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Assessing the Coral Reef Fish Biodiversity in the Al-Wajh Region of the Northern Red Sea, Saudi Arabia

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ABSTRACT

This study presents the current status of coral reef fish biodiversity in the Al-Wajh region, focusing on both near shore and offshore areas. A comprehensive survey was conducted at 30 different stations, encompassing coastal and offshore locations. A total of 117 fish species belonging to 31 families were identified during the survey, with an overall abundance of 20,810 individuals observed. The fish assemblages in the area exhibited a balanced representation by all functional groups across different trophic levels, indicating a healthy state. Of particular interest were the families Chaetodontidae (butterfly fishes) and Serranidae (Groupers), known as reliable indicators of reef health and effective predators, respectively, as they were adequately represented. The family Labridae exhibited the highest number of species (16), followed by Scaridae (13). Overall, the assessment revealed the healthy nature of the Al-Wajh region in terms of fish stock, providing valuable insights for conservation and management efforts.

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INTRODUCTION

The Red Sea is home to a diverse array of fish species, making it a globally significant marine ecosystem. Situated between Africa and Asia, the Red Sea provides a unique environment for fish to thrive due to its warm waters, extensive coral reef systems, and rich biodiversity (Berumen *et al*., 2013). The Red Sea's fish fauna consists of a wide range of species representing various families, orders, and ecological niches (Roberts, 1986; Bogorodsky and Randall, 2019). These fishes have adapted to the specific environmental conditions and habitat features of the Red Sea, resulting in a distinct assemblage of marine life (Golani and Bogorodsky, 2010). The warm tropical waters and extensive coral reefs serve as critical factors supporting the abundance and diversity of fish species. The Red Sea is renowned for its coral reef ecosystems, which are among the most extensive and diverse in the world (Riegl and Purkis, 2012). Coral reefs provide essential habitats for fish, offering shelter, feeding grounds, and reproductive areas. The complex three-dimensional structure of the reefs, composed of corals, sponges, and other benthic organisms, creates a diverse array of microhabitats that can support a wide range of fish species. Several families of fish are particularly abundant in the Red Sea. For example, the family Pomacentridae, which includes the popular clownfish species, is well represented in the region. The Red Sea is also known for its diversity of butterflyfish (family Chaetodontidae), angelfish (family Pomacanthidae), and wrasses (family Labridae). Additionally, species from families such as Serranidae (groupers), Lethrinidae (emperors), and Acanthuridae (surgeonfish) are commonly observed in Red Sea waters (Roberts, 1986; Roberts *et al*., 1992; Golani and Bogorodsky, 2010).

The ecological importance of fish in the Red Sea extends beyond their diversity and abundance. Fish play crucial roles in maintaining the overall health and functioning of the marine ecosystem. They contribute to nutrient cycling, control populations of smaller organisms, and act as indicators of environmental conditions. Moreover, certain fish species participate in symbiotic relationships with corals and other organisms, enhancing the resilience and stability of the reef ecosystem. To understand the coral fish diversity and ecology in the Red Sea, numerous scientific studies have been conducted. These studies have employed various research methods, including underwater surveys, genetic analyses, and

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ecological modelling, to document and investigate the fish species found in the region (Roberts, 1986; Roberts *et al.*, 1992; Khalaf and Kochzius, 2002; Brokovich *et al.*, 2006; Golany and Bogorodsky, 2010; DiBattista *et al.*, 2017; Isari *et al.*, 2017; Coker *et al.*, 2018; Atta *et al.*, 2019; Bogorodsky and Randall, 2019). Researchers have also examined the impact of human activities, such as overfishing and pollution, on fish populations and the overall ecosystem health (IPCC, 2021).

The current study region is one of the unique in terms of fish biodiversity in the Red Sea (Atta *et al.*, 2019). The coastal waters of Al-Wajh are home to a rich and diverse array of marine life. The Red Sea's warm and nutrient-rich waters support a wide range of coral reefs, seagrass meadows, and mangrove forests. These habitats provide crucial nurseries, feeding grounds, and shelter for various marine species (Bruckner *et al.*, 2012). The marine biodiversity in the Al-Wajh region includes a variety of fish species, invertebrates, and marine mammals. Colorful reef fish, such as butterflyfish, angelfish, and surgeonfish, are commonly observed, along with larger species like groupers and snappers (Atta *et al.*, 2019). Dolphins and sea turtles are also known to frequent the area.

