although not aggressive, they can be dangerous if improperly handled. Injuries associated with these species are mainly caused by electric discharges. No official statistics are available in the Gaza Strip; however, local fishermen indicate that incidents are rare and typically minor, with most cases not requiring hospitalization. According to both the General Directorate of Fisheries at the Ministry of Agriculture and fishermen, no fatalities have been documented from handling or catching these fish. Injuries from electric rays are generally rare and mild, a pattern often attributed by fishermen to the predominance of small or juvenile individuals in catches, which produce weaker discharges. In contrast, larger, mature specimens are capable of delivering stronger shocks. Based on consultations with the General Directorate of Fisheries at the Ministry of Agriculture and experienced fishermen, the main risks include:

Electric shock hazard: Contact during net retrieval or handling may result in painful shocks, muscle spasms, and temporary loss of motor control.

Handling-related injuries: Sudden shocks can lead to secondary injuries such as cuts, bruises, or falls, particularly on wet or unstable surfaces.

Post-capture risk: Electric rays may continue to discharge electricity after capture, posing a hazard even when they appear inactive.

Utilization of electric rays in the Gaza Strip

Electric rays (*Torpedo marmorata* and *Torpedo torpedo*) are occasionally caught in shallow coastal waters, mainly as bycatch, and are usually discarded due to low market value, soft flesh, and handling challenges associated with their electric organs. In the Gaza Strip, other elasmobranchs are more commonly consumed. Following the October 7, 2023 war and the resulting humanitarian crisis, food shortages and restricted fishing areas led fishermen to retain previously discarded species. Consequently, electric rays began appearing more often in local markets and were consumed as an alternative protein source, sometimes alongside species of conservation concern. Despite this shift, their consumption remains limited due to their soft texture, electric organs, and lack of culinary tradition. Although their flesh is safe to eat, it is generally not preferred and is considered a secondary food source. Some fishermen and fishmongers also report that certain Gazan women consume it based on the belief that it enhances milk production during breastfeeding.

Preservation of electric ray in educational institutions

The preservation of electric ray specimens (Torpedo marmorata and Torpedo torpedo) in educational institutions is important for teaching, research, and biodiversity awareness. However, restrictions on the entry of preservation chemicals such as formalin-due to the ongoing blockade-have created significant challenges. As a result, taxidermy practices are largely limited to smaller organisms. Relatively small electric ray specimens (15-30cm) are more feasible to preserve under such conditions and are typically stored in airtight glass containers to minimize evaporation and deterioration. Previously, numerous specimens were housed in university biology museums and in the Marine Biology Museum managed by the General Directorate of Fisheries at the Ministry of Agriculture. However, following the October 7, 2023 war, most of these facilities were destroyed, resulting in the loss of preserved collections.

Ecological significance

Despite their low economic value, electric rays (*Torpedo marmorata* and *Torpedo torpedo*) play an important ecological role in coastal ecosystems. As benthic predators, they feed on small fishes and invertebrates, helping regulate prey populations and maintain trophic balance. They also contribute to energy transfer within the food web and, through resting and foraging, promote minor bioturbation that influences sediment structure and nutrient cycling.

Discussion

The present study provides one of the few localized assessments of Mediterranean electric rays in the southeastern Mediterranean, confirming that the Marbled Electric Ray (*Torpedo marmorata* Risso, 1810) and the Common or Eyed Electric Ray (*Torpedo torpedo*

Linnaeus, 1758) are regular components of bycatch in the Gaza Strip's coastal fisheries [27] and even other neighboring countries [28,29]. This finding aligns with broader Mediterranean patterns, where torpedinid rays are widely distributed but rarely targeted, being primarily recorded in demersal fisheries as incidental catch [5,6,9,30,31]. Similar observations have been reported from Tunisia, Turkey, and Morocco, where benthic elasmobranchs are frequently captured in trawl and net fisheries due to their close association with the seabed and limited escape capacity [32-36]. Several local studies have documented both targeted fishing and incidental bycatch of numerous cartilaginous fishes-including rays, sharks, and guitarfishes-captured using a variety of fishing gears [27,37-45].

The dominance of Marbled Electric Ray over the Common or Eyed Electric Ray in the current study (Figure 4) is consistent with regional trends indicating higher relative abundance or detectability of the former species in nearshore habitats [7,31]. However, recent evidence suggests that the Common or Eyed Electric Ray populations may be declining or becoming less frequently encountered in parts of the Mediterranean, raising concerns about shifting species composition and local depletion [24]. The relatively low representation of the Common or Eyed Electric Ray in the Gaza Strip waters may therefore reflect broader basin-scale population dynamics rather than purely local ecological conditions. The predominance of juvenile individuals in both species is particularly noteworthy. Comparable size structures have been documented in other Mediterranean regions, where coastal and shallow habitats often function as nursery areas for elasmobranchs [46,47]. The repeated capture of immature specimens in the Gaza Strip suggests that these coastal waters may serve a similar ecological role. This pattern is ecologically significant, as fishing pressure on juvenile stages can disproportionately affect population sustainability, especially for species characterized by slow growth, late maturity, and low fecundity [3,19].

Figure 4: The Marbled Electric Ray is more commonly caught than the Common (Eyed) Electric Ray, and is sometimes offered for sale with other species of cartilaginous fishes in the fish markets of the Gaza Strip.

From a fisheries perspective, the consistent bycatch of electric rays reflects the non-selective nature of artisanal fishing gears used in the Gaza Strip. Bottom trawls, trammel nets, and gillnets are widely recognized as major drivers of elasmobranch bycatch across the Mediterranean [31,48]. The vulnerability of torpedinid rays is further exacerbated by their benthic behavior and tendency to remain partially buried in sediment, making them highly susceptible to capture [5]. Although longlines contribute less significantly, their role in occasional capture highlights the broad exposure of these species to multiple fishing methods.

Despite their regular occurrence, electric rays remain of low economic value, a trend consistently reported throughout the Mediterranean [5,10]. This is primarily due to their soft flesh, limited consumer preference, and the risks associated with handling electrically active individuals. Nevertheless, the findings of this study indicate a shift in utilization patterns under conditions of socio-economic stress. The increased retention and consumption of electric rays following the 2023-2025 Israeli war reflects an adaptive response to food insecurity, mirroring observations for other non-target or conservation-sensitive species in the Gaza Strip [41-45]. Such opportunistic exploitation underscores the complex interaction between ecological resources and humanitarian crises.

The occupational risks associated with electric rays documented in this study are consistent with earlier biological

descriptions of their electric organs and discharge capabilities [1,2]. While generally non-lethal, these discharges can cause significant discomfort and secondary injuries, particularly in artisanal fisheries where protective equipment is limited. The persistence of electrical activity after capture increases handling risks, emphasizing the need for safe practices among fishermen and market workers. Reports from Gazan fishermen on electric ray injuries and the link between shock strength and ray size are supported by scientific evidence. Electric ray injuries are usually mild and rarely fatal, causing short-term pain, numbness, or brief muscle paralysis, with recovery typically quick and treatment seldom needed [49,50]. Although discharges can reach up to 220V, serious effects are uncommon and mostly occur in rare or repeated exposures [51]. Shock strength varies by species and size, with larger rays producing stronger discharges than smaller or juvenile individuals [3]. Ecologically, electric rays play an important but often overlooked role in coastal ecosystems. As benthic predators, they contribute to regulating populations of small fishes and invertebrates, thereby maintaining trophic balance [8]. Their foraging behavior may also influence sediment structure and nutrient cycling through bioturbation. Recent studies have additionally highlighted emerging aspects of batoid biology, including potential acoustic behavior and complex ecological interactions, suggesting that these species may be more functionally diverse than previously assumed [52].

The study also highlights significant challenges in biodiversity documentation and specimen preservation in the Gaza Strip. The destruction of scientific collections and restricted access to preservation materials have resulted in the loss of valuable biological records, as previously noted for Palestinian fauna [27,38]. This loss not only limits taxonomic and ecological research but also hinders educational efforts and long-term monitoring of marine biodiversity. In a broader conservation context, the findings reinforce concerns regarding the status of Mediterranean elasmobranchs, many of which are experiencing population declines due to overfishing, habitat degradation, and inadequate management [53]. Although electric rays are not currently among the most threatened species, their life-history traits and exposure to persistent bycatch place them at potential risk. The situation in the Gaza Strip, characterized by intensive fishing pressure and environmental stressors, may further exacerbate these vulnerabilities. Overall, this study contributes to filling a regional knowledge gap by documenting the occurrence, bycatch patterns, and human interactions of electric rays in Palestinian waters. The results emphasize the need for targeted monitoring of non-commercial species, improved bycatch mitigation strategies, and greater integration of ecological considerations into fisheries management. In regions facing compounded environmental and socio-political challenges, such efforts are essential for balancing biodiversity conservation with human livelihoods.

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