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AN ASSESSMENT OF RAZOR CLAM FISHERIES OF PAKISTAN: HISTORY, SPECIES COMPOSITION, POPULATION AND EXPORT

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ABSTRACT

Fourteen species of razor clams belong to three families of Order Adapadonta including Solenidae, Cultellidae and Pharidae are known from Pakistan coast. One species *Solecurtus subcandidus* Sturany, 1899 is reported for the first time from Pakistan. *Solen dactylus* von Cosel, 1989 which mainly inhabits mudflats in the creek systems of the River Indus is exploited on commercial scale and exported in large quantities. These razor clams are found in abundance with density as high as in the intertidal area about 300 m from mangrove line in some areas. Razor clams are harvested throughout the year using traditional technique of using table salt as an irritant. Harvesting *Solen dactylus* is done by fishermen and their families. When the stocks of razor clams is exhausted on a particular mudflat or major reduction in sizes is noticed, then the fishermen with their families migrate to other islands/areas. Harvesting of razor clams started in 2004 and now about 500 m. tons of these clams are annually exported from Pakistan generating an income of about US $ 1.0 million annually. These razor clams are exported in live and frozen form mainly to China and other Southeast Asian countries.

Keywords: Razor clams, *Solen dactylus*, mudflats, Indus Delta, Creeks, razor clam export

INTRODUCTION

Razor clams are marine bivalves belonging to three families Solenidae, Solecurtidae and Pharidae in Pakistan and known to have fragile shell, with open ends. The razor shell lives in the sand and muddy cum sandy shore, using its powerful foot to dig to a safe depth. The shell of razor clams are elongated and rectangular shape, similar to the shaving razor hence its name. Since long, razor clams are dug out from sandy and muddy cum sandy shores in Pakistan for use as bait for handline fishing especially in Indus Creek areas and some parts of Balochistan including Bandri and Jiwani. The bait is preferably used in rocky and rocky cum sandy shore for catching groupers, Spanish mackerel and pompanos in Balochistan and groupers and snappers in the Indus Delta. Use of razor clam as bait is not an organized activity and undertaken only when other baits (fish and shrimp) are not available.

Commercial harvesting and export of razor clams were started in 2004, when their small quantities were harvested from Daryapir area in Bhambore and exported to Thailand. Considering that there is adequate demand in the Southeast Asian market for razor clams, an organized razor clam industry was established since then.

Melvill (1898) was the first to report razor clam *Solen ceylonensis* (as *Solen truncatus*) from Karachi. Melvill and Standen (1906) reported *Solen corneus, Solen ceylonensis* (as *Solen truncatus*) and *Siliqua polita (as Machaera polita*) from Karachi and *Ensiculus cultellus* (as *Cultellus cultellus*), *Siliqua radiata* (as *Machaera radiata*) and *Azorinus coarctatus* (as *Solenocurtus coarctatus*) from Mekran coast. Later on a number of other species were reported from Pakistan.

Information about distribution, abundance and population of razor have been studied by Ahmed (1988), Moazzam and Ahmad (1994), Mahar (2018), Moazzam and Moazzam (2021) and Pirzado and Mahar (2021). Present paper provides a review the occurrence of razor clams belong to families Solenidae, Cultellidae and Pharidae in Pakistan as well as status of their fisheries in the Indus Delta and along Balochistan coast.

MATERIAL AND METHODS

A review of literature on the occurrence and fisheries of razor clams in Pakistan was made. In addition, fishing grounds were visited along Sindh and Balochistan coasts to collect information its fishing methods, abundance and distribution from major fishing grounds. In addition, data for landings and export of razor clams from Pakistan were obtained from archives of Marine Fisheries Department, Government of Pakistan.

RESULTS AND DISCUSSION

Razor clam is commercially harvested in Pakistan for export in live and frozen forms whereas there is no local consumption of this bivalve in Pakistan. These clams belong to 6 genera *Solen*, *Sinonovacula*, *Ensiculus*, *Siliqua*, *Azorinus* and *Solecurtus*, reported from Pakistan of which *Solen* is commercially exploited.

Taxonomic Enumeration

Razor clams belongs to a number of families and genera, however, these are represented by 6 genera and 3 families Solenidae, Pharidae and Solecurtidae in Pakistan.