The present study aims to investigate the biodiversity of fishes in the Al-Wajh region, specifically focusing on the reef fish community. The researchers conducted a comprehensive survey to provide an up-to-date census of the fish species found in the area. The study's primary objective is to raise awareness about the fish population and the importance of conservation efforts in the region. By providing a latest census of fish biodiversity in the Al-Wajh region, the study serves as a valuable resource for researchers, conservationists, and policymakers. The data collected can contribute to the understanding of local fish populations, their ecological interactions, and the potential impacts of human activities on their habitats. Moreover, the study's focus on creating awareness about fish populations in the area is crucial for promoting conservation efforts. Increased awareness can lead to the implementation of sustainable fishing practices, the establishment of marine protected areas, and the development of conservation strategies to preserve the unique marine biodiversity of the Al-Wajh region.

MATERIALS AND METHODS

Sampling sites

In the Al-Wajh region, a comprehensive research study was conducted at 30 carefully selected study sites (Fig. 1). These sites were chosen to facilitate various research objectives. The study sites were categorized into three groups: near shore, small coral patch and offshore stations. The near shore stations, designated as S1 to S16, were strategically located close to the shoreline. These sites were specifically chosen to examine phenomena and collect data related to the coastal areas of the Al-Wajh region. The proximity to the shore allowed for detailed investigations of near shore ecosystems, coastal processes, and related factors. Stations S17 to S18 can be considered as small coral patches even though it is located offshore. On the other hand, the offshore stations, labelled as S19 to S30, were positioned farther from the shoreline. These sites were selected to explore phenomena and gather data pertaining to the offshore areas of the Al-Wajh region. The offshore stations enabled researchers to investigate deep-sea ecosystems, oceanic processes, and other relevant aspects beyond the coastal zone.

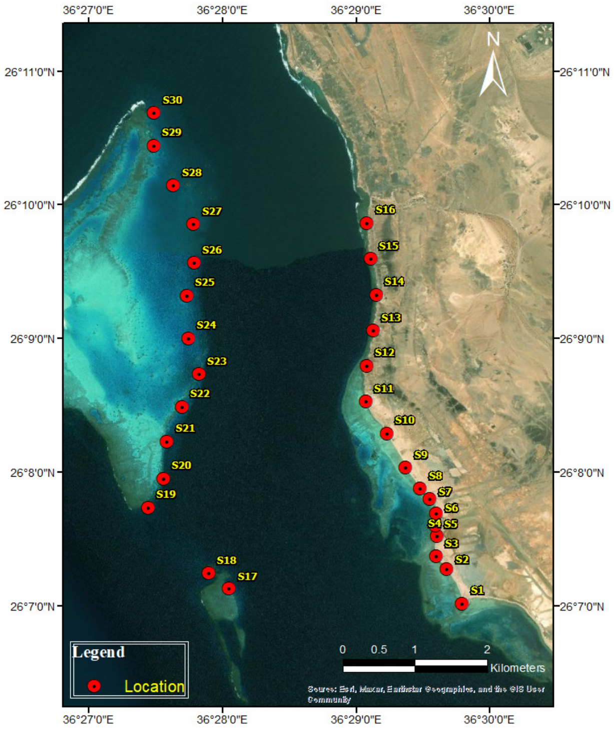

Fig. 1. Map showing the study sites in the Al-Wajh region.

Fish census strategy

In the fish counting method included, a transect sampling technique called the PIT (Point Intercept Transect) method was utilized (Hill and Wilkinson, 2004). The PIT method involves setting up a transect line in the water and visually surveying the area around it to estimate fish abundance. A transect line was established as a reference point, serving as the middle line for a belt transect. The belt transect consisted of segments that were 5 meters wide. Each segment was 20 meters long, and they were spaced apart by 5-meter gaps. By using this arrangement, the total surface area covered for the fish visual census was 400 square meters (5 meters wide × 20 meters long = 100 square meters per segment, with 4 segments per belt transect, resulting in a total of 400 square meters). During the fish census, observers moved along the transect line, visually scanning the area within the 5-meters wide belt for fish presence. The fish encountered within this belt were recorded and counted. The observer's line of sight was focused on the area around the PIT, which served as a reference point for the survey. This method allowed for systematic sampling along the transect line, ensuring that a representative area was covered to estimate fish abundance. The 5-meter width of the belt transect provided a standardized area for assessment, and the 20-meter segment length facilitated efficient data collection. By employing the PIT method with these specific parameters, researchers could estimate the number of fish within the surveyed area and gain insights into the fish population in that particular habitat. To current study employed various survey methods and techniques. These may include underwater visual surveys, snorkelling or diving expeditions, and the use of scientific equipment such as underwater cameras or nets to capture fish specimens for identification. The surveys were conducted across different habitats within the region, including coral reefs, sea grass beds, and rocky shores, to obtain a comprehensive assessment of fish biodiversity. The graphical representations are created using ORIGIN60, while the statistical analysis, one-way ANOVA, is performed to determine the variation in fish abundance and species numbers using PAST4.03.

