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On the Mummified Marine and Terrestrial Vertebrate Fauna Adorning the Biology Department Museum at the Islamic University of Gaza, Gaza Strip, Palestine, before the Israeli War on October 7, 2023

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Abstract

Palestine (27,000 km^2) is home to a diversity of marine and terrestrial vertebrate fauna of Afrotropical, Oriental and Palaearctic origins. Numerous vertebrate species have been mummified and preserved in the Biology Department Museum at the Islamic University of Gaza, Gaza Strip, Palestine. The study documents specimens of marine and terrestrial vertebrates preserved in

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the Biology Department Museum at the Islamic University of Gaza between 2018 and early 2023. This work provides the only published record of this collection, which was bombarded and destroyed during the Israeli war on the Gaza Strip following October 7, 2023. Using field guides and taxonomic keys, the authors identified 156 species, belonging to 92 families and 43 orders, distributed across six vertebrate classes, identifying the proportions of native, invasive, and endemic species. Bony fishes constituted 33.6% of the total recorded species, followed by birds (30.1%), reptiles (15.4%), cartilaginous fishes (5.1%), mammals (3.9%), and amphibians (1.9%). Of the 68 recorded bony fish species, 27 (39.7%) were described as invasive, with the Silver-cheeked Toadfish (*Lagocephalus sceleratus*) being considered one of the worst marine invasive species worldwide. The Indian Myna (*Acridotheres tristis*) and the Ring-necked Parakeet (*Psittacula krameri*) were considered invasive birds and posed a threat to the ecology of the Gaza Strip. Three endemic species were recorded during the study; the Palestine Viper (*Daboia palaestinae*), the Palestine Sunbird (*Cinnyris osea*) and the Palestine Mole-rat (*Spalax leucodon ehrenbergi*). In conclusion, the study recommends that, in the event of political stability in the Gaza Strip, model museums be established under the auspices of the responsible authorities. These museums would benefit students, researchers, and all segments of Palestinian society, and would contribute to increasing ecological awareness of wildlife and its sustainable conservation.

Keywords

Vertebrate Fauna, Mummification and Preservation, Exotic *vs.* Native, Biology Department Museum, October 7, 2023 Israeli War, Islamic University of Gaza, Gaza Strip, Palestine

1. Introduction

The strategic position of Palestine (27,000 km^2) at the meeting point of Asia, Africa and Europe encourages the diversity of vertebrate fauna of Afrotropical, Oriental and Palaearctic origins [1]. Terrestrial vertebrates are abundant in Palestine, with 551 bird species, 130 mammal species, 97 reptile species, and eight amphibian species recorded [2]. Numerous studies conducted on the terrestrial vertebrate fauna of the Gaza Strip have shown the presence of dozens of species of mammals and reptiles and hundreds of species of birds, totaling 250 species, in addition to only three species of amphibians (order Anura) [3]-[10]. Palestine's waters are home to a diverse array of fish species, numbering more than 400, including both native and invasive species, in both freshwater and marine environments, as evidenced by numerous studies [11]-[14]. A few years ago, Abu Amra [15] recorded 128 species of bony fish (Osteichthyes) in the marine ecosystem of the Gaza Strip, Regarding the cartilaginous fishes (Chondrichthyes) in the marine ecosystem of the Gaza Strip, it is believed that there may be more than 30 species of sharks and rays, although no specialized studies have been conducted on them yet (Personal Observations). In their inventory of some relatively large marine organisms, Abd

Rabou *et al.* [16] described 10 species of large cartilaginous fishes in the Mediterranean waters of the Gaza Strip. In the entire Mediterranean waters of Palestine, Golani [17] reported the presence of 57 species of cartilaginous fishes (31 sharks, 25 skates and rays, and only one species of Chimaera).

A natural history museum is a scientific institution that houses natural history collections that include current and historical records of animals, plants, fungi, ecosystems, geology, paleontology, climatology, and more. Natural history museums provide scientists and the public with a better and clearer understanding of the biodiversity and value of the natural world around them [18]-[22]. According to Qumsiyeh *et al.* [23], the biggest goals of biological museums are to change human attitudes toward the environment and to encourage biodiversity preservation. In most Palestinian universities, biological museums, regardless of their size or the extent of their collections, are considered an integral part of biological sciences departments. Biological museums at Palestinian universities typically thrive thanks to donations from various members of the Palestinian community, including scientists, students, fishermen, and ordinary citizens. University students, laboratory technicians, and/or teaching assistants often perform taxidermy and conservation works [24] [25]. Local university museums can provide educational services to school students by introducing them to biodiversity issues [23].

The small Biology Department Museum at the Islamic University of Gaza, which was established in 1980, is home to a variety of biological collections. In late December 2008, the museum was subjected to an Israeli airstrike, destroying it and its collection of mummified animals [24]. Following the end of the first Israeli war on the Gaza Strip (2008/2009), the Biology Department at the Islamic University began to recover and began restoring new collections of mummified animals, with the hope of establishing a new museum that would serve the scientific community, researchers, students, and visitors [25]. Years before the Israeli war that followed October 7, 2023, the museum became even more magnificent and beautiful than its predecessor. Fishes, amphibians, reptiles, birds and mammals are almost well represented among the specimens preserved or stuffed at the Biology Department Museum of the Islamic University of Gaza. The majority of vertebrate specimens were preserved in formalin according to wet taxidermy standards, while other specimens were stuffed according to dry taxidermy principles. Most of the preserved specimens have been classified according to the scientific keys of classification, with each specimen having a label attached to it showing the Arabic, English and scientific (Latin) names. This museum has been a frequent destination for researchers, university and school students, foreign visitors, and members of the public to learn about its modest collections of animals (and plants) and increase their ecological awareness of Palestinian biodiversity (**Figure 1**).

During its war on the Gaza Strip, October 7, 2023, Israel destroyed numerous buildings, structures, homes, and recreational facilities, including zoos housing predatory and ornamental animals, as well as the Biology Department Museum at the Islamic University of Gaza, which housed numerous stuffed animals, particularly vertebrates (cartilaginous and bony fish, amphibians, reptiles, birds, and

mammals). Therefore, this study aims to document the mummified marine and terrestrial vertebrates preserved in the Biology Department Museum at the Islamic University of Gaza before its complete destruction at the beginning of the Israeli war on the Gaza Strip on October 7, 2023.

Figure 1. The Biology Department Museum at the Islamic University of Gaza is a frequent destination for researchers, students, international visitors, and members of the Palestinian public to learn about biodiversity.

2. Methods

2.1. The Gaza Strip

The Gaza Strip (31˚25'N, 34˚20'E) is a 365 km^2 arid strip of the Palestinian land along the southeastern Mediterranean (**Figure 2**). The Gaza Strip has a population of 2.4 million, most of whom are refugees registered with the United Nations, living in the Strip's five governorates (North Gaza, Gaza, Middle Gaza, Khan Yunis, and Rafah). The annual rainfall ranges from 200 mm in the south to 400 mm in the north. Three dry to semi-dry wadis (valleys) dissect the Gaza Strip. They are, from north to south, Wadi Beit Hanoun, Wadi Gaza and Wadi Al-Salqa [26]. The

Gaza City is the largest city in the Gaza Strip. It has a total area of about 56 km^2, and a population of about 700,000 people, making it one of the most densely populated cities in the world.

Figure 2. A map of Palestine showing the geographical location of the Gaza Strip.

2.2. The Biology Department Museum at the Islamic University of Gaza

The Islamic University of Gaza (Figure 3) was founded in 1978. It currently enrolls more than 20,000 students and has approximately 600 faculty members. It comprises eleven main colleges, including the College of Science, founded in 1980-1981, which houses the Department of Biology. In addition to the Bachelor's program, the Department of Biology has launched a Master's program since 2004. The Department of Biology has a strong track record in scientific research. The Biology Department Museum contains numerous cabinets, shelves, and display tables of various sizes, housing hundreds of mummified animal species (Figure 3). Often, laboratory technicians, teaching assistants, or even biology students preserve and taxidermize marine and terrestrial animal specimens to provide museums with important specimens that serve science, its researchers, students, and society as a whole. In this context, the Biology Department Museum almost always attracts visitors from university and school students and various segments of Palestinian society, who come to learn about wet or dry taxidermied marine and terrestrial animals that they might not have the opportunity to see in the wild.

2.3. Procedure

The current study was based on an ongoing inventory of marine and terrestrial vertebrate specimens (cartilaginous and bony fishes, amphibians, reptiles, birds,

and mammals) preserved in the Biology Department Museum at the Islamic University of Gaza. Often, specimens brought by students or interested individuals, or those used in vertebrate anatomy and morphology classes, are used for taxidermy and preservation in the Biology Department Museum, with particular emphasis on bony and cartilaginous fish specimens (**Figure 4** and **Figure 5**). However, many vertebrate specimens brought to the Biology Department by Gazans were photographed before being mummified, especially fishes and birds (**Figure 6**). The survey period spanned five years, from early 2018 to early 2023. All preserved animal specimens were cataloged shortly after their introduction to the Biology Department Museum. The use of available keys and guides facilitated the identification of preserved vertebrate species [27]-[42]. It should be noted that the specimens preserved in the Biology Department Museum were cataloged and recorded upon receipt or after embalming, without mentioning the date of receipt or the name of the donor.

Figure 3. The Islamic University of Gaza as it appeared before it was bombed at the beginning of the Israeli war that followed October 7, 2023.

Figure 4. Some bony fishes were brought by interested individuals to the Biology Department at the Islamic University of Gaza for study and preservation: (A) Half-smooth Golden Pufferfish (*Lagocephalus spadiceus*), (B) Ornate Wrasse (*Thalassoma pavo*), and (C) Alexandria Pompano or African Threadfish (*Alectis alexandrina*).