Family Solenidae Lamarck, 1809
Solen corneus Lamarck, 1818

This species was reported by Melvill and Standen (1906) to be commonly occurring on intertidal mudflats in Karachi, however, there is no other records of its occurrence in Pakistan. According to Bernard *et al*. (1993) and Tuaycharoen and Matsukuma (2001) this species is distributed in Fareast Asia (Thailand, Indonesia, China, Hong Kong, Japan. Korea and Taiwan). It seems that specimens from Karachi by Melvill and Standen (1906) possibly *Solen corne*us Lamarck, 1818, sensu Philippi, 1847 which is considered as synonym of *Solen cylindraceus* Hanley, 1843. S. *cylindraceus* is already reported from Pakistan (Kazmi, *et al*., 2018) but is of rare occurrence. Melvill and Standen (1906) reported this to be common occurrence on mudflats, however, commonly encountered species on mudflats of Karachi is *Solen dactylus* von Cosel, 1989 (Moazzam and Moazzam, 2021). It seems that Melvill and Standen (1906) report of *Solen corneus* is possibly based on misidentification of *Solen dactylus* which was undescribed at that time.

Solen cylindraceus Hanley, 1843
(Fig. 1)

This species was reported by Kazmi, *et al.* (2018). It seems to be occasionally found on some sandy cum muddy shore located in the bays in Balochistan. Kazmi *et al*., (2018) reported that it is an infaunal species inhabiting estuarine area. It is known from Indo-Pacific area including Red Sea and Djibouti (Oliver, 1992), Zanzibar, Madagascar, Mozambique (EOL, 2018) and South Africa (Nel, *et al*., 2012). This species seems to be extremely rare occurrence in Pakistan.

Fig. 1. *Solen cylindraceus* collected from sandy-cum muddy shore at Ormara (Demi Zur).

Solen dactylus von Cosel, 1989
(Fig. 2)

Fig. 2. *Solen dactylus* von Cosel, 1989 collected from Waddi Khuddi Creek, Sindh.

This species was described by von Cosel (1989) based on holotype collected by H. C. Winckworth in 1932, from Baba Island, Karachi (24'50'N/66'58'E), 8 + 5 shells, coll. H. C. Winckworth, l. XI. 1932. Karachi, 5 shells (associated specimens to the paratype), collected by H. C. Winckworth; Karachi, 4 juvenile shells, collected by H. C. Winckworth, 20. XI. 1932, all of these are housed British Museum of Natural History (now known as Natural History Museum, London). This species was also reported from Pakistan by Kazmi *et al*. (2018), Mahar (2018), Moazzam and Moazzam (2021), Pirzado and Mahar (2021). Ahmed (1988) studies population of this razor clams (as *Solen truncatus*) from Bundal Island. Similarly Moazzam and Ahmed (1994) reported this species from Bundal Island and Jiwani as *Solen truncatus.*

According to von Cosel (1989) *Solen dactylus* is a moderately large, solid, white, elongate-rectangular straight razor clam with parallel dorsal and ventral margins, sharply and mostly obliquely truncated anterior and posterior ends, the posterior adductor scar connected with the pallial sinus, with an unusually long ventral limb of the pallial sinus and with a sharp, deep and narrow external furrow parallel to the anterior margin.

There is no closely related species to *S. dactylus* (von Cosel, 1989). It was compared with *S. marginatus* Pulteney, 1799 from the NE-Atlantic and *S. capensis* P. Fischer, l88l from South Africa but both these species have coloured shell and also have structural differences. *Solen dactylus* was previously reported from the Arabian Gulf as *S. vagina* Linnaeus 1758 by Tadjalli-Pow (1974) and Ahmed (1975), as *S. capensis* by Glayzer *et al.* (1984) and *S. truncatus* by Kundu (1965).

Solen dactylus seems to be confined to the Northern Arabian Sea coast of India, Pakistan and Iran and the northern part of the Persian Gulf down to a line between the Strait of Hormuz and the Peninsula of Qatar (von Cosel, 1989). According to Kundu (1965), razor clam is locally found in India (Gulf of Kutch, Gulf of Cambay) in very dense population and mostly caught alive and is used for bait and occasionally consumed.

According to von Cosel (1989) *Solen dactylus* lives in mud and fine sand with detritus on tidal flats in the lower intertidal zone, where it can be found in high population densities. He reported dense population of this species in the northern part of the Bay of Kuwait having 250 *S. dactylus* per square meter.

