The Possibility of Applying Citizen Science in the Countries Bordering the Arabian Peninsula

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Abstract Citizen science, known as the contribution of the general public in scientific research, could considerably aid scientists to adopt biodiversity issues, through observing the state of biodiversity, outlining indicators which synthesize and communicate information on the state of biodiversity and construct states to assess the reasonable values of different policies. This sort of partnership stimulates both the scientific competence and social validity of these tools, so that they can implicitly notify debates and decisions on public policy.

Missions that include citizen scientists are increasing, chiefly in ecology and the environmental subjects, while the origins of citizen science originated in the early stages of contemporary science itself.

In the present chapter, a call is put forward to the policy makers in the countries bordering the Arabian Peninsula to involve citizen scientist in biodiversity, ecological and environmental studies. Such involvement will increase the knowledge of the fields they will work on and provide wide base of data for the professional scientists in performing their different projects. An example of the contribution of the citizen scientist in the biodiversity and ichthyology activities of the author in certain countries bordering the Arabian Peninsula was given and explained in this chapter. Within a short period of time, large number of fish species recorded new for their new habitats and huge number of abnormality cases were revealed with the assistant of the citizen scientists that provide the fish specimens and made them available for the author of this chapter.

As a recommendation, the citizen scientists' contribution should be looked after and developed in the states neighbouring the Arabian Peninsula. This area is poorly studied from different aspects such as biodiversity, ecology and other environmental sciences.

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L. A. Jawad (ed.), *The Arabian Seas: Biodiversity, Environmental Challenges and Conservation Measures*, https://doi.org/10.1007/978-3-030-51506-5_32

1 Introduction

To discuss the issue of citizen science, it is important to shed light on its history to realize the context of this science that has recently taken a prominent place in the natural history studies, for example, Goffredo et al. (2010).

Citizen science, similarly denoted to as society science or communal contribution in scientific findings, is a mounting effort that recruits the public in scientific studies, checking and research across a variety of field of knowledge. It ranges from microbiology (Cooper et al. 2010) to astronomy (Lintott et al. 2008); millions of non-specialists offered their time and ability to resolving problem skills to findings (Cardamone et al. 2009).

Citizen science was and is still in use since the time of Benjamin Franklin (1706–1790), who was a writer and political figure, and Charles Darwin (1809–1888), who worked on the board of Beagle as an unpaid companion of Captain Robert FitzRoy and not as a nature specialized person. This is in inconsistency with the paid professional, which emerge relatively recent not early than the second part of the nineteenth century (Silvertown 2009).

In the present time, a large number of citizen scientists work with professional colleagues on missions that have been precisely planned or changed to give laypersons a chance or the possibility, either for the teaching advantage of the helpers themselves or to assist in the project or for the benefit of both (Goffredo et al. 2010). The distinctive feature that obviously discerns present-day citizen science from what it has been in past time is that it is at the moment considered as a movement that is possibly accessible to all, not just to an advantaged few. Citizen scientists now contribute to different aspects of sciences of knowledge with the help of modern technology and computerization (Nadkarni and Stevenson 2009). As Silvertown (2009) stated, the causes behind the wide spread of citizen science in the present time can be due to and not restricted to:

1. The availability of effortlessly technical tools for distributing knowledge regarding studies and collecting figures from the community. The main factors here are the Internet and the transportable computing, which play a vital part and will perhaps develop with the spread of smart phones.
2. The cumulative assurance among expert scientists that the community embody a free source of work, assistances, computational power and economics (Cohn 2008; Goffredo et al. 2010).

The countries boarding the coasts of the Arabian Peninsula are rich in marine environmental habitats. These areas are mostly remote, and seldom there is a centre or institute that deals with marine biodiversity in particular and biodiversity in general. Besides these areas are out of reach of main cities and even villages, and they are usually visited by locals and nature lovers to enjoy the natural habitat at these places. Those locals and visitors from all nationalities can play a vital role in citizen science through collaborating with the institutes and organizations that protect biodiversity (Goffredo et al. 2010). In the present chapter, the issue of citizen

science has been shortly reviewed to show the challenges and the benefits for both the citizen and the professional scientists and to assess the applicability of this issue in the countries bordering the seas around the Arabian Peninsula.