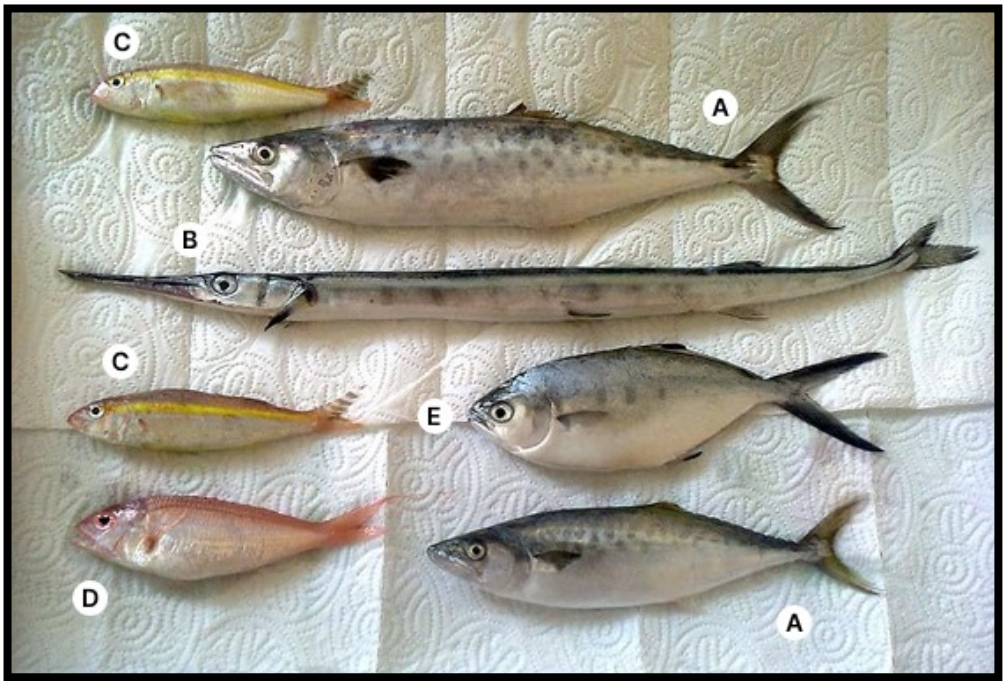

Figure 5. Specimens used in vertebrate anatomy and morphology classes are commonly used for preservation in the Biology Department Museum at the Islamic University of Gaza: (A) Narrow-barred Spanish Mackerel (*Scomberomorus commerson*), (B) Atlantic Saury (*Scomberesox saurus*), (C) Goldband Goatfish (*Upeneus moluccensis*), (D) Japanese Threadfin Bream (*Nemipterus japonicus*), and (E) Pompano (*Trachinotus ovatus*).

Figure 6. Many bird specimens brought to the Biology Department by Gazans were photographed before being mummified: (A) Western Jackdaw (*Coloeus monedula*), (B) Blackcap (*Sylvia atricapilla*), (C) Common Swift (*Apus apus*), and (D) Pallid Swift (*Apus pallidus*).

2.4. Photography and Statistical Analysis

Professional digital cameras have been used throughout the study period and photos of preserved specimens were taken for documentary and confirmatory purposes. Sometimes, some living animals were caged and then photographed before their mummification and preservation. The data collected throughout the study were statistically analyzed and graphs were plotted using Microsoft Excel program 2010.

3. Results

The current study examines the Palestinian marine and terrestrial vertebrate fauna (cartilaginous fish, bony fish, amphibians, reptiles, birds, and mammals) preserved in the Biology Department Museum at the Islamic University of Gaza before it was bombed at the beginning of the Israeli war that erupted after October 7, 2023. The results revealed a remarkable diversity of marine, freshwater, and terrestrial vertebrate species, reflecting the vertebrate fauna inhabiting the various ecosystems in the Gaza Strip. A total of 156 species belonging to 92 families and 43 orders was recorded (Table 1). Bony fishes (Osteichthyes) accounted for 33.6% of the total recorded species, followed by birds (Aves) (30.1%), reptiles (Reptilia) (15.4%), cartilaginous fishes (Chondrichthyes) (5.1%), mammals (Mammalia) (3.9%), and amphibians (Amphibia) (1.9%), as shown in Table 1 and Figure 7. The details of each vertebrate class are described as follows:

Table 1. Numbers of orders, families and species of vertebrate fauna preserved at the Biology Department Museum at the Islamic University of Gaza.

Classes	Orders	Families	Species	%
Chondrichthyes (Cartilaginous Fishes)	5	6	8	5.1
Osteichthyes (Bony Fishes)	20	39	68	43.6
Amphibia (Amphibians)	3	3	3	1.9
Reptilia (Reptilians)	2	13	23	15.4
Aves (Birds)	12	29	52	30.1
Mammalia (Mammals)	3	4	6	3.9
TOTAL	**43**	**92**	**156**	**100%**

3.1. Cartilaginous Fishes (Chondrichthyes)

The current study recorded eight cartilaginous fish species belonging to six families and five orders preserved in the Biology Department Museum at the Islamic University of Gaza before it was bombed by the Israeli army at the beginning of the October 7, 2023 war (Table 2 and Figure 8). They inhabit the marine ecosystem of the Gaza Strip. Because of the large sizes of the Mediterranean cartilaginous fish species, only the small-sized specimens were preserved. The order Rajiformes, which had flat bodies and large, wing-like pectoral fins attached to the side of their heads and extending along the length of their bodies, was the largest and included

three species. The Common Guitarfish (*Rhinobatos rhinobatos*), which belongs to the order Rajiformes, was by far the most preserved cartilaginous fish among the species recorded.

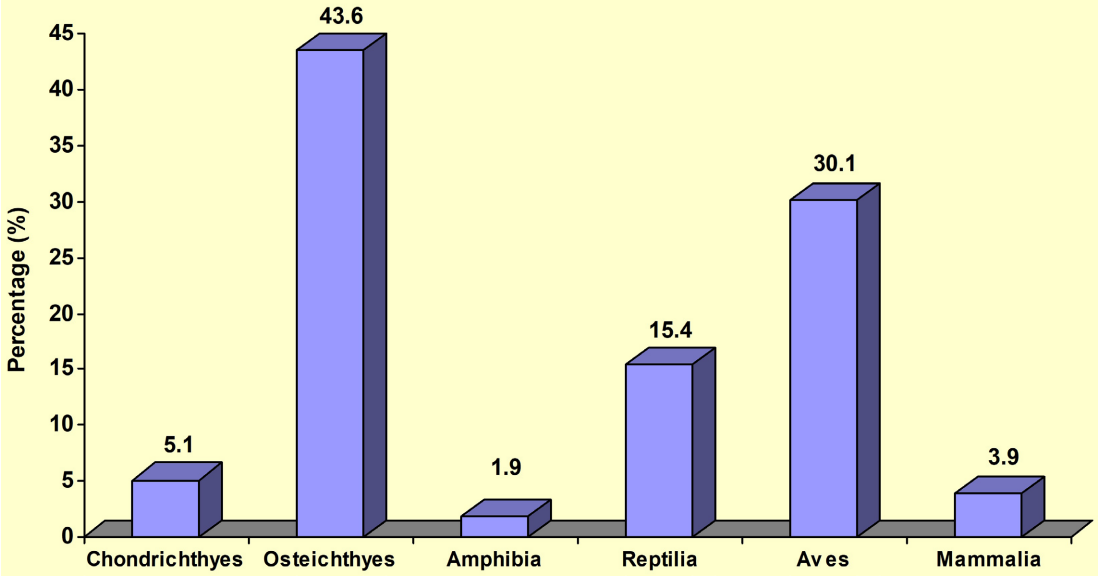

Figure 7. A graphic model showing the percentages of species of each vertebrate class in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023.

Table 2. Cartilaginous fish species preserved at the Biology Department Museum at the Islamic University of Gaza before October 7, 2023.

Family	Scientific Name	Common Name	Arabic/Local Name
Order: Lamniformes			
Lamnidae القروش الأسقمرية	*Isurus oxyrinchus*	Shortfin Mako Shark	قرش الماكو قصير الزعنفة (الماكو النيلي)
Order: Carcharhiniformes			
Carcharhinidae كواسح الترتيلة	*Carcharhinus plumbeus*	Sandbar Shark	قرش الجرف الرملي (القرش الرمادي)
Order: Rajiformes			
Rhinobatidae السلفوحيات	*Rhinobatos rhinobatos*	Common Guitarfish	السلفوح
Rajidae الورانك	*Raja asterias*	Mediterranean Starry Ray	البسة المنمشة (الورنك المتوسطي)
	Raja miraletus	Brown Ray	البسة العيون (الراي البني أو راي الأعين الأربع)
Order: Torpediniformes			
Torpedinidae الراي الكهربائي	*Torpedo marmorata*	Spotted Torpedo (Marbled Electric Ray)	الرعاش المنمش
	Torpedo torpedo	Common Torpedo (Eyed Electric Ray)	الرعاش العيون (الرعاد المنقط)
Order: Myliobatiformes			
Dasyatidae الراي اللاسع	*Dasyatis pastinaca*	Common Stingray	البرشة أو الدهنية الصفراء (الشفنين البحري الشائع)