RESULTS

Fish abundances

The current study conducted in the region revealed a significant number of fish species, highlighting the diverse marine ecosystem. The study yielded a noteworthy total of 5202 individuals per 100 m^2, offering valuable insights into the abundance and distribution of fish populations in the region. To assess the density of fish populations, the study examined 30 different stations, including both near shore and offshore areas. The average density of fish specimens across these stations was calculated to be 173±113 individuals per 100 m^2 (Fig. 2). This measurement takes into account the variation in fish density observed across the sampled locations. The results of the study indicate that the near shore station exhibited higher fish abundances compared to the offshore stations. On average, the near shore station had a fish abundance of 204±95.60 individuals per 100 m^2, whereas the offshore stations had an average fish abundance of 94±60 individuals per 100 m^2. The coral patch stations recorded an average abundance of 393±113 individuals per 100 m^2 (Fig. 3). However, it is worth noting that despite the generally higher abundances observed in the near shore area, there was an exception in the offshore region. Station S18, situated in the offshore area exhibited the highest fish abundance throughout the study period, with a recorded count of 473 individuals per 100 m^2. On the other hand, the lowest fish abundance of 17 individuals per 100 m^2 was observed at station S26, also located in the offshore region.

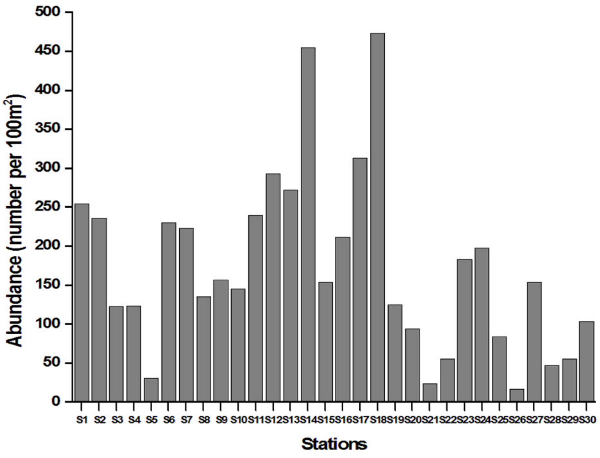

Fig. 2. Fish abundances (number/100m^2) obtained from different stations during the study period.

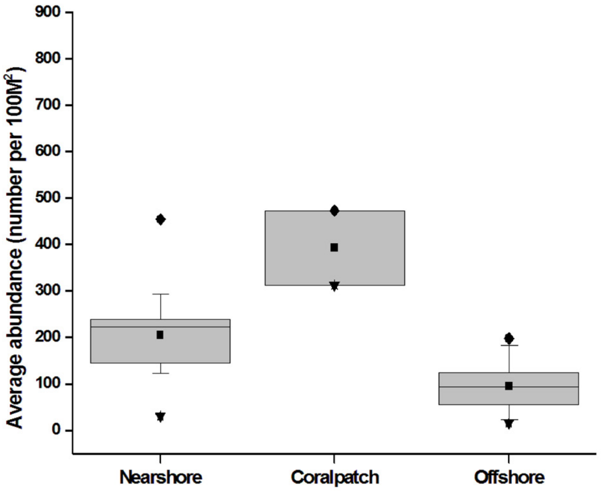

Fig. 3. Average fish abundances obtained from the different zones during the study period (the whiskers represent the 25th and 75th percentile (lower and upper, respectively), the median is a solid line, the mean is indicated by a black square, and the error bars represents the variation within the region).

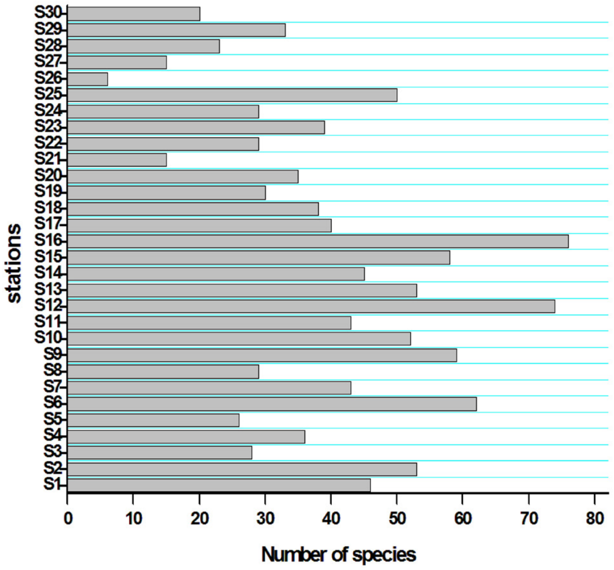

Fig. 4. Number of species obtained from different stations during the study period.