2 What are the Challenges and Opportunities for Citizen Science

With the advancement of communication technology and with the development of computer science, citizen science has also advanced, and everyday more citizens are involved in this activity (Goffredo et al. 2010). To put the work of the citizen scientist in an acceptable perspective that can be applied globally, there are certain points that need to be considered when such framework is prepared.

There was always a possibility of trouble when requesting helpers to trip at their personal expenditure to precise locations to do studies conferring to the protocol of the examination techniques. Such a request might guarantee identical information collection, but on the other hand conveys the jeopardy of making contribution in the research scheme less willing and so dropping the number of helpers keen to contribute. In place of some thorough studies, the use of helpers would even be inappropriate as this type of surveys needs better knowledge in, for instance, taxa recognition and the capability to uphold interest and correctness. If loads are in addition pronounced, people will not take part (Greenwood 2007; Goffredo et al. 2010).

For any society, there are chief educational and social benefits from the participation as citizen helpers in technical studies. Such an involvement offers an environment in which participants involve in believed progressions like those that are part of science surveys and upsurge their acquaintance of ecology and environmental matters (Brossard et al. 2005).

3 Citizen Science in Countries Bordering the Arabian Peninsula in Its Early, but Promising, Stage

3.1 Diversity of Fishes as an Example of Contribution of Citizen Scientist

Scientific surveys, encompassing scientists and research vessels, would be expensive and insufficient to warrant good spatial analysis in countries like those bordering the

Arabian Peninsula that have long costal lines. In contrary, citizen scientists aim for groups that can provide information and would otherwise be lost and thus warrant rapid data flow.

The presence and spread of marine invasive species frequently pass unobserved as only few people are able to detect events under water, comprising, e.g. marine scientists and scuba divers.

In this section, a focus on the issue of the role citizen scientists at the present time in some countries bordering the shorelines of the Arabian Peninsula will be given. The information given in this section is based on the experience the author gained while servicing as fish diversity expert and consultant at the Ministry of Agriculture and Fisheries, Muscat, Sultanate of Oman, in the period 2008–2012. In addition, data from other countries in the area were also included.

It is not usual for any ichthyologist and specifically fish taxonomist to receive or obtain on a regular basis fish specimen(s) designated as a new record or even a new species to science to the area that he is working in. During my stay in the Sultanate of Oman, there was a regular delivery of fish specimen(s) caught by locals, divers and tourists from the waters around the coasts of Oman. In addition, reports about stranded large fish specimens were also received while I was there. Moreover, my weekly or sometimes daily visit to the main fish markets in Muscat ended in having specimen(s) shown to be a new record to Omani waters later on.

It is clear from Table 1 that the contribution of the citizen scientists in collecting fish samples, for example, is excellent. The information given in Table 1 contain description of 3 new fish species science (1 from Iraq and 2 from Oman) and 81 new records of fish (3 from Yemen, 3 from Saudi Arabia, 34 from Iraq and 41 from Oman). This contribution was for 9 years (2010–2019) for Oman and less period of time for the other countries. The example given in Table 1 is the scientific activity of the author of this chapter only. The number of species of aquatic and land organisms will certainly be higher if investigation is made about the activity of other scientists.

The scientific significance of the contribution of the citizen scientists drawn from the facts given in Table 1 can be seen mainly in certain groups of fishes described as new species to science and those recorded for the first time in a new locality. The seas bordering the Arabian Peninsula are still virgin in the sense of the number of marine organisms it contains. As a fish taxonomist and as an author of this chapter, I predict that at least 100 fish species can be described as new for science from the Omani waters alone in addition to several hundreds of species that can be a new record to this area. The waters around the Omani coasts are distinctive in having fish groups originating from different zoogeographical regions. As to the Arabian Gulf and Sea of Oman, those two water ways are considered important as they represent the international water path for the commercial and giant oil tankers. With such a nature, the possibility of invasion of marine organisms is very high.