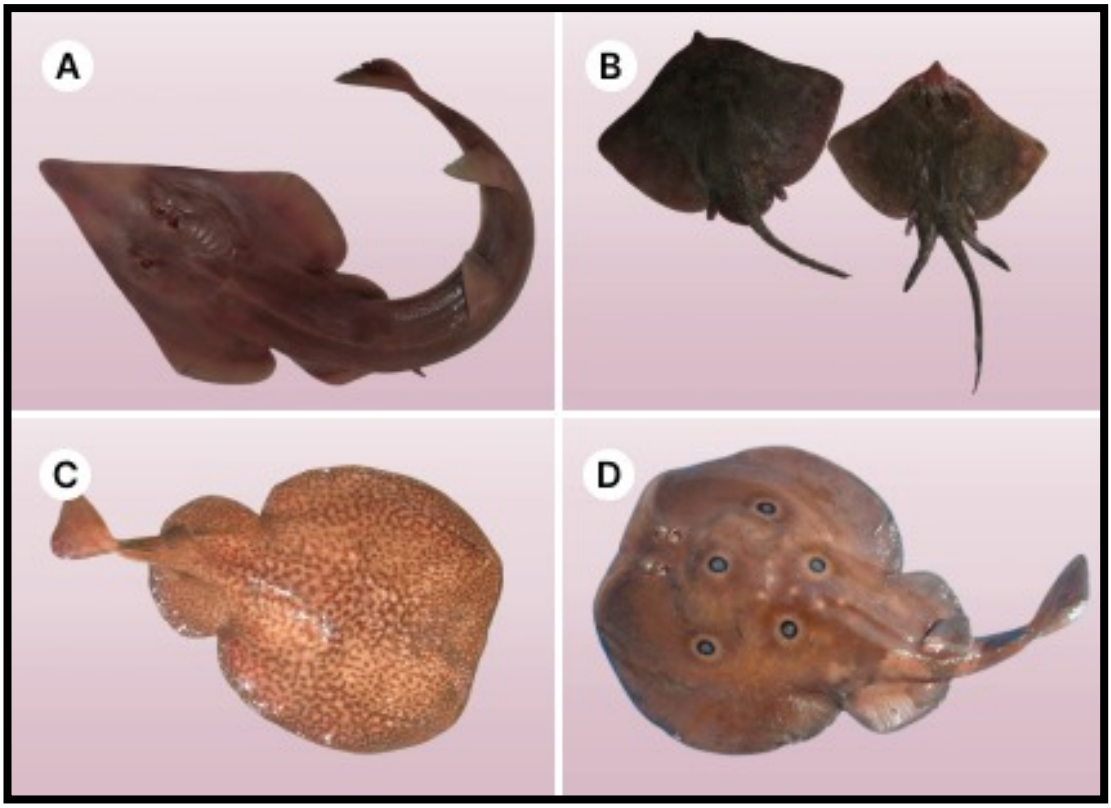

Figure 8. Cartilaginous fish species preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023: (A) Common Guitarfish (*Rhinobatos rhinobatos*), (B) Mediterranean Starry Ray (*Raja asterias*), (C) Spotted Torpedo (*Torpedo marmorata*), and (D) Common Torpedo (*Torpedo torpedo*).

3.2. Bony Fishes (Osteichthyes)

The current study recorded 68 bony fish species belonging to 39 families and 20 orders preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023 (**Table 3** and **Figure 4**, **Figure 5**, **Figure 9** and **Figure 10**). They inhabit the marine ecosystem of the Gaza Strip. It is well known that the Mediterranean bony fish species have different forms, shapes, colors and sizes. Accordingly, most of the preserved specimens had medium or small sizes. Many bony fish species were preserved in multiple copies in the same bottle. Two farmed fish species mainly the Nile Red Tilapia (*Oreochromis niloticus*) and the Hybrid Tilapia (*Oreochromis hybrids*) are commonly used for dissection purposes in the vertebrate zoology laboratories at the Islamic University of Gaza. Regarding the bony fish families, the Sparidae family represented the largest family with 9 species (13.2%), followed by the Carangidae family with 6 species (8.8%). Of the 68 recorded species, 27 species (39.7 %) were described as invasive or exotic (denoted to with asterisks in **Table 3**) in the sense that they have been moved to areas outside of their native ranges (**Figure 10**). One of the exotic species is the Silver-cheeked Toadfish (*Lagocephalus sceleratus*) which was and stills one of the most poisonous fish species throughout the world. This species is commonly characterized by its grey or brown back that owes darker spots, while the belly is white (**Figure 19**).

Table 3. Bony fish species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023.

Family	Scientific Name	Common Name	Arabic/Local Name
Order: Acanthuriformes الأسماك أشباه الفرخ			
Sparidae الأسبوريات (أسماك الشانك)	*Sparus aurata*	Gilthead Seabream	الدنيس
	Spicara smaris	Blotched Picarel	أنديرا غاندي
	Lithognathus mormyrus	Sand Steenbras	المرمير
	Boops boops	Bogue	الغبس
	Diplodus vulgaris	Common Two-banded Seabream	الصروص المكحل
	Diplodus sargus	White Seabream	الصروص الأصلي
	Diplodus cervinus	Zebra Seabream	الحداد
	Pagrus auriga	Red-banded Seabream	العروس/الفريدن
	Sarpa salpa	Salema Porgy or Dream Fish	الصلبية
Nemipteridae العندقات	*Nemipterus japonicus*	Japanese Threadfin Bream (*)	الجربيدن الهجين
Moronidae القاروصيات	*Dicentrarchus labrax*	European Seabass	الكرفوش (القاروص)
Lobotidae ثلاثيات الذيل	*Lobotes surinamensis*	Atlantic Tripletail (*)	الشبارة
Sciaenidae	*Umbrina cirrosa*	Shi Drum	اللبط
اللوتيات	*Argyrosomus regius*	(Croaker) Meagre	الجرع المسقار
Siganidae	*Siganus rivulatus*	Marbled Spinefoot (*)	القراص الأبيض
الأرنبيات	*Siganus luridus*	Dusky Spinefoot (*)	القراص الأسود
Pomacanthidae السنقفيات	*Pomacanthus maculosus*	Yellowbar Angelfish (*)	السمكة الملائكية ذات الشريط الأصفر
Order: Perciformes شوكية الزعانف			
Scorpaenidae الأسماك العقربية	*Pterois volitans*	Red Lionfish (*)	السمكة النارية أو المخططة
Trachinidae الطرخينيات	*Trachinus draco*	Greater Weever	العقربة السودة (الطرخين)
Echeneidae اللشكيات	*Echeneis naucrates*	Slender Sharksucker	قملة الدرفيل
Serranidae (Epinephelidae) ذناب البحر	*Mycteroperca rubra*	Mottled Grouper	القريدية
	Epinephelus aeneus	White Grouper	اللوقس الأبيض
	Epinephelus costae	Golden Grouper	الياسينة (لوقس صخري)
Order: Centrarchiformes الأسماك الأعجوبية			
Terapontidae أعجوبيات البحر أو الطربونيات	*Terapon puta*	Small-scaled Terapon (Three-lined Grunter) (*)	الجاسوس صغير الحراشف
Order: Scombriformes أسقمريات الشكل			
Scombridae الأسقمريات	*Scomberomorus commerson*	Narrow-barred Spanish Mackerel (*)	الكنعن
	Scomber scombrus	Atlantic Mackerel	السكمبلة
Pomatomidae القنبريات	*Pomatomus saltatrix*	Bluefish	المياس

Continued

Trichiuridae شعريات الذيل	*Trichiurus lepturus*	Largehead Hairtail (Beltfish)	السيف
Order: Carangiformes شيميات الشكل			
Coryphaenidae أسماك الدلفين أو الفورمايات	*Coryphaena hippurus*	Common Dolphinfish	الحرباية
Carangidae الشيميات (الحماميات)	*Trachinotus ovatus*	Pompano (Silverfish or Derbio)	العريان
	Alectis alexandrina	Alexandria Pompano (African Threadfish)	الجمل
	Pseudocaranx dentex	White Trevally or Striped Jack	الطرخون الأبيض
	Caranx crysos	Blue Runner	الطرخون الباغة
	Alepes djedaba	Shrimp Scad (*)	الطرخون الأصفر العريض
	Decapterus russelli	India Indian Scad or Russell's Mackerel Scad (*)	الإسكاد الهندية
Sphyraenidae الباراكودا (الاسفرنيات)	*Sphyraena obtusata*	Obtuse Barracuda (*)	المليطة السمراء
	Sphyraena chrysotaenia	Yellowstripe Barracuda (*)	المليطة الصفراء
Order: Syngnathiformes زماريات البحر			
Fistulariidae الزراقيات	*Fistularia commersonii*	Bluespotted Cornetfish (*)	الشفاط
Mullidae السلطانيات	*Mullus barbatus*	Red Mullet	السلطان الأحمر
	Mullus surmuletus	Striped Red Mullet	السلطان الأحمر المخطط
	Upeneus moluccensis	Goldband Goatfish (*)	البربونيا الصفراء
Order: Gobiiformes قوبيونيات الشكل			
Apogonidae اللحلحيات	*Apogon poecilopterus* (*Jaydia poeciloptera*)	Pearly-finned Cardinalfish	أبو جنيد (الكاردينال ذات الزعانف اللؤلؤية)
	Apogon imberbis	Mediterranean Cardinalfish	ابو جنيد أحمر (كاردينال البحر الأبيض المتوسط)
Order: Clupeiformes الصابوغيات			
Dorosomatidae (Clupeidae) الرنكيات أو الشابوطيات (الصابوغيات)	*Sardinella maderensis*	Madeiran Sardinella (*)	السردينة العريضة
	Sardinella aurita	Round Sardinella	السردينة المبرومة
Order: Pleuronectiforme الأسماك المسطحة - المقلطحات			
Soleidae الخوفعيات	*Solea solea*	Common Sole	الصول الشائع
	Microchirus ocellatus	Foureyed Sole	الصول العيون
Order: Mugiliformes أسماك البوري			
Mugilidae البوريات	*Mugil cephalus*	Mullet Flathead Grey	البوري
	Liza aurata	Golden Grey Mullet	الذهبان
	Liza ramada	Thinlip Mullet	الطوبارة
Order: Beloniformes الخرمانيات أو أسماك الإبرة			
Scomberesocidae أسماك الساوري أو البالون	*Scomberesox saurus*	Atlantic Saury	الكرباج