Species diversity

In the present study, a total of 117 distinct fish species were identified, representing a diverse range spanning 31 different families**.** Within the entire study region, station S12, located in the coastal zone recorded the highest number of species, with a total of 76. In contrast; station S26, situated in the offshore region recorded the lowest number of species, with only 6 observed (Fig. 4). The study conducted during the specified period revealed notable variations in the number of fish species observed across different stations. Coastal stations displayed a higher number of fish species on average, with an average of 49±15 species, compared to the offshore stations, which had an average of 27±12 species. The coral patch station observed with an average species number of 39±1 (Fig. 5).

During the study period, the research documented the presence of 117 fish species distributed among 31 different families (Table I). Among these families, Family Labridae exhibited the highest number of species, with a total of 16. This family, known as the wrasses, demonstrated a diverse representation within the study area. Following closely behind, the family Scaridae, commonly known as parrotfishes, was observed with 13 species, indicating their significant presence in the surveyed locations. Two families, Cheatodontidae and Serranidae, were tied with 10 species each. Cheatodontidae, also known as the squirrelfishes, and Serranidae, the group that includes groupers, exhibited a notable level of species richness during the study. Additionally, the family Acanthuridae, which encompasses surgeonfishes, was observed with 9 species, further contributing to the overall diversity of fish populations. Another noteworthy family in terms of species count was Pomacanthidae, which recorded 8 different species. Pomacanthidae, commonly referred to as angelfishes, showcased a significant presence within the study area, further adding to the overall variety of fish species.

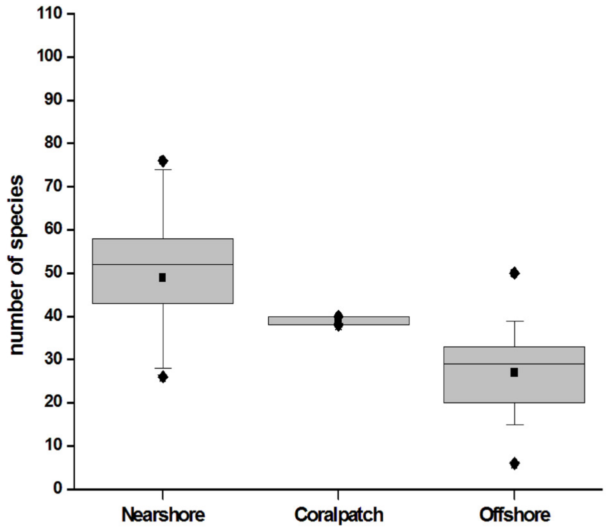

Fig. 5. Average Number of species obtained from different zones during the study period (the whiskers represent the 25th and 75th percentile (lower and upper, respectively), the median is a solid line, the mean is indicated by a black square, and the error bars represents the variation within the region).

The family Labridae played a crucial role in the present study, encompassing several important species that contributed to the overall fish diversity within the surveyed area. The following species were identified as significant representatives of the Labridae family: *Cheilinus abudjubbe* Rüppell, 1835, *Cheilinus fasciatus* (Bloch, 1791), *Cheilinus lunulatus* (Forsskål in Niebuhr, 1775), *Cheilinus undulatus* Rüppell, 1835, *Coris aygula* Lacepède, 1801, *Hemigymnus sexfasciatus* (Bloch, 1792), *Anampses twistii* Bleeker, 1856, *Oxycheilinus digramma* (Lacepède, 1801), *Thalassoma rueppellii* (Klunzinger, 1871), *Gomphosus caeruleus* Lacepède, 1801, *Labroides dimidiatus* (Valenciennes, 1839), *Halichoeres hortulanus* (Lacepède, 1801), *Halichoeres marginatus* Rüppell, 1835, *Epibulus insidiator* (Pallas, 1770), *Pseudocheilinus hexataenia* (Bleeker, 1857) and *Bodianus anthioides* (Bennett, 1832).These species collectively represent a diverse range of morphological characteristics, ecological roles, and behaviors within the Labridae family. Each species likely occupies specific niches and contributes to the

Table I. Comprehensive list of Families and observed Species along with their feeding habits in the current study.