The remarkable example that can be drawn from Table 1 is that of the members of the sunfish family Molidae. This family contains three genera and five species. The citizen scientists in Oman have assisted in collecting four species belonging to three genera, *Ranzania laevis*, *Mola mola*, *Mola ramsayi* and *Masturus lanceolatus*, out of

Table 1 Contribution of citizen scientists in providing fish specimens to the author of the chapter during his work on the fish fauna of the countries bordering the Arabian Peninsula

Species	Date of record/ description	Locality	Reference
Mobula diabolus (Shaw, 1804)	1972	Khor al-Zubair, north-west of the Arabian Gulf, Iraq	Al-Hassan and Al-Badri (1986)
Bregmaceros mcclellandi (Thompson, 1840)	–	–	–
Hippocampus kuda (Bleeker, 1852)	–	–	–
Carasobarbus luteus (Heckel, 1843)	1985	–	Al-Hassan and Muhsin (1986)
Heteropneustes fossilis (Bloch, 1794)	–	–	–
Rhinogobius brunneus (Temminck and Schlegel, 1845)	1987	Khor Abdullah, north-west of the Arabian Gulf, Iraq	Al-Hassan and Miller (1987)
Carasobarbus luteus (Heckel, 1843)	1993	Fao City, southern part of Iraq	Mohamed et al. (1993)
Raja pita (Fricke and Al-Hassan 1995)	1995	Khor al-Zubair, north-west of the Arabian Gulf, Iraq	Fricke and Al-Hassan (1995)
Peristedion cataphractum (Linnaeus, 1758)	2001	Coastal waters of Mukallah, Yemen	Jawad and Al-Badri (2004)
Neoharriotta pinnata (Schnakenbeck, 1931)	2009	Coast of Aden, Republic of Yemen	Ali et al. (2009)
Satyrichthys adeni (Lloyd, 1907)	–	–	–
Ranzania laevis (Pennant, 1776)	2010	Sea of Oman, Sultanate of Oman	Jawad et al. (2010)
Ranzania laevis (Pennant, 1776)	2011	Marine waters of Iraq	Jawad et al. (2011)
Hippocampus suezensis (Duncker, 1940)	2011	Sea of Oman, Sultanate of Oman	Jawad et al. (2011)
Tenualosa toli (Valenciennes, 1847)	–	–	Jawad et al. (2011)
Gymnocranius griseus (Temminck and Schlegel 1843)	–	Arabian Sea coasts of Oman	Jawad et al. (2011)
Johnius (*Johnius*) *majan* (Iwatsuki, Jawad, Al-Mamry)	2012	–	Iwatsuki et al. (2012)
Mola ramsayi (Giglioli, 1883)	–	Sea of Oman, Sultanate of Oman	Jawad et al. (2012a)
Equulites klunzingeri (Steindachner, 1898)	–	–	Jawad et al. (2012d)
Caranx lugubris (Poey, 1880)	2012	–	Jawad (2012)

(continued)

Table 1 (continued)

Species	Date of record/ description	Locality	Reference
Atractoscion aequidens	2012	–	Jawad et al. (2012c)
Acanthopagrus catenula	2012	–	Jawad et al. (2012c)
Tripterodon orbis (Playfair, 1867)	2012	Arabian Sea coasts of Oman	Jawad et al. (2012b)
Equulites elongatus (Günther, 1874)	2013	–	Jawad et al. (2013c)
Masturus lanceolatus (Liénard, 1840)	2013	Sea of Oman, Sultanate of Oman	Jawad et al. (2013a)
Gazza minuta (Bloch, 1795)	2013	–	Jawad and Al-Mamry (2013b)
Mola mola (Linnaeus, 1758)	2013	–	Jawad et al. (2013b)
Pempheris schwenkii (Bleeker 1855)	2013	Arabian Sea coasts of Oman	Jawad and Koeda (2013)
Pempheris mangula (Cuvier 1829)	–	–	–
Uranoscopus crassiceps (Alcock, 1890)	–	–	Fricke et al. (2013)
Plectorhinchus pictus (Tortonese 1936)	–	–	Jawad et al. (2013c)
Satyrichthys adeni (Lloyd 1907)	–	–	–
Chascanopsetta lugubris (Alcock 1894)	–	–	–
Parapterois macrura (Alcock, 1896)	–	–	Matsunuma et al. (2013)
Umbrina robinsoni (Gilchrist and Thompson, 1908)	–	Sea of Oman, Sultanate of Oman	Jawad and Al-Mamry (2013a)
Monodactylus argenteus (Linnaeus, 1758)	–	Jubail, Saudi Arabia, Arabian Gulf	Jawad et al. (2013a)
Plectorhinchus playfairi (Pellegrin, 1914)	–	Jubail, Saudi Arabia, Arabian Gulf	Jawad and Ibrahim (2013)
Taractes rubescens (Jordan and Evermann, 1887)	2014	Sea of Oman, Sultanate of Oman	Jawad et al. (2014c)
Lophiomus setigerus (Vahl, 1797)	–	Marine waters of Iraq	Jawad and Al-Badri (2014)
Nemipterus zysron (Bleeker, 1856)	–	–	–
Parascolopsis eriomma (Jordan and Richardson, 1909)	–	–	–
Opisthognathus muscatensis Boulenger, 1888	–	–	Hussain and Jawad (2014)