Continued

Hemiramphidae نصفيات المنقار	*Hemiramphus far*	Black-barred Halfbeak (*)	الإسفرنة
Exocoetidae القنبروريات	*Hirundichthys rondeletii*	Black Wing Flyingfish	العصفور الأزرق
Order: Tetraodontiformes المنافخ - رباعيات الأسنان			
Monacanthidae الأسماك المبردية	*Stephanolepis diaspros*	Reticulated Leatherjacket (*)	الخنزير الرملي
Balistidae الفنطريات	*Balistes capriscus*	Grey Triggerfish	الخنزيرة أو الحلوفة (القادوح الرمادي)
Tetraodontidae رباعية الأسنان	*Lagocephalus sceleratus*	Silver-cheeked Toadfish (*)	الأرنب المرقط السام
	Lagocephalus spadiceus	Half-smooth Golden Pufferfish (*)	الأرنب المذهب
Order: Aulopiformes أسماك السحالي			
Synodontidae ملتحمات الاسنان	*Saurida undosquamis*	Brushtooth Lizardfish (*)	السويسي
Order: Anguilliformes ثعابين السمك			
Anguillidae الأنقليسيات	*Anguilla anguilla*	European Eel	الأنقليس
Order: Beryciformes الأسماك السنجابية			
Holocentridae السنقفيات	*Sargocentron rubrum*	Redcoat (*)	الحموري
Order: Acropomatiformes or Pempheriformes أسماك الدم العميقة			
Pempheridae أسماك الكناس أو السويبر	*Pempheris vanicolensis*	Vanikoro Sweeper (*)	سمكة العدسة
Order: Labriformes اللبروسيات			
Labridae الببغائية أو الرأسيات	*Xyrichtys novacula*	Pearly Razorfish	الفارة
	Thalassoma pavo	Ornate Wrasse	سمكة الشفاهي المزخرفة
Order: Scorpaeniformes الأسماك العقربية أو المدرعة			
Platycephalidae الأسماك مسطحة الرأس	*Platycephalus indicus*	Bartail Flathead (*)	السمكة مسطحة الرأس الهندية
Order: Siluriformes أسماك القط أو السلوريات			
Ariidae السِلَّوْرِيَّات أو الجِرِّيثِيَّات	*Carlarius parkii*	Guinean Sea Catfish (*)	القرموط أو السلور الغيني
Plotosidae السِلَّوْرِيَّات المرجانية	*Plotosus lineatus*	Striped Eel Catfish (*)	القرموط الثعباني المخطط (السلور الأنقليسي المخطط)
Order: Cichliformes الأسماك البلطية			
Cichlidae البلطيات أو السكليد	*Oreochromis niloticus*	Nile Red Tilapia (*)	البلطي النيلي الأحمر
	Oreochromis hybrids	Hybrid Tilapia (*)	البلطي الهجين (الرمادي)

(*): Invasive or exotic.

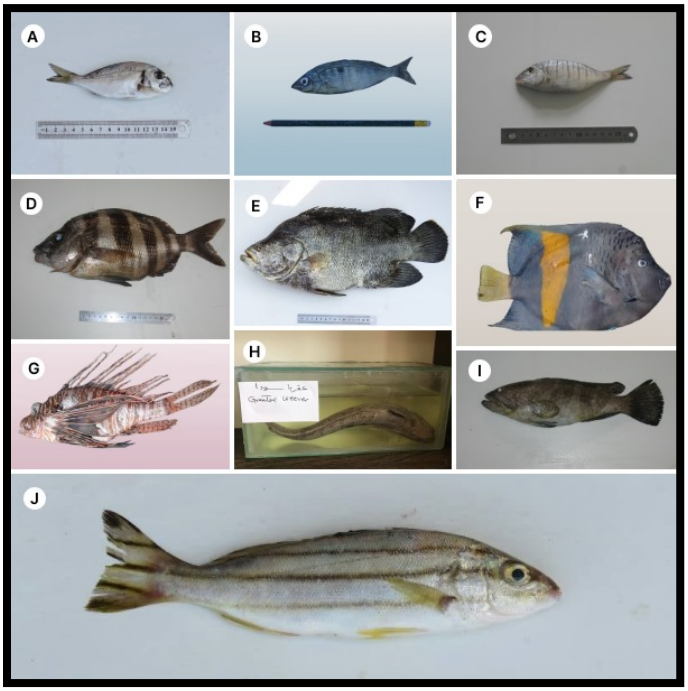

Figure 9. Bony fish species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023: (A) Gilthead Seabream (*Sparus aurata*), (B) Blotched Picarel (*Spicara smaris*), (C) Sand Steenbras (*Lithognathus mormyrus*), (D) Zebra Seabream (*Diplodus cervinus*), (E) Atlantic Tripletail (*Lobotes surinamensis*), (F) Yellow-bar Angelfish (*Pomacanthus maculosus*), (G) Red Lionfish (*Pterois volitans*), (H) Greater Weever (*Trachinus draco*), (I) White Grouper (*Epinephelus aeneus*), and (J) Small-scaled Terapon or Three-lined Grunter (*Terapon puta*).

Figure 10. Bony fish species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023: (A) Common Dolphinfish (*Coryphaena hippurus*), (B) Black Wing Flyingfish (*Hirundichthys rondeletii*), (C) Reticulated Leatherjacket (*Stephanolepis diaspros*), (D) Grey Triggerfish (*Balistes capriscus*), (E) Grey Triggerfish (*Balistes capriscus*), (F) Brushtooth Lizardfish (*Saurida undosquamis*), (G) Vanikoro Sweeper (*Pempheris vanicolensis*), (H) Pearly Razorfish (*Xyrichtys novacula*), (I) Striped Eel Catfish (*Plotosus lineatus*), and (J) Guinean Sea Catfish (*Carlarius parkii*).

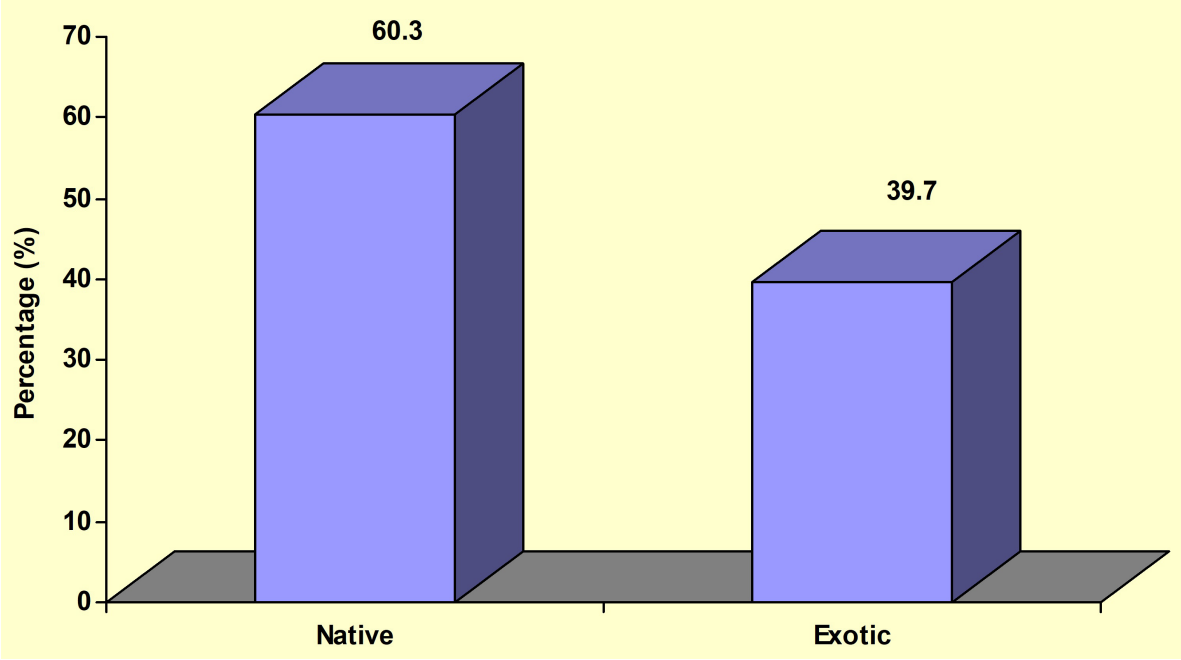

Figure 11. A graphic model showing the percentages of native and exotic bony fish species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023.

3.3. Amphibians (Amphibia)

The current study recorded three amphibian species belonging to three families and one order (Anura) preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023 (**Table 4** and **Figure 12**). All amphibians are resident and present year-round. They inhabit valleys, ponds, swamps, irrigation canals, and agricultural fields in the Gaza Strip. The Common Toad (*Bufo viridis*) was by far the most preserved species among the frog species recorded. This toad species is commonly used for dissection purposes in the vertebrate zoology laboratories at the Islamic University of Gaza.

Table 4. Amphibian species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023.

Family	Scientific Name	Common Name	Arabic/Local Name
Order Anura (عديمة الذيل) اللافيليات			
Bufonidae (True Toads) (العلاجيم الحقيقية)	*Bufotes viridis*	European Green Toad	الضفدع الشائع أو العلجوم الأخضر الأوروبي
Ranidae (Riparian Frogs) (الضفدعيات المشاطئة)	*Pelophylax bedriagae*	Levant Water Frog	ضفدع الماء الأخضر أو الجزاع الأخضر
Hylidae (Tree Frogs and Allies) (الضفادع الشجرية)	*Hyla savignyi*	Savigny's Tree Frog or Middle East Tree Frog	ضفدع الشجر أو الضفدع الشجري شرق الأوسطي

3.4. Reptiles (Reptilia)

A total number of 24 reptilian species belonging to 14 different families and two

orders was preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023 (Table 5 and Figure 13, Figure 14). All reptilian species are resident in the Gaza Strip environment and are present throughout the year. Squamata was the biggest order, comprising 21 species (9 lizards and 12 snakes). The Desert Monitor (*Varanus griseus*) was, by far, the biggest lizard species preserved. The Bosc's Lizard (*Acanthodactylus boskianus*) and the Agama (*Laudakia stellio*) were the most common preserved species; they were found in tens. With regard to snakes, the family Colubridae was the biggest among the snake species listed in Table 5. It was represented by seven species. Both the venomous Palestine Viper (*Daboia palaestinae*) and the non-venomous Syrian Black Snake or Arbeed (*Dolichophis jugularis*) were, by far, the most common preserved snakes. The Palestine Viper (*Daboia palaestinae*) is endemic in Palestine and some neighboring countries. Most snake bites are attributed to this dangerous and venomous species. The Testudines order was represented by three species of turtles, all of which are resident and often present year-round. The Greece Turtle or Spur-thighed Tortoise (*Testudo graeca*) is the only terrestrial species. The Caspian Terrapin (*Mauremys caspica*) is a freshwater species inhabiting Wadi Gaza wetlands in the middle of the Gaza Strip. Despite the abundance of sea turtle species in the Gaza Strip's marine ecosystem, only one specimen of the Green Sea Turtle (*Chelonia mydas*) has been found preserved in the museum.