Fish family	Fish species	Feeding habit
Acanthuridae	*Acanthurus gahhm* (Forsskål, 1775)	Herbivorous
	Acanthurus nigrofuscus (Forsskål, 1775)	Herbivorous
	Acanthurus sohal (Forsskål, 1775)	Herbivorous
	Ctenochaetus striatus (Quoy and Gaimard, 1825)	Herbivorous
	Zebrasoma desjardinii (Bennett, 1836)	Herbivorous
	Zebrasoma xanthurum (Blyth, 1852)	Herbivorous
	Naso elegans (Rüppell, 1829)	Herbivorous
	Naso hexacanthus (Bleeker, 1855)	Herbivorous
	Naso lituratus (Forster, 1801)	Herbivorous
Scaridae	*Cetoscarus bicolor* (Rüppell, 1829)	Herbivorous
	Chlorurus genazonatus (Randall and Bruce, 1983)	Herbivorous
	Chlorurus gibbus (Rüppell, 1829)	Herbivorous
	Chlorurus sordidus (Forsskål in Niebuhr, 1775)	Herbivorous
	Chlorurus spilurus (Valenciennes, 1840)	Herbivorous
	Hipposcarus harid (Forsskål in Niebuhr, 1775)	Omnivorous
	Scarus collana (Rüppell, 1835)	Herbivorous
	Scarus ferrugineus (Forsskål in Niebuhr, 1775	Herbivorous
	Scarus frenatus (Lacepède, 1802)	Omnivorous
	Scarus fuscopurpureus (Klunzinger, 1871)	Herbivorous
	Scarus niger (Forsskål in Niebuhr, 1775	Herbivorous
	Calotomus viridescens (Rüppell, 1835)	Herbivorous
	Cetoscarus ocellatus (Valenciennes, 1840)	Herbivorous
Siganidae	*Siganus argenteus* (Quoy and Gaimard, 1825)	Herbivorous
	Siganus luridus (Rüppell, 1829)	Herbivorous
	Siganus rivulatus Forsskål, 1775)	Herbivorous
Pomacentridae	*Stegastes lacrymatus* (Quoy and Gaimard, 1825)	Omnivorous
	Plectroglyphidodon leucozonus (Bleeker, 1859)	Omnivorous
	Stegastes nigricans (Lacepède, 1802)	Omnivorous
	Pycnochromis dimidiatus (Klunzinger, 1871)	Carnivorous
	Pomacentrus sulfureus (Klunzinger, 1871)	Omnivorous
	Dascyllus aruanus (Linnaeus, 1758)	Omnivorous
Chaetodontidae	*Chaetodon auriga* (Forsskål in Niebuhr, 1775)	Omnivorous
	Chaetodon austriacus (Rüppell, 1836)	Omnivorous
	Chaetodon fasciatus (Forsskål in Niebuhr, 1775)	Omnivorous
	Chaetodon larvatus (Cuvier, 1831)	Omnivorous
	Chaetodon lineolatus (Cuvier, 1831)	Omnivorous
	Chaetodon melannotus (Bloch and Schneider, 1801)	Omnivorous
	Chaetodon paucifasciatus (Ahl, 1923)	Omnivorous

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Fish family	Fish species	Feeding habit
	Chaetodon semilarvatus (Cuvier, 1831)	Omnivorous
	Chaetodon trifascialis (Quoy and Gaimard, 1825)	Omnivorous
	Heniochus intermedius (Steindachner, 1893)	Carnivorous
Pomacanthidae	*Pomacanthus asfur* (Forsskål in Niebuhr, 1775)	Omnivorous
	Pomacanthus imperator (Bloch, 1787)	Omnivorous
	Pomacanthus maculosus (Forsskål in Niebuhr, 1775)	Omnivorous
	Amphiprion bicinctus (Rüppell, 1830)	Omnivorous
	Chromis viridis (Cuvier, 1830)	Herbivorous
	Abudefduf saxatilis (Linnaeus, 1758)	Omnivorous
	Pygoplites diacanthus (Boddaert, 1772)	Omnivorous
	Amblyglyphidodon indicus (Allen and Randall, 2002	Omnivorous
Balistidae	*Balistapus undulatus* (Park, 1797)	Carnivorous
	Balistoides viridescens (Bloch and Schneider, 1801)	Omnivorous
	Pseudobalistes fuscus (Bloch and Schneider, 1801)	Carnivorous
	Rhinecanthus assasi (Forsskål in Niebuhr, 1775)	Omnivorous
	Sufflamen albicaudatum (Rüppell, 1829)	Carnivorous
Tetraodontidae	*Arothron diadematus* (Rüppell, 1829)	Carnivorous
	Arothron stellatus (Bloch and Schneider, 1801)	Carnivorous
	Ostracion cubicum (Linnaeus, 1758)	Omnivorous
Serranidae	*Aethaloperca rogaa* (Forsskål in Niebuhr, 1775)	Carnivorous
	Cephalopholis argus (Bloch and Schneider, 1801)	Carnivorous
	Cephalopholis hemistiktos (Rüppell, 1830)	Carnivorous
	Cephalopholis miniata (Forsskål in Niebuhr, 1775)	Carnivorous
	Epinephelus chlorostigma (Valenciennes, 1828)	Carnivorous
	Epinephelus lanceolatus (Bloch, 1790)	Carnivorous
	Epinephelus polyphekadion (Bleeker, 1849)	Carnivorous
	Epinephelus tukula (Morgans, 1959)	Carnivorous
	Pseudanthias squamipinnis (Peters, 1855)	Omnivorous
	Variola louti (Forsskål in Niebuhr, 1775)	Carnivorous
Lutjanidae	*Lutjanus ehrenbergii* (Peters, 1869)	Carnivorous
	Lutjanus fulviflamma (Rüppell, 1830)	Carnivorous
	Lutjanus russellii (Bleeker, 1849)	Carnivorous
	Lutjanus bengalensis (Bloch, 1790)	Carnivorous
Haemulidae	*Plectorhinchus flavomaculatus* (Cuvier, 1830)	Carnivorous
	Plectorhinchus gaterinus (Forsskål in Niebuhr, 1775)	Carnivorous
	Plectorhinchus gaterinus (Forsskål, 1775)	Carnivorous
Lethrinidae	*Lethrinus harak* (Forsskål in Niebuhr, 1775)	Carnivorous
	Lethrinus mahsena (Forsskål in Niebuhr, 1775)	Carnivorous
Carangidae	*Carangoides ferdau* (Forsskål in Niebuhr, 1775)	Carnivorous