(continued)

Table 1 (continued)

Species	Date of record/ description	Locality	Reference
Trachinotus baillonii (Lacepède, 1801)	–	–	–
Atrobucca nibe (Jordan & Thompson, 1911)	–	–	–
Iniistius pavo (Valenciennes, 1840)	–	Sea of Oman, Sultanate of Oman	Jawad et al. (2014c)
Antennarius indicus (Schultz, 1964)	–	Marine waters of Iraq	Jawad and Hussain (2014)
Equulites elongatus (Günther, 1874)	–	–	–
Cheilinus lunulatus (Forsskål, 1775)	–	–	–
Callionymus omanensis (Fricke, Jawad, Al-Mamry, 2014)	–	Arabian Sea coasts of Oman	Fricke et al. (2014)
Monocentris japonica (Houttuyn, 1782)	–	Khor Abdullah, north-west of the Arabian Gulf, Iraq	Jawad et al. (2014d)
Naso unicornis (Forsskål, 1775)	–	Arabian Sea coasts of Oman	Al-Shogebai et al. (2014)
Acanthopagrus catenula (Lacepède, 1801)	–	Marine waters of Iraq	Al-Badri and Jawad (2014)
Zebrasoma xanthurum (Blyth, 1852)	–	–	–
Plectorhinchus sordidus (Kluzinger 1870)	–	–	Jawad et al. (2014a)
Pomadasys olivaceus (Day 1875)	–	–	–
Pomadasys punctulatus (Rüppell 1838)	–	–	–
Takifugu oblongus (Bloch, 1786)	2015	Sea of Oman, Sultanate of Oman	Jawad and Pitassy (2015)
Lobotes surinamensis (Bloch, 1790)	–	–	Jawad et al. (2015)
Bodianus macrognathos (Morris, 1974)	–	Marine waters of Iraq	Jawad and Al-Badri (2015)
Coris nigrotaenia (Mee and Hare, 1995)	–	–	–
Bothus pantherinus (Rüppell, 1830)	–	–	–
Argyrosomus heinii (Steindachner, 1902)	–	–	Jawad et al. (2015)
Atractoscion aequidens (Cuvier, 1830)	–	–	–

(continued)

Table 1 (continued)