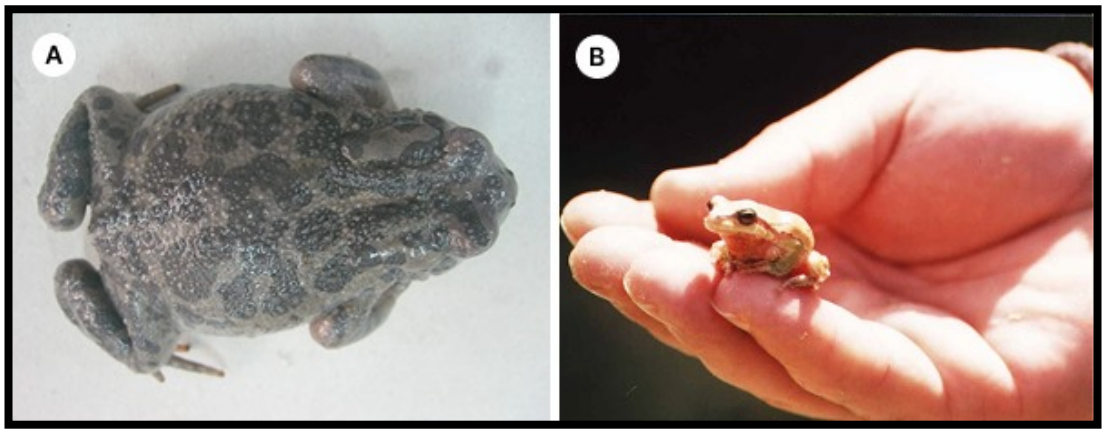

Figure 12. Amphibian species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023: (A) European Green Toad (*Bufotes viridis*), and (B) Savigny's Tree Frog (*Hyla savignyi*).

Table 5. Reptilian species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023.

Family	Scientific Name	Common Name	Arabic/Local Name
	Order Testudines السلحفيات		
Cheloniidae اللجئيات	*Chelonia mydas*	Green Sea Turtle	السلحفاة البحرية الخضراء
Testudinidae السلاحف الأرضية	*Testudo graeca*	Greece or Spur-thighed Tortoise	السلحفاة مهمازية الورك اليونانية

Continued

Geoemydidae سلاحف المياه العذبة	*Mauremys caspica*	Caspian Terrapin	سلحفاة الماء العذب القزوينية
Order Squamata الحرشفيات			
Varanidae الأورال	*Varanus griseus*	Desert Monitor	الورل الصحراوي
Lacertidae السحالي الحقيقية	*Acanthodactylus boskianus*	Bosc's Lizard	سحلية بوسك هدبية الأصابع
Chamaeleonidae الحرابي	*Chameleo chameleon*	Mediterranean Chameleon	الحرباة المتوسطية
Agamidae العضايا	*Stellagama stellio*	Agama	الحردون
Scincidae السقنقورات	*Heremites vittatus*	Bridled Skink or Bridled Mabuya	السحلية الجراية المخططة
	Eumeces schneiderii	Schneider's or Berber Skink	أم الحيات - السقنقور البربري
	Chalcides ocellatus	Ocellated Skink	الدفان (السقنقور العيني)
Geckonidae الأبراص أو الوزغيات	*Hemidactylus turcicus*	Turkish Gecko	أم بريص التركية
	Ptyodactylus hasselquistii	Light Fan-footed Gecko	أم بريص مروحية القدم
Typhlopidae الثعابين العمياء	*Xerotyphlops vermicularis*	European Worm or Blind Snake	الأوروبي الأعمى الدودي الثعبان
Boidae العاصرات	*Eryx jaculus*	Sand Boa	البوا الرملية
Colubridae الأحناش (الثعابين الحقيقية)	*Dolichophis jugularis*	Syrian Black Snake (Arbeed)	السوري (العربيد) الأسود الثعبان
	Dolichophis schmidti	Schmidt's Whip Snake (Red-bellied Racer)	ثعبان شميدت - الثعبان أحمر البطن
	Coluber nummifer	Coined Snake	الثعبان النقدي
	Spalerosophis diadema	Blotched Diadem or Clifford's Royal Snake	الأفعى البقلاوية الصحراوية (الثعبان الملكي)
	Natrix tessellata	Dice Snake	ثعبان النرد المائي
	Telescopus nigriceps	Black-headed Cat Snake	الرأس أسود القط ثعبان
	Platyceps collaris	Red Whip Snake	الثعبان أحمر السوط (الأفعى النشابة)
Lamprophiidae حيات الرمل	*Malpolon monspessulanus*	Arabian Rear-fanged Snake	أفعى الفئران (الثعبان الخضاري
	Psammophis schokari	Schokari Sand Racer	ثعبان أبو السيور (الزاروق)
Viperidae الأفاعي	*Daboia palaestinae*	Palestine Viper	الأفعى الفلسطينية (الحية الفلسطينية الزعرة)

3.5. Birds (Aves)

A total number of 47 bird species belonging to 26 different families and 12 orders was preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023 (Table 6 and Figure 6 and Figure 15). The bird

species encountered were either residents or migrants. Passeriformes, which forms the passerine birds, was, by far, the largest order comprising 19 species (40.4%). The non-passerine birds, which form the rest of bird orders, comprised 28 species (59.6%) as was illustrated in Figure 16. In terms of percentages, the Passeriformes order was the largest, consisting of 19 species (40.4%), followed by the Accipitriformes, Galliformes and Strigiformes orders, which were represented by 4 species (8.3%) each (Table 6). The Palestine Sunbird (*Cinnyris osea*) was the only endemic Palestinian bird encountered. The Ring-necked Parakeet (*Psittacula krameri*) and the Indian Myna (*Acridotheres tristis*) were the only exotic bird species encountered as well. Waterbirds were represented in this study by only seven species (14.9%).

Figure 13. Reptilian species preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023: (A) Green Sea Turtle (*Chelonia mydas*), (B) Greece or Spur-thighed Tortoise (*Testudo graeca*), (C) Desert Monitor (*Varanus griseus*), (D) Bosc's Lizard (*Acanthodactylus boskianus*), (E) Mediterranean Chameleon (*Chameleo chameleon*), (F & G) Agama (*Laudakia stellio*), (H) Schneider's or Berber Skink (*Eumeces schneiderii*), and (I) Ocellated Skink (*Chalcides ocellatus*).

Figure 14. Reptilian species preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023: (A) European Worm or Blind Snake (*Xerotyphlops vermicularis*) (B) Sand Boa (*Eryx jaculus*), (C & D) Syrian Black Snake – Arbeed (*Dolichophis jugularis*), (E) Coined Snake (*Coluber nummifer*), (F) Blotched Diadem Snake (*Spalerosophis diadema*), (G) Black-headed Cat Snake (*Telescopus nigriceps*), (H) Red Whip Snake (*Coluber rubriceps*), (I) Schokari Sand Racer (*Psammophis schokari*) and (J) Palestine Viper (*Daboia palaestinae*).

Table 6. Bird species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023.

Family	Scientific Name	Common Name	Arabic/Local Name
Pelecaniformes رتبة البجعيات			
Ardeidae البلشونية	*Bubulcus ibis*	Cattle Egret (**)	أبو قردان (بلشون الماشية)
	Egretta garzetta	Little Egret (**)	البلشون الأبيض الصغير
Accipitriformes رتبة الجوارح العابرة			
Accipitridae الكواسر	*Milvus migrans*	Black Kite	الحدأة السوداء
	Accipiter nisus	Eurasian Sparrowhawk	الباشق الأوراسي
	Buteo buteo	Common Buzzard	الصقر الحوام الشائع
	Buteo rufinus	Long-legged Buzzard	الصقر طويل الساقين

Continued

Falconiformes رتبة الصقريات			
Falconidae الصقرية	*Falco naummani*	Lesser Kestrel	العويسق
	Falco tinnunculus	Common Kestrel	العوسق
Galliformes رتبة الدجاجيات			
Rallidae التفلقية	*Fulica atra*	Common Coot (**)	الغرة
	Gallinula chloropus	Moorhen (**)	دجاجة الماء
Phasianidae التدرجية	*Alectoris chukar*	Chukar	الشنار
	Coturnix coturnix	Quail	الفر (السمان)
Charadriiformes رتبة الزقزاقيات			
Charadriidae القطقاطية	*Vanellus spinosus*	Spur-winged Plover (**)	الزقزاق أو القطقاط شوكي الجناح (القطا)
Burhinidae الكروانيات	*Burhinus oedicnemus*	Stone Curlew	الكروان الصحراوي
Columbiformes رتبة الحماميات			
Columbidae الحمامية	*Columba livia*	Rock or Feral Pigeon	الحمام الصخري
	Streptopelia turtur	Turtle Dove	اليمامة القمرية (الرقطية)
	Streptopelia senegalensis	Laughing Dove	اليمامة الضاحكة (فاختة النخيل)
Psittaciformes رتبة الببغائيات			
Psittacidae الببّغاويّة	*Psittacula krameri*	Ring-necked Parakeet (*)	ببغاء الذُرَّة (الببغاء ورديّ الطوق)
Strigiformes رتبة البوميات			
Strigidae البومية	*Asio otus*	Long-eared Owl	البومة القرناء أو الأذناء
	Otus scops	Eurasian Scops Owl	بومة الأشجار الأوروبية (الثبج الأوراسي)
	Athene noctua	Little Owl	أم قويق (البومة الصغيرة)
Tytonide بوميات الحظائر	*Tyto alba*	Barn Owl	بومة المخازن
Apodiformes رتبة السماميات			
Apodidae السماسم	*Apus apus*	Common Swift	السمامة الشائعة
	Apus pallidus	Pallid Swift	السمامة الباهتة أو الفاتحة
Bucerotiformes رتبة قرنيات المنقار			
Upupidae الهدهدية	*Upupa epops*	Eurasian Hoopoe	الهدهد الأوراسي
Coraciiformes رتبة الشقراقيات			
Meropidae الوروارية	*Merops apiaster*	European Bee-eater	الوروار الأوروبي