Solen grandis Dunker, 1862

This species was reported from shallow subtidal and intertidal sand by Anonymous (1986), however, no specific location or further detail was provided. *Solen grandis* is known to be distributed in the Western Pacific including Kampuchea, Japan, Philippines, Taiwan, Thailand and Vietnam (OBIS, 2006; Tuaycharoen and Matsukuma, 2001; Poutiers, 1998), China, Hong Kong and North and South Korea (Bernard *et al.*, 1993). It is known from northern and eastern Australia (OBIS, 2022). It was reported from Koswari Island, Gulf of Mannar, India (Hylleberg and Kilburn, 2002).

Solen ceylonensis Leach, 1814
(Fig. 3)

This species was reported for the first time from Karachi by (Melvill, 1898) as *Solen truncatus*. Later on it was reported from Pakistan coast by Ranjha (1960), from Karachi by Melvill and Standen (1906), Pitiani Creek, Manora Sonmiani, Pasni by Khan and Dastagir (1970). It was reported from Bundal Island and Jiwani by Moazzam and Ahmed (1994). In all these studies it was reported as *Solen truncatu*s. It was reported as by Subba Rao *et al*. (1991) from India (Orissa, Madras, Bombay, Kutch and Gujarat, Pakistan (Gwadar) and Sri Lanka. OBIS (2006) reported it from Red Sea, Aden and Sri Lanka. Kazmi *et al*. (2018) reported it from Pakistan as *Solen guinensis* Hanley, 1842. This species is reported from western Africa as *Solen truncatus* Philippi, 1843 which is considered to be synonym of this species.

Solen ceylonensis is found burrowing in muddy and sandy bottom (Kazmi *et al*., 2018). It was also observed that this species is found in coarse sandy cum muddy shores whereas other species of genus *Solen* prefers fine sandy cum muddy shores.

Fig. 3. *Solen ceylonensis* Leach, 1814.

Solen strictus Gould, 1861

This species was reported from Pakistan by Kazmi, *et al*., (2018) based on report of Moazzam and Ahmed, (1994), however, latter did not record this species from Pakistan!). This report of this species from Pakistan, therefore, may be considered as erroneous.

Solen vagina Linnaeus, 1758

This species was reported from Bandri, Jiwani, Pakistan by Ghani *et al.* (2018). It is commonly known as known to European razor clam and widely distributed in the Eastern Atlantic and the Mediterranean: Turkey and Western Europe, UK, France, Germany, Spain, Portugal to Senegal (EOL, 2018; Fischer *et al*., 1981). It is also known from India, Oman, Vietnam, Thailand, Malaysia, Indonesia and Philippines (EOL, 2018).

Family Pharidae H. Adams and A. Adams, 1856
Siliqua polita Wood, 1828

This species is reported from for the first time from Karachi, Pakistan by Melvill and Standen (1906) as *Machaera polita.* This species is known to Yemen, Red Sea (Dekker and Orlin, 2000), Kunark and Pozm-Tiyab, Iran, South Africa (EOL, 2018), and Pakistan (Melvill and Standen, 1906; OBIS, 2022).

Siliqua radiata (Linnaeus, 1758)
(Fig. 4)

This species is reported for the first time from Karachi, Pakistan by Melvill and Standen (1906) as *Machaera radiata*. It is widely distributed in the Indo-Pacific area including China, Philippines, Thailand, Indonesia,

Indonesia, Malaysia, Papua and New Guinea, India, Pakistan, Oman, Sri Lanka, South Africa (EOL, 2018; Hylleberg and Kilburn, 2002; OBIS, 2006). From Pakistan, it was reported by Kazmi *et al*. (2018), from Bandri (Jiwani) by Ghani, *et al.* (2018), and from Kemari, West Wharf, Pitiani Creek and Pasni by Khan and Dastagir (1970). This species is typically have broad wedge shaped bands of mauve colour and usually found on sandy shores in the intertidal areas (Kazmi *et al*., 2018).

Fig. 4. *Siliqua radiata* (Linnaeus, 1758).

Ensiculus cultellus Linnaeus, 1758

It is commonly known as knife finger oyster and reported for first time from Mekran Coast by Melvill and Standen (1906). It was also reported from mangrove areas of Port Qasim (Kazmi *et al*., 2018; Moazzam and Ahmed, 1994). According to Melvill and Standen (1906), this species is dredged from 15 to 20 m depth with muddy sand and rocks. It is reported from Australia (Taylor and Glover, 2004), China, Japan, Philippines, Taiwan (Bernard *et al*., 1993), Madagascar and Tanzania by Kazmi *et al*. (2018). Melvill and Standen (1906) and Moazzam and Ahmed (1994) reported this species as