Table continued on next page..........

Fish family	**Fish species**	**Feeding habit**
	Carangoides fulvoguttatus (Forsskål in Niebuhr, 1775)	Carnivorous
Labridae	*Cheilinus abudjubbe* (Rüppell, 1835)	Carnivorous
	Cheilinus fasciatus (Bloch, 1791)	Carnivorous
	Cheilinus lunulatus (Forsskål in Niebuhr, 1775)	Carnivorous
	Cheilinus undulatus (Rüppell, 1835)	Carnivorous
	Coris aygula (Lacepède, 1801)	Omnivorous
	Hemigymnus sexfasciatus (Bloch, 1792)	Carnivorous
	Anampses twistii (Bleeker, 1856)	Omnivorous
	Oxycheilinus digramma (Lacepède, 1801)	Omnivorous
	Thalassoma rueppellii (Klunzinger, 1871)	Omnivorous
	Gomphosus caeruleus (Lacepède, 1801	Carnivorous
	Labroides dimidiatus (Valenciennes, 1839)	Omnivorous
	Halichoeres hortulanus (Lacepède, 1801)	Omnivorous
	Halichoeres marginatus (Rüppell, 1835)	Omnivorous
	Epibulus insidiator (Pallas, 1770)	Carnivorous
	Pseudocheilinus hexataenia (Bleeker, 1857)	Omnivorous
	Bodianus anthioides (Bennett, 1832)	Carnivorous
Dasyatidae	*Taeniura lymma* (Forsskål, 1775)	Carnivorous
Muraenidae	*Gymnothorax javanicus* (Bleeker, 1859)	Carnivorous
Scorpaenidae	*Pterois miles* (Bennett, 1828)	Carnivorous
Holocentridae	*Sargocentron spiniferum* (Forsskål, 1775)	Carnivorous
	Neoniphon sammara (Forsskål, 1775)	Carnivorous
	Myripristis berndti (Jordan and Evermann, 1903)	Carnivorous
Cirrhitidae	*Paracirrhites forsteri* (Schneider, 1801)	Carnivorous
Apogonidae	*Cheilodipterus quinquelineatus* (Cuvier, 1828)	Carnivorous
Pempheridae	*Pempheris adusta* (Bleeker, 1877)	Carnivorous
Pinguipedidae	*Parapercis hexophtalma* (Cuvier, 1829)	Carnivorous
Pseudochromidae	*Pseudochromis flavivertex* (Rüppell, 1835)	Carnivorous
Myliobatidae	*Myliobatis aquila* (Linnaeus, 1758)	Carnivorous
Mullidae	*Parupeneus forsskali* (Fourmanoir and Guézé, 1976)	Carnivorous
	Parupeneus cyclostomus (Lacepède, 1801)	Carnivorous
	Mulloidichthys vanicolensis (Valenciennes, 1831)	Carnivorous
Caesionidae	*Caesio suevica* (Klunzinger, 1884)	Herbivorous
	Caesio striata (Rüppell, 1830)	Herbivorous
Ptereleotrinae	*Ptereleotris evides* (Jordan and Hubbs, 1925)	Carnivorous
	Priacanthus hamrur (Forsskål, 1775)	Carnivorous
Priacanthidae	*Heteropriacanthus cruentatus* (Lacepède, 1801)	Carnivorous
Nemipteridae	*Scolopsis ghanam* (Forsskål, 1775)	Carnivorous
Synodontidae	*Synodus intermedius* (Spix and Agassiz, 1829)	Carnivorous
Belonidae	*Tylosurus choram* (Rüppell, 1837)	Carnivorous

overall functioning and biodiversity of the fish community. The family Scaridae is predominantly represented by two major genera, *Chlorurus* and *Scarus*. In contrast, the family Cheatodontidae is heavily represented by the genus *Chaetodon*. The detailed list of families, species and the feeding behaviour of each species are given in Table I.

DISCUSSION

The findings of the current study provide valuable insights into the abundance, distribution, and diversity of fish populations within the studied region. The study documented a significant number of fish species, highlighting the presence of a diverse marine ecosystem. The close proximity of Al-Wajh banks, a highly productive area, situated in the thriving Red Sea region (Racault *et al*., 2015; Devassy *et al*., 2017), may have played a significant role in fostering the remarkable abundances and diversity observed in the current study. The Al-Wajh banks hold ecological importance as they support the biodiversity and overall health of the Red Sea ecosystem (Atta *et al*., 2019). Coral reefs, in particular, play a crucial role in maintaining the balance of marine ecosystems, providing shelter, breeding grounds, and food sources for numerous species (Bruckner *et al*., 2012). These reefs also act as a natural barrier, protecting the coastline from erosion and providing essential ecosystem services. The current study observed significant variations in fish abundances between the near shore and offshore regions of the Red Sea (F= 3.09, P<0.01). Precisely, the near shore stations showed a higher number of fish compared to the offshore stations, highlighting the critical importance of the coral reef ecosystem for the thriving fish populations in the Red Sea (Pratchett *et al*., 2011; Roberts *et al*., 1992; Atta *et al*., 2019). In contrary, the current study documented the highest density reported from one of the offshore stations (St 18). This particular station likely provided highly favourable conditions for fish populations to thrive, resulting in a high fish density in the surveyed area. The location of this site likely contributed to the increased fish abundance, as offshore regions often offer various ecological benefits for fish, including suitable habitats, ample food availability, and favourable environmental conditions. On the other hand, the study also revealed the lowest fish abundance in the offshore region (stations S19-S30). This particular station exhibited significantly fewer fish compared to other surveyed areas. Several factors could contribute to this low abundance, such as less favourable habitat conditions including coral densities, limited food resources due to sheltered conditions, unfavourable environmental factors, or other ecological variables that negatively impact fish populations in that specific location. It's also possible that these stations represent an area where fish populations naturally tend to be lower, potentially due to specific oceanographic or ecological characteristics. The observed contrasting fish abundances within the offshore stations emphasize the spatial variability in fish populations within the offshore region and are known to happen in the Red Sea (Brokovich *et al*., 2006; Isari *et al*., 2017). These findings highlight the importance of considering the specific locations and habitats within the offshore area when studying and managing fish populations to gain an accurate understanding of their dynamics and address their conservation needs. Such variations can arise from a combination of factors, including differences in habitat quality, availability of food resources, oceanographic processes, and local environmental conditions (Sawall *et al*., 2014).

The coastal stations consistently recorded a higher number of species compared to the offshore stations, indicating greater species diversity in near shore areas (F=20.03, P<0.001). This finding is well in accordance with the previous studies happened in the region (Pratchett *et al*., 2011; Roberts *et al*., 1992; Atta *et al*., 2019). This, coupled with the higher fish abundances observed in the coastal stations, provides clear evidence of the thriving nature of reef-associated fishes in the study region. These findings align with similar patterns observed in other regions of the Red Sea, highlighting the importance of reef ecosystems in supporting diverse and abundant fish populations (Khalil *et al*., 2017: Roberts *et al*., 1992). The high species richness observed at one of the coastal stations may be attributed to various factors such as the availability of diverse habitats, nutrient inputs from coastal environments, and proximity to other important ecosystems sea (Khalaf and Kochzius, 2002). These factors likely contribute to the overall ecological significance of the Al-Wajh banks in supporting such findings. The Al-Wajh banks play an important role in providing suitable habitats, nutrient sources, and connections to other ecosystems, which in turn support the high species richness observed in the coastal areas (Bruckner *et al*., 2012). This finding implies that the offshore area represented a less diverse habitat for fish species. The offshore region might lack certain ecological features or environmental conditions required to sustain a wide range of fish species. Factors such as reduced food availability, limited habitat complexity, or specific oceanographic characteristics specific to the offshore region could have contributed to the lower species richness observed at this station. The variations in species numbers between coastal and offshore stations, as well as the contrasting results between the stations with higher and lower species richness, highlight the significance of habitat types and environmental conditions in shaping fish species diversity (Beukers and Jones, 1998; Gratwicke and Speight, 2005). Understanding these patterns is crucial for effective conservation and management of fish populations, as well as informing decisions related to coastal and offshore ecosystem protection and sustainable resource utilization.

In terms of species diversity, the Labridae family, commonly known as wrasses, emerged as the most important family in the present study. Wrasses are a diverse and vibrant group of fish found in oceans worldwide. They are known to inhabit various marine environments, including coral reefs, rocky shores, seagrass beds, and sandy bottoms (Fulton *et al*., 2001; Westneat, 2001) and are well known to dominate the coastal waters of the Red Sea (Khalaf and Kochzius, 2002). The Al-Wajh region's wide range of habitats likely provides suitable conditions for wrasses to thrive, contributing to their prominence in the study area. The availability of diverse habitats within the Al-Wajh region likely aligns with the preferred lifestyles and ecological requirements of wrasses, allowing them to establish and flourish in the region. Wrasses exhibit a wide range of feeding behaviors, with certain species being herbivorous and feeding on algae and seagrasses, while others are carnivorous and prey on small invertebrates, crustaceans, or even other fish (Rice and Westneat, 2005; Clements and Choat, 2018). The availability of suitable habitats, combined with the abundance and diversity of food resources, likely contributes to the dominance of wrasses in the Al-Wajh region. This combination of factors provides favourable conditions for the feeding preferences and ecological requirements of various wrasse species, allowing them to thrive and establish their dominance in the region. In addition to their diversity and dominance in the Al-Wajh region, Labridae species, or wrasses, play crucial roles in reef ecosystems. These fish contribute to the overall health and balance of reef ecosystems through various ecological functions. Overall, Labridae species in reef ecosystems, including the ones found in the Al-Wajh region, play important roles in algae control, cleaning symbiosis, and the maintenance of ecological balance (Grutter, 1996; Bellwood *et al*., 2004; Burkepile and Hay, 2006; Bellwood and Choat, 2011; Grutter *et al*., 2020). Their diverse feeding behaviors and ecological functions contribute to the overall health, resilience, and functioning of coral reefs and other associated marine habitats. So, the ecosystem in the Al-Wajh region benefits from the dominance of Wrasses.

The second most important family, Scaridae, commonly known as parrotfishes, represents a distinct and ecologically significant group of fish found in tropical and subtropical marine environments (Arai *et al*., 2015). Parrotfishes possess unique morphological features, such as their parrot-like beaks, which are specialized for feeding on coral polyps, algae, and other organic material. These adaptations likely contribute to their successful adaptation and thriving in the Al-Wajh reef area. Parrotfishes play a crucial role in the ecology of coral reefs. They graze on the reef surface, consuming algae and dead coral, which helps control the growth of algae and promotes the health and growth of corals. By feeding on algae, they contribute to maintaining a balance between coral growth and algae proliferation, preventing the overgrowth of algae that could otherwise smother corals (Bellwood and Choat, 1990; Hoey and Bellwood, 2008; Bonaldo *et al*., 2014; Shantz *et al*., 2020). This grazing behavior is essential for the overall health and resilience of the reef ecosystem. Overall, the distinctive feeding habits and ecological functions of parrotfishes, combined with their adaptability to the Al-Wajh reef area, make them an ecologically important group. Their grazing activities help control algae growth, promote coral health, and contribute to the ecological balance and resilience of the reef ecosystem in Al-Wajh and beyond.

The Chaetodontidae family, commonly known as butterflyfishes, represents another important group of fish that are well adapted to marine habitats with high corals density similar to the Al-Wajh region. Butterflyfishes are renowned for their diversity and captivating appearance, and they are commonly found in tropical and subtropical marine habitats, including coral reefs (Roberts, 1986; Roberts *et al*., 1992). Butterflyfishes possess a compressed body shape, which enables them to navigate effortlessly through coral branches and crevices (Berumen and Pratchett, 2008). This morphology allows them to explore and take advantage of the intricate habitat structures within reef ecosystems. Their ability to maneuver within the reef habitat is crucial for finding shelter, food sources, and suitable breeding sites (Harmelin-Vivien, 1989; Pratchet, 2007; Russ and Leahy, 2017). Their compressed body shape, maneuverability, and specialized feeding adaptations allow them to thrive in the complex reef structures and feed on small invertebrates within the ecosystem. As visually captivating members of the fish community, they contribute to both the ecological balance and aesthetic appeal of reef ecosystems.

CONCLUSION

In conclusion, the findings of the current study provide valuable insights into the abundance, distribution, and diversity of fish populations in the studied region, particularly in the Al-Wajh area. The study highlights the importance of the Al-Wajh banks in supporting diverse fish communities and the ecological significance of coral reefs in maintaining the health and balance of the Red Sea ecosystem. The study demonstrates the spatial variability in fish abundances between near shore and offshore regions, emphasizing the importance of considering specific locations and habitats in studying and managing fish populations. Additionally, the dominance of wrasses, parrotfishes, and butterflyfishes in the Al-Wajh region underscores their adaptability and ecological importance within reef ecosystems. Overall, these findings contribute to our understanding of the complex dynamics and conservation needs of fish populations, highlighting the significance of habitat types, environmental conditions, and species interactions in shaping the marine biodiversity and maintaining the ecological balance in the Al-Wajh region and similar reef ecosystems.

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