Species	Date of record/ description	Locality	Reference
Johnius majan Iwatsuki (Jawad and Al-Mamry 2012)	–	–	–
Osteomugil cunnesius (Valenciennes, 1836)	–	–	–
Naso brevirostris (Cuvier, 1829)	2016	Sea of Oman, Sultanate of Oman	Al-Mamry et al. (2016)
Conger macrocephalus (Kanazawa, 1958)	2017	Arabian Sea coasts of Oman	Smith et al. (2017)
Megalops cyprinoides (Broussonet, 1782)	–	Arabian Gulf coast of Oman	Jawad and Al-Mamry (2018a)
"*Congromuraena*" *musteliceps* (Alcock, 1894)	–	–	–
Xenomystax trucidans (Alcock, 1894)	–	–	–
Gymnocranius cf. *grandoculis*	2018	Arabian Gulf coast of Oman	Al-Marzouqi et al. (2018)
Decapterus muroadsi (Temminck and Schlegel, 1843)	–	Sea of Oman, Sultanate of Oman	Jawad and Al-Mamry (2018b)
Xiphias gladius (Linnaeus, 1758)	–	–	Al-Mamry and Jawad (2018a)
Lutjanus rivulatus (Cuvier, 1828)	–	Arabian Gulf coast of Oman	Jawad et al. (2018c)
Mene maculata (Bloch and Schneider, 1801)	–	Sea of Oman, Sultanate of Oman	Jawad et al. (2018b)
Lutjanus erythropterus Bloch, 1790	–	–	–
Tylosurus crocodilus (Péron and Lesueur, 1821)	–	–	Al-Mamry and Jawad (2018b)
Epinephelus diacanthus (Valenciennes, 1828)	2019	Jubail, Saudi Arabia, Arabian Gulf	Jawad and Ibrahim (2018e)
Rhincodon typus (Smith, 1828)	–	Khor al-Zubair, Shatt al-Arab River, Iraq	Jawad et al. (2019a)
Epinephelus lanceolatus (Bloch, 1790)	–	Shatt al-Arab Estuary, Basrah, Iraq	Jawad et al. (2019b)
Serrasalmus maculatus (Kner, 1858)	–	Tigris River, Baghdad, Iraq	Jawad and Qasim (2019)

Fish specimens were described either as new species to science or as a new record to the new area they were found in. Species are arranged according to the date of the description or record

five species consisting the family. I am quite sure that the fifth species of the family could also be recorded from the Omani waters if longer observations were allocated.

The other amazing finding of the citizen scientists is the record of the finding of the pineapple fish *Monocentris japonica* (Houttuyn, 1782). The members of the family Monocentridae have not been reported from the Arabian Gulf waters, and therefore, the presence of *M. japonicus* in the Iraqi marine waters was distinguished.

3.2 Biodiversity Contribution by the Citizen Scientist in the Countries Bordering the Arabian Peninsula

With some countries bordering the Arabian Peninsula, there are non-governmental organizations (NGO) where their members are citizen scientists and are interested in studying natural history sciences in particular. Such organizations can give a perfect example on the vital role of the citizen scientists in supporting the biodiversity in the areas they are operating.

The "Tribulus" is the official bi-annual journal of the Emirates Natural History Group. Probably, it is the only well-reviewed English language scientific journal of its kind in the countries bordering the Arabian Peninsula. This journal expresses clearly the vital and important role of citizen scientists in supporting the biodiversity archives of the Arabian Gulf and Sea of Oman areas. Over the history of more than 20 years, *Tribulus* has succeeded in disseminating the natural history knowledge in the eastern part of the Arabian Peninsula.

3.3 Abnormal Fish Specimens Contributed by Citizen Scientist

The contribution of citizen scientists in providing fish specimens to the author with different cases of abnormalities was significant. During the 37 years the author spent studying fish anomalies cases in the countries bordering the Arabian Peninsula, 78 cases were reported from 6 countries (Table 2). The largest number of cases was recorded from the coasts of Jubail City, Saudi Arabia, Arabian Gulf, followed by Iraqi marine waters with 16 cases and then Omani waters having 15 cases. For the Iranian waters, two cases were reported, and for the United Arab Emirates and Yemeni waters, one case was recorded. Within this investigation, 30 cases were reported in the year 2018, 12 for 2017 and 6 cases for each of the years 2014 and 2013.

The 78 cases of abnormalities examined by the authors covered anomalies in different parts of the fish body such as the head; dorsal, anal and caudal fins; vertebral column; and colouration. Without the assistance of citizen scientists,

Table 2 Contribution of citizen scientists in providing fish specimens with abnormalities to the author of the chapter during his work on the fish fauna of the countries bordering the Arabian Peninsula

Species	Date of study	Locality	Reference
Mesopotamichthys sharpeyi (Günther, 1874)	1982	Iraq	Al-Hassan (1982)
Carasobarbus luteus (Heckel, 1843)	–	–	–
Luciobarbus xanthopterus (Heckel, 1843)	–	–	–
Aphanius dispar (Rüppell, 1829)	–	–	–
Pampus argenteus (Euphrasén, 1788)	–	United Arab Emirates	–
Mesopotamichthys sharpeyi (Günther, 1874)	1983	Iraq	Al-Hassan (1983)
Carasobarbus luteus (Heckel, 1843)	–	–	–
Gambusia affinis (Bairdand Girard, 1853)	1985	Basrah, Baghdad, Iraq	Al-Hassan (1985)
Mesopotamichthys sharpeyi (Günther, 1874)	1986	Euphrates River, Iraq	Al-Hassan and Na'ama (1986)
Arabibarbus grypus (Heckel, 1843)	–	–	–
Planiliza abu (Heckel, 1843)	–	–	–
Mesopotamichthys sharpeyi (Günther, 1874)	1987	Iraq and Arabistan	Al-Hassan (1987)
Luciobarbus xanthopterus (Heckel, 1843)	–	–	–
Planiliza abu (Heckel, 1843)	–	–	–
Johnieops aneus (Bloch, 1793)	1988	Khor al-Zubair, Iraq	Al-Hassan and Na'ama (1988)
Planiliza macrolepis (Smith, 1846)	1997	Red Sea, Yemen	Al-Hassan et al. (1997)
Arius dussumieri (Valenciennes, 1840)	2005	Sea of Oman, Sultanate of Oman	Al-Jufaili et al. (2005)
Pampus argenteus (Euphrasén, 1788)	2010	Arabian Gulf coasts of Oman	Al-Mamry et al. (2010)
Hypophthalamichthys nobilis (Richardson, 1844)	2011	Aquaculture activity, Iran	Jawad and Koush (2011)
Moolgarda pedaraki (Valenciennes, 1836)	2012	Sea of Oman, Sultanate of Oman	Jawad and AL-Mamry (2012a)
Pampus argenteus (Euphrasén, 1788)	–	Arabian Gulf coasts of Oman	Jawad and AL-Mamry (2012b)
Lethrinus nebulosus (Forsskål, 1775)	2013	Arabian Sea coast of Oman	Jawad et al. (2013b)
Epinephelus stoliczkae (Day, 1875)	–	Sea of Oman, Sultanate of Oman	Jawad and Al-Kharusi (2013)

(continued)

Table 2 (continued)

Species	Date of study	Locality	Reference
Pomadasys stridens (Forsskål, 1775)	–	–	Jawad et al. (2013c)
Drepane longimana (Bloch and Schneider, 1801)	–	–	–
Platax teira (Forsskål, 1775)	–	–	–
Carangoides armatus (Rüppell, 1830)	–	Nay Band, Iran	Jawad et al. (2013e)
Platax teira (Forsskål, 1775)	2014	Marine waters of Iraq, Arabian Gulf	Jawad and Bannai (2014)
Pampus argenteus (Euphrasén, 1788)	–	Arabian Sea coast of Oman	Jawad et al. (2014a)
Tenualosa ilisha (Hamilton, 1822)	–	–	Jawad et al. (2014b)
Lactoria cornuta (Linnaeus, 1758)	–	Sea of Oman, Sultanate of Oman	Tyler et al. (2014)
Brachirus orientalis (Bloch and Schneider, 1801)	–	–	Jawad et al. (2014b)
Siganus canaliculatus (Park, 1797)	–	Jubail City, Arabian Gulf, Saudi Arabia	Jawad and Ibrahim (2014)
Epinephelus areolatus (Forsskål, 1775)	2017	–	Ibrahim and Jawad et al. (2017)
Bodianus macrognathus (Morris, 1974)	–	–	Jawad and Ibrahim (2017a)
Lethrinus nebulosus (Forsskål, 1775)	–	–	–
Scatophagus argus (Linnaeus, 1766)	–	–	–
Diagramma pictum (Thunberg, 1792)	–	–	–
Argyrops spinifer (Forsskål, 1775)	–	–	–
Alepes vari (Cuvier, 1833)	–	–	–
Diagramma pictum (Thunberg, 1792)	–	Arabian Sea coast of Oman	Jawad et al. (2017)
Pardachirus marmoratus (Lacepède, 1802)	–	–	–
Epinephelus stoliczkae (Day, 1875)	–	Jubail City, Arabian Gulf, Saudi Arabia	Jawad and Ibrahim (2017b)
Plectorhinchus sordidus (Lacepède, 1802)	–	–	–
Plectorhinchus playfairi (Pellegrin, 1914)	–	–	–
Epinephelus tauvina (Forsskål, 1775)	2018	–	Jawad and Ibrahim (2018c)
Siganus canaliculatus (Park, 1797)	–	–	–
Argyrops spinifer (Forsskål, 1775)	–	–	–
Scomberomorus guttatus (Bloch and Schneider, 1801)	–	–	–

(continued)

Table 2 (continued)

Species	Date of study	Locality	Reference
Lethrinus nebulosus (Forsskål, 1775)	–	–	–
Carangoides bajad (Forsskål, 1775)	–	–	–
Epinephelus areolatus (Forsskål, 1775)	–	–	–
Alepes vari (Cuvier, 1833)	–	–	–
Carangoides bajad (Forsskål, 1775)	–	–	–
Carangoides chrysophrys	–	–	–
Parastromateus niger (Bloch, 1795)	–	–	–
Argyrops spinifer (Forsskål, 1775)	–	–	–
Brachirus orientalis (Bloch and Schneider, 1801)	–	–	–
Oreochromis mossambicus (Peters, 1852)	2018	–	Jawad et al. (2018a)
Epinephelus stoliczkae (Day, 1875)	–	–	–
Diagramma pictum (Thunberg, 1792)	–	–	–
Cephalopholis hemistiktos (Rüppell, 1830)	–	–	–
Lethrinus nebulosus (Forsskål, 1775)	–	–	–
Lutjanus sanguineus (Cuvier in Cuvier and Valenciennes, 1828)	–	–	–
Epinephelus areolatus (Forsskål, 1775)	–	–	Jawad and Ibrahim (2018d)
Epinephelus epistictus (Temminck and Schlegel, 1842)	–	–	–
Carangoides bajad (Forsskål, 1775)	–	–	–
Diagramma pictum (Thunberg, 1792)	–	–	–
Plectorhinchus sordidus (Lacepède, 1802)	–	–	–
Acanthopagrus bifasciatus (Forsskål, 1775)	–	–	–
Argyrops spinifer (Forsskål, 1775)	–	–	–
Lethrinus nebulosus (Forsskål, 1775)	–	–	–
Nemipterus japonicus (Bloch, 1791)	–	–	–
Platax teira (Forsskål, 1775)	–	–	Jawad and Ibrahim (2018e)
Pampus argenteus (Euphrasén, 1788)	–	Marine waters of Iraq, Arabian Gulf	Jawad et al. (2018d)
Brachirus orientalis (Bloch and Schneider, 1801)	2019	Jubail City, Arabian Gulf, Saudi Arabia	Jawad et al. (2019c)
Argyrops spinifer (Forsskål, 1775)	–	–	–
Platycephalus indicus (Linnaeus, 1758)	–	–	–

Fish specimens represent cases of abnormalities. Species are arranged according to the date of the description or record

such a wide range of abnormal cases was impossible to obtain, and such cases could go without noticing detection.

4 The Future Steps

It is clear from the contributions of the citizen scientists to the research activities of only one scientist shown in Tables 1 and 2 how the role of the citizen scientists was vital and significant in producing such a large number of publications. Therefore, a call is given here in this chapter for the governments of the countries bordering the Arabian Peninsula to take an action and create opportunities for citizen scientists and locals to contribute to research programmes run by professionals. I am absolutely certain that such a contribution will lead to a great benefit for the professionals and their projects.

Among the suggestions to develop this issue in the future, one crucial step needs to be taken by the organizations or the governments managing citizen science involvement to apply obvious data administration strategies with average licences to stop misapprehensions concerning data sharing. Data operators should back the events of citizen researchers and communities via credit of their assistances in a way that matters for the citizen scientists.

To progress data frankness, citizen researchers must be inspired in ways that agree with their incentives. Initially it would be for data supply centres to define flawless licencing methods and to thereby allow citizen experts to choose suitable stages of data availability.

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