Continued

Alcedinidae القاوندية	*Alcedo atthis*	Common or River Kingfisher (**)	السماك الشائع أو النهري
	Halycon smyrnensis	White-breasted Kingfisher (**)	السماك أبيض الصدر (القاوند)
Passeriformes رتبة العصفوريات أو الجواثم			
Hirundinidae السنونية	*Hirundu rustica*	Barn Swallow	السنونو (عصفور الجنة)
Sturnidae الزرازير	*Sturnus vulgaris*	Common Starling	الزرزور الشائع
	Acridotheres tristis	Indian Myna (*)	المينا الهندية
Corvidae الغرابية	*Corvus corone*	Hooded Crow	الغراب البلدي الرمادي
	Coloeus monedula	Western Jackdaw	الغُراب الزرعِي أو غراب الزيتون
	Garrulus glandarius	Eurasian Jay	أبو زريق (الزريقي)
Motacillidae الفتاحية (الذعريات)	*Motacilla flava*	Yellow Wagtail	الذعرة الصفراء
	Motacilla alba	White Wagtail	الذعرة البيضاء
	Anthus trivialis	Tree Pipit	جشنة الأشجار
Turdidae المغردات	*Turdus merula*	Blackbird	الشحرور (الدج)
	Turdus philomelos	Song Thrush	المغنية السمّنة
Passeridae العصفورية	*Passer domesticus*	House Sparrow	العصفور المنزلي (الدوري)
Nectariniidae المغثريات	*Cinnyris osea*	Palestine Sunbird	عصفور الشمس الفلسطيني
Pycnonotidae البلبلية	*Pycnonotus xanthopygos*	White-spectacled Bulbul	البلبل أصفر العجز
Muscicapidae خاطفات الذباب	*Erithacus rubecula*	European Robin	أبو الحناء الأوروبي (سراق حن أمه)
	Luscinia svecica	Bluethroat	المسهر (أزرق الزور)
Sylviidae (الدخل) الخناشع	*Sylvia atricapilla*	Blackcap	أبو قلنسوة
Fringillidae الحساسين	*Carduelis carduelis*	Goldfinch	الحسون الذهبي
	Carduelis chloris	Green Finch	الخضر

(*): Invasive or exotic birds, (**): Waterbirds.

3.6. Mammals (Mammalia)

A total number of 6 mammalian species belonging to 4 different families and 3 orders was preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023 (Table 7 and Figure 17). All mammalian species are resident in the Gaza Strip and mostly found throughout the year. Rodentia was the largest order, containing only three species, and were considered pests that caused damage to agricultural crops, public health, and other human property. The Palestine Mole Rat (*Spalax leucodon ehrenbergi*) is endemic to Pal-

estine. The Egyptian Fruit Bat (*Rousettus aegyptiacus*) is the largest bat species found in Palestine and is already a pest threatening Gazans due to its frequent attacks and damage to fruit orchards. The order Insectivora was represented by two species of nocturnal hedgehogs: The Long-eared Hedgehog (*Hemiechinus auritus*) and the Ethiopian Hedgehog (*Paraechinus aethiopicus*).

Figure 15. Bird species preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023: (A) Eurasian Sparrowhawk (*Accipiter nisus*), (B) Chukar (*Alectoris chukar*), (C) Stone Curlew (*Burhinus oedicnemus*), (D) Feral Pigeon (*Columba livia*), (E) Eurasian Scops Owl (*Otus scops*), (F) Barn Owl (*Tyto alba*), (G) White-breasted Kingfisher (*Halycon smyrnensis*), (H) Common Starling (*Sturnus vulgaris*), (I) Indian Myna (*Acridotheres tristis*), (J) Eurasian Jay (*Garrulus glandarius*), (K) Tree Pipit (*Anthus trivialis*), and (L) Song Thrush (*Turdus philomelos*).

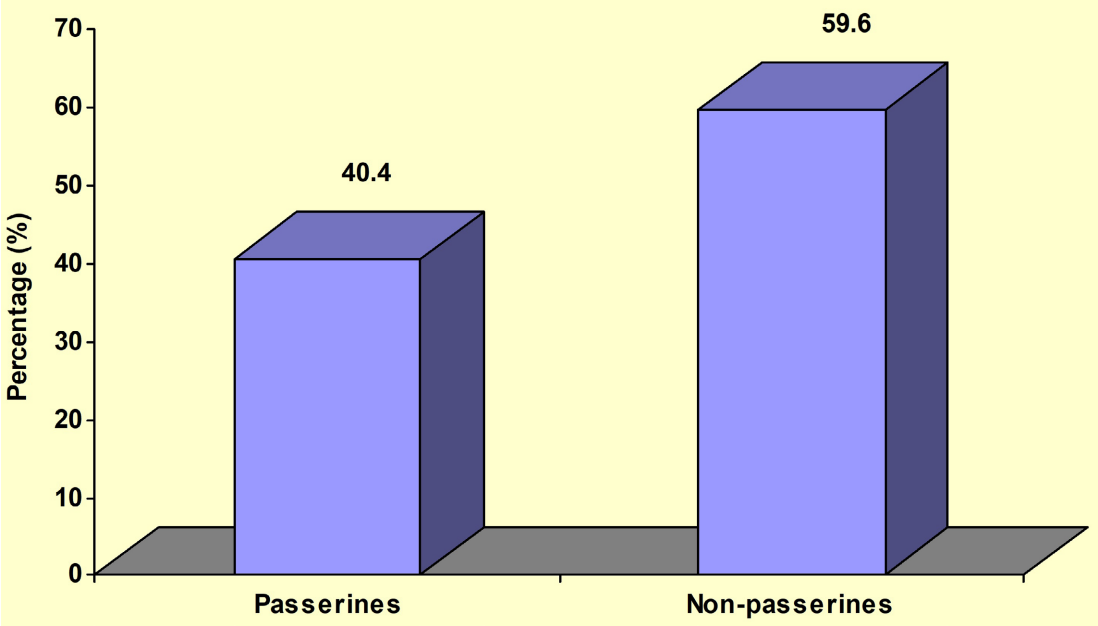

Figure 16. A graphic model showing the percentages of passerine and non-passerine bird species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023.

Table 7. Mammalian species preserved at the Biology Department Museum at the Islamic University of Gaza prior to October 7, 2023.

Family	Scientific Name	Common Name	Arabic/Local Name
Order Chiroptera الخفاشيات			
Pteropodidae الخفافيش آكلة الثمار	*Rousettus aegyptiacus*	Egyptian Fruit Bat	خفاش الثمار المصري
Order Insectivora آكلة الحشرات			
Erinaceidae القنفذيات	*Paraechinus aethiopicus*	Ethiopian Hedgehog	القنفذ الأثيوبي
	Hemiechinus auritus	Long-eared Hedgehog	القنفذ طويل الأذن
Order Rodentia القوارض			
Spalacidae الخلديات	*Spalax leucodon ehrenbergi*	Palestine Mole-rat	الخلند الفلسطيني (أبو عماية)
Muridae الفأريات	*Mus musculus*	House Mouse	الفأر المنزلي
	Rattus rattus	Black Rat	الفأر الأسود (العرسة)

4. Discussion

Palestine (27,000 km^2) boasts a rich biodiversity of vertebrate fauna representing the classes of Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves and Mammalia. This diversity is supported by the geographical location of Palestine, as well as by the diversity of climates, terrain, habitats, and ecosystems [1]. This vertebrate biodiversity currently faces numerous threats, including urban expansion, desertification, pollution, habitat alteration and destruction, weak environmental legislation and laws, the Israeli apartheid walls separating the Palestinian territories from the lands occupied by Israel in 1948, and repeated Israeli invasions and

wars in the West Bank and the Gaza Strip [43]-[46]. This situation of vertebrate fauna in Palestine is reflected in the diversity of vertebrate fauna in the Gaza Strip, which has been under an 18-year Israeli occupation blockade. It is therefore not surprising that the Biology Department Museum at the Islamic University of Gaza, which was destroyed by the Israeli war machine, contains a total of 156 species of mummified vertebrates, as the results of the current study reveal.

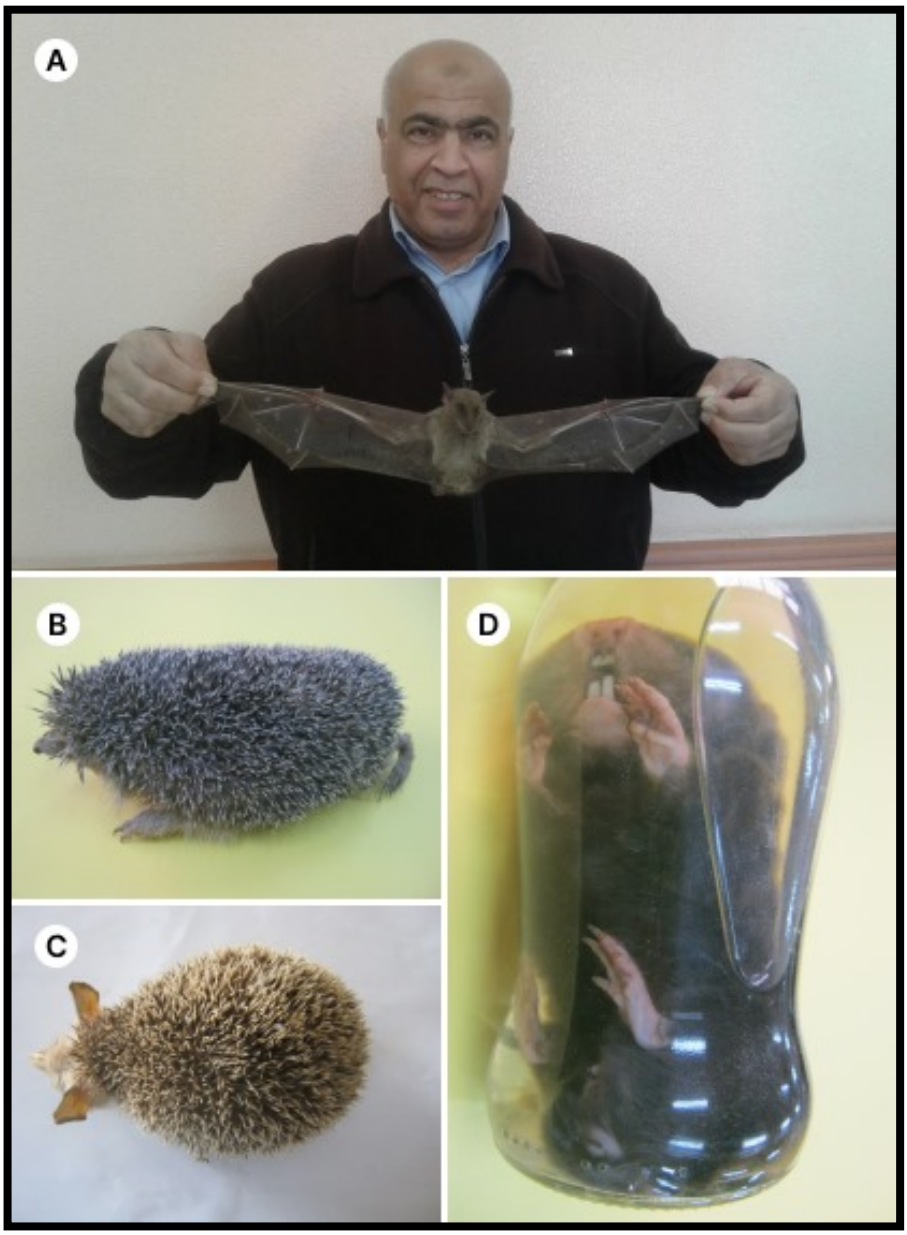

Figure 17. Mammalian species preserved in the Biology Department Museum at the Islamic University of Gaza before October 7, 2023: (A) Egyptian Fruit Bat (*Rousettus aegyptiacus*), (B) Ethiopian Hedgehog (*Paraechinus aethiopicus*), (C) Long-eared Hedgehog (*Hemiechinus auritus*), and (D) Palestine Mole-rat (*Spalax leucodon ehrenbergi*).

This is not the first time that museums or zoos in the Gaza Strip, which house

various preserved or live vertebrates, have suffered damage during periods of wars. In 2004, the Rafah Zoo was struck, resulting in the death or displacement of many animals [3] [47]. During the 2008/2009 war, the Biology Department Museum at the Islamic University of Gaza was completely destroyed [24]. In the same period, the Gaza Zoo in Gaza City was also affected, leading to the death of many animals. Some predatory animals and monkeys escaped from their enclosures, creating a potential public health concern. More recently, during the ongoing war, the Namaa Zoo in northern Gaza sustained significant damage, resulting in the death of most of its animals, while others either escaped or were left without care due to restricted staff access (Personal Observations and Communications).

The current study revealed the presence of only eight species of cartilaginous fish preserved in the Biology Department Museum at the Islamic University of Gaza. This number included small specimens, due to the Biology Department's limited resources in terms of space, taxidermy equipment, and preservation fluids, and its inability to mummify larger specimens, which may reach meters in length. In fact, cartilaginous fish are huge predators, with some reaching lengths of one, two, or three meters, and sometimes more. Abd Rabou *et al.* [16] described ten species of these fishes, including various sharks and rays. Some of these sharks have been recorded in rare attacks to humans along the Palestinian coast, resulting in injuries and deaths [48]. In particular, the Common Guitarfish (*Rhinobatos rhinobatos*), is the most popular stuffed cartilaginous fish in the Biology Department Museum. This is due to several reasons, including the widespread fishing and consumption of various sizes (especially small ones) from the marine environment of the Gaza Strip, its low price, which enables the poor to purchase it, and its use as a model in practical lessons on the anatomy of cartilaginous fishes in biology departments at Palestinian universities in the Gaza Strip [16] [24]. The presence of eight species of cartilaginous fish preserved in the Biology Department Museum, compared to 68 species of bony fish, may not seem surprising. In a similar study, conducted on the fishes of the Alexandria region, southeastern Mediterranean, Egypt, Farag *et al.* [49] found that cartilaginous fish were represented by five species (5.3%), while bony fish were represented by 89 species (94.7%).

Mummified bony fishes constituted the largest proportion of preserved specimens, accounting for approximately one-third (33.6%). This is due to several reasons, including the ease of obtaining samples of marine bony fish, even farmed ones, the ease of embalming and preserving them in glass containers, their low prices, and the ease of purchasing them from fish markets. Most importantly, one master's female student identified 128 fish species in the marine ecosystem of the Gaza Strip [15]. The researcher mummified many of these specimens, making the number of preserved bony fishes the largest among vertebrate samples in the Biology Department Museum at the Islamic University of Gaza (**Figure 18**). In this context and on a global scale, the class of Osteichthyes (bony fishes) is the largest class among all vertebrates, comprising more than 23,000 species belonging to about 435 families and 45 orders [50].

The Sparidae family was the biggest among the bony fish families representing the preserved bony fishes at the Biology Department Museum. Such results coincided with the studies of Abu Amra [15], Al-Hassan and El-Silini [51], Saad [52] and Haroun *et al.* [53] who pointed out that the Sparidae was the biggest among the fishes surveyed at the Mediterranean coasts of the Gaza Strip of Palestine, Libya, Syria, and Egypt respectively. The Gilthead Sea Bream (*Sparus aurata*), which belongs to the Sparidae family, is well represented in the collections of mummified bony fishes in the Biology Department Museum at the Islamic University of Gaza. The sources of stuffed Gilthead Sea Breams are fish caught in the Mediterranean Sea or raised in closed or open aquaculture systems in the Gaza Strip [54] [55]. One of the good observations about the Gilthead Sea Bream is that its culture is remarkably adapted to brackish and marine pond conditions [56] prevailing in the Gaza Strip, as pointed out by Shaheen [55]. Gilthead Sea Bream farming began years ago as part of a pilot project in cages off the coast of the Gaza Strip, and this type of mariculture may prove successful in the future [57]. In fact, over the years, the Gilthead Sea Bream has become a prominent species in Mediterranean aquaculture, with an estimated increase in its production volume [58] [59].

Figure 18. A female master's researcher preserving collected samples of bony fish in a 10% formalin solution in the Biology Department at the Islamic University of Gaza.

The current results showed that 27 species of bony fishes (39.7%) were described as invasive (exotic or alien). Most of these fish reached the Mediterranean Sea from the Indo-Pacific and the Red Sea via the Suez Canal in Egypt. This invasion is scientifically known as the "Lessepsian migration". Of course, some arrived from the Atlantic Ocean via the Strait of Gibraltar [15] [60]-[65]. Such invasive species form a considerable deal of the Mediterranean fisheries [66] [67]. Some invasive bony fishes have been recorded in the marine ecosystem of the Gaza Strip, Palestine and were proven in the current study to be toxic and cause injury and death. The invasive Red Lionfish (*Pterois volitans*) is also known among the

Gazans to pose a public health risk due to their venomous spines, which can cause painful stings and sometimes serious injuries if not handled properly [15]. The potential threats posed by this species to human health have been addressed in some countries around the world [68]-[70]. Although not included in this study, Abd Rabou *et al.* [71] highlighted the risks of the invasive and rare Reef Stonefish (*Synanceia verrucosa*) to the public health of swimmers and divers in the Gaza Strip.

Figure 19. An academic specialist explains the dangers of the invasive Silver-cheeked Toadfish (*Lagocephalus sceleratus*) to students in the biology labs at the Islamic University of Gaza.

One of the most dangerous and poisonous exotic bony fish species preserved at the Biology Department Museum was the Silver-cheeked Toadfish (*Lagocephalus sceleratus*). This species is considered as one of the most recent invaders into the Mediterranean Sea [72]-[75]. It represents a serious ecological risk to Mediterranean biodiversity and fisheries resources and a health risk to public health. Abd Rabou [76] and Ulman *et al.* [77] reported several cases of poisoning and death due to these dangerous bony fish in some Mediterranean countries, including Palestine. Amid the ongoing war in the Gaza Strip, some Palestinians resorted to consuming available local fish species, including the Silver-cheeked Toadfish, which unfortunately led to several cases of poisoning, resulting in injuries and fatalities (Personal Communications). In fact, the tetrodotoxin (TTX) intoxication of the Silver-cheeked Toadfish has been disastrous in several Mediterranean countries, as some studies have indicated [78]-[80]. The danger posed by the Silver-cheeked Toadfish has prompted some governmental and academic bodies in the Gaza Strip to highlight its health and ecological risks, both in the media and during meetings with segments of Palestinian society at educational institutions

(**Figure 19**).

It is known that the Gaza Strip is home to only three species of amphibians belonging to the order Anura [7] [9] [81] [82], which are the same as those shown in **Table 4** of this study. In the West Bank of Palestine, four species of frogs and toads were recorded; the three recorded in the current study in the Biology Department Museum, in addition to another species, which is, the Eastern or Syrian Spadefoot (*Pelobates syriacus*) as pointed out by Salman *et al.* [83]. There are no other orders of amphibians in the Gaza Strip, although the upper regions of Palestine are home to about eight species of amphibians, from the orders Anura (tailless amphibians) and Caudata (Urodela), as some studies have indicated [2] [84] [85]. This comes as a reflection of rainfall level in the country. The Banded Newt (*Triturus vittatus*), for example, is not found in the Gaza Strip because aridity and semi-aridity as the Gaza Strip receives rainfall levels ranging from 250 in the south to 400 mm in the north per year, but it is found in northern Palestine because rainfall levels exceed the 500 mm per year threshold [35]. The ease of capturing frogs and toads in their aquatic or semi-aquatic habitats in the Gaza Strip has contributed to their taxidermy in the Biology Department Museum at the Islamic University of Gaza. Amphibians, as sensitive creatures, face many threats in the Gaza Strip, Palestine, and even in some neighboring countries such as habitat change, modification, and destruction, excessive use of chemical pesticides, discharge of raw sewage into valleys, pollution of waterways and ponds, and the ongoing global climate change catastrophe [81] [85]-[87].

The arid and semi-arid nature of the Gaza Strip attracts a large number of different reptile species, including turtles, lizards, and snakes. The reptile species preserved in the Biology Department Museum at the Islamic University represent a significant portion of these Mediterranean reptiles found in Palestine and neighboring countries such as Jordan and Egypt [88]-[94]. Greece or Spur-toughed Tortoises (*Testudo graeca*) of various sizes were the most common turtle species preserved in the Biology Department Museum, as well as in other Palestinian university museums. This is due, of course, to their remarkable prevalence in the wild despite the threats they face, and to their ease of handling. Moreover, some Gazans as well as some Jordanians keep these turtles in their homes or in pet shops for trade [95] [96], and occasional breeding and hatching have been recorded (Personal Observations). Their habit of feeding on plants in the wild [97] encourages their keeping in local homes and gardens, as they do not cost much to eat and can eat plant scraps.

The Caspian Turtle or the Striped-neck Terrapin (*Mauremys caspica*) is the only freshwater turtle found in the Wadi Gaza wetland ecosystem and can also be easily caught by hands or nets in its habitat. Although three species of sea turtles were recorded in the marine ecosystem of the Gaza Strip [16] [98]-[101], only a relatively small specimen of the Green Sea Turtle (*Chelonia mydas*) was found among the taxidermy specimens in the Biology Department Museum. Sea turtles that frequently strand on beaches of the Gaza Strip are often in varying states of

decomposition and can be difficult to use for taxidermy. Due to their heavy weight, transporting them to the Islamic University of Gaza can be challenging, especially since most taxidermied vertebrate specimens are small and are donated by students or others to the Islamic University's Biology Department. In fact, the Biology Department Museum's capabilities in the field of taxidermy are very modest, and most of the taxidermy and preservation work is limited to smaller specimens [24].

The squamates or scaled reptiles (order Squamata), are a highly successful and familiar group of reptiles including lizards, snakes and amphisbaenians [28]. The squamates of the Gaza Strip were best represented in the Biology Department Museum of the Islamic University of Gaza and they are also well represented, live or stuffed, in Gaza zoos as pointed out by Abd Rabou [102]. In fact, Palestine is very attractive to lizards and snakes among other reptilian categories [25] [90] [92] [102]-[104]. The Desert Monitor (*Varanus griseus*) is the largest among the lizards preserved at the Biology Department Museum. There were more than six preserved specimens of the Desert Monitor, either dry or wet mummified. The species often inhabits different varieties of substrates in the Gaza Strip as was stated by Abd Rabou *et al.* [5]. This species is locally threatened due to deliberate killing by Gazans for unclear reasons. Some Gazans claimed they killed the animal because it preyed on domestic animals and their eggs. Various studies have confirmed this predation by the Desert Monitor on wild and domestic animals [105]-[107]. The most common stuffed lizards in the Biology Department Museum were the Bosc's Lizard (*Acanthodactylus boskianus*), Mediterranean Chameleon (*Chameleo chameleon*), and Agama (*Stellagama stellio*). This documentation reflects their wide distribution in nature and in the biology department museums of Palestinian universities in the Gaza Strip [25] [90] [92] [102] [103].

Colubridae was the largest family of snake species found in the Biology Department Museum at the Islamic University of Gaza. This was not surprising, as this family is the largest in Palestine and neighboring Jordan [5] [108]. A clear example of this family is the Syrian Black Snake (*Dolichophis jugularis*), known locally as the *Arbeed*. It was the most common non-venomous snake species preserved in the biology museums at local universities as well (Personal Observations). According to local measurements, the species may reach two meters or more in length. By contrast, the Palestine Viper (*Daboia palaestinae*), which is endemic to Palestine [109] [110] and some of its neighboring countries [111] [112], was the most poisonous snake encountered in the Biology Department Museum. In fact, Palestine is home to more than 40 snake species, with one-fourth of these snakes being poisonous [41] [113]. Most snake bites in Palestine and even Jordan are commonly attributed to the Palestine Viper as pointed out by many studies [35] [90] [109] [110] [113] [114]. Unfortunately, Gazans sometimes deliberately kill venomous and non-venomous snakes without regard for their ecological role. These behaviors and practices must be stopped in Palestine through effective ecological awareness campaigns.

A recent study revealed the presence of a total of 250 species of resident and migratory birds in the Gaza Strip, both terrestrial and aquatic [115]. Of these birds, only 47 stuffed bird species were recorded in the Biology Department Museum at the Islamic University of Gaza. Most of the stuffed birds were brought to the Biology Department live by students or bird hunters. Taxidermy classes for students have undoubtedly contributed to the increase in the number of stuffed bird species there. Poaching of birds such as sparrows, quails, pigeons, waterfowl, waders, birds of prey, etc. is a common practice in the Gaza Strip [116]-[118]. In fact, there are no restrictions on bird hunting in the Gaza Strip, which poses a threat to them [119]. For example, Chukars (*Alectoris chukar*), Common Quail (*Coturnix coturnix*), and various species of doves (*Streptopelia spp.*), among others, were traditionally hunted for their delicious meat, while others like finches, raptors and parrots were hunted for the pet trade [118]-[125].

The Passeriformes was the largest order, comprising 19 species (40.4%) of the bird species recorded in the Biology Department Museum. This does not seem strange or exceptional, as passerines (order Passeriformes) were the highest rank in many studies conducted in several locations in the Gaza Strip and other localities of Palestine [8] [9] [119] [126]-[128]. Worldwide, passerine birds make up nearly 60% of all living birds as well [129] [130]. Aquatic birds were represented by only seven species (14.9%). The Cattle Egret (*Bubulcus ibis*) is a scavenging bird [131] found everywhere in the Gaza Strip, especially in valleys, sewage pools, and solid waste dumps [119], so catching it is not difficult. The Little Egret (*Egretta garzetta*) looks elegant and is also found in valleys, sewage pools, and even in Gaza City's fishing port [132]. Although considered an aquatic bird, the White-breasted Kingfisher (*Halycon smyrnensis*) is found throughout the Gaza Strip and is often recognized by its distinctive calls or its bright blue and brown colors [133]. It is a truly beautiful bird, and Palestinians adore its presence [126]. The Common or River Kingfisher (*Alcedo atthis*) is primarily an aquatic bird, compared to the previous White-breasted Kingfisher, and is therefore not commonly seen in pure terrestrial habitats. However, it has been seen in the fishing port of Gaza City, as well as in other bodies of water and wadis in the Gaza Strip [4].

The Palestine Sunbird (*Cinnyris osea*) is the only endemic bird species of Palestine that was preserved in the Biology Department Museum. Of course, it was the smallest preserved bird as well, weighing just a few grams [134]. It inhabits different natural, rural and urban habitats rich in flowering plants [31] [126] [133]. As far as the invasive (exotic or alien) bird species are concerned, there were two species of them prevailing in the Gaza Strip; namely the Common or Indian Myna (*Acridotheres tristris*) and the Ring-necked Parakeet (*Psittacula krameri*). The two species seemed to invade the Palestinian environment two decades ago. The remarkable spread of these two invasive bird species in the region can be attributed to deliberate introduction, accidental escapes from zoos, or natural range expansion from neighboring countries [123] [124] [134]-[136]. These two species are captured in large numbers from the open environment using specific methods

for keeping in captivity or selling in pet stores [96]. Holzapfel *et al.* [137] pointed out that the Common Myna was listed as one of the 100 worst invading species worldwide. The Ring-necked Parakeet, with its bright green feathers and red beak, poses several potential threats in Palestine due to its feeding on agricultural crops, especially fruits, and its competition with some local wild birds, especially those that nest in cavities [124].

The Gaza Strip is home to dozens of species of wild mammals such as bats, rodents, carnivores, insectivores and rare deer and hares, as many studies have shown [43] [109] [138] [139]. The current study revealed only 6 species preserved at the Biology Department Museum. All the mummified mammal species were relatively small, and included two species of hedgehogs, three species of rodents, and the Egyptian Fruit Bat, the largest of the Palestinian bats. The presence of these small mummified mammals can be attributed to the ease of hunting and capturing them, on the one hand, and the ease of formalin mummification in jars or containers, on the other. The absence of preserved specimens of medium or large mammals is primarily due to the limited financial and technical capabilities of the Biology Department Museum to mummify larger specimens.

The two hedgehog species; namely the Long-eared Hedgehog (*Hemiechinus auritus*) and the Ethiopian Hedgehog (*Paraechinus aethiopicus*) found in the Biology Department Museum, were common nocturnal mammals of the Gaza Strip and the West Bank [6] [109] [140]. The easy catch of these creatures facilitated their introduction and preservation at all biology exhibitions of the local universities (Personal Observations). Both species are now under serious threat due to habitat destruction and killing for unclear reasons and are rarely consumed as food by a few Bedouin families on the outskirts of the Gaza Strip [139]. Some Palestinians likely eat hedgehogs because they believe they are permissible (halal). From an Islamic perspective, eating hedgehogs appears to be halal, as Al-Ahdal [141] explained in a recent study. In Israel, hedgehogs were poached and hunted among other wildlife species by Thai guest workers for food purposes [142]. The Egyptian Fruit Bat (*Rousettus aegyptiacus*), several mummified specimens of which are housed in the Biology Department Museum, can be considered a local pest due to its dietary habit of eating fruits, including date palm fruits, which are produced in huge quantities in the Gaza Strip [143] [144]. The aforementioned bat is also considered a harmful pest that attacks agricultural crops, especially ripe fruits, causing economic losses in many Middle Eastern countries [145]-[147].

Rodentia is the largest mammalian order in Palestine [1] and worldwide [148]. Bottles containing preserved specimens of the Palestinian Mole-rat (*Spalax leucodon ehrenbergi*) were common in the Biology Department Museum and other museums in local universities. In fact, the ability of this species to dig tunnels between the roots, tubers and bulbs of plants that animals feed on [27] makes it a real pest in the Gaza Strip, threatening crops and plants [7]. The House Mouse (*Mus musculus*) and the Black Rat (*Rattus rattus*) are the most common commensal rodents in the Gaza Strip environment, posing a threat to agricultural crops,

human health, and property as pointed out by Abd Rabou *et al.* [7]. This requires the use of multiple control tools, which can sometimes pose a risk to human health and non-target organisms [149] [150].

5. Concluding Remarks

In conclusion, the estimated 156 Palestinian marine and terrestrial vertebrate species preserved in the Biology Department Museum at the Islamic University, which were bombed by the Israeli occupation forces at the beginning of the Israeli war that followed October 7, 2023, represent only a fraction of the actual terrestrial and marine wildlife in the Gaza Strip. If the political situation in the Gaza Strip improves and stabilizes, it is essential to allocate large areas to establish well-equipped, well-ventilated, and well-lit zoological museums, housing well-preserved and sustainable animal specimens. The idea of establishing central natural history museums, under the supervision of a responsible scientific authority, would serve as a scientific and educational reference point serving scientific bodies specializing in the environment, biology and biodiversity, as well as all segments of Palestinian society, especially school and university students, with the aim of changing people's perceptions of the environment and ways to preserve it in the Gaza Strip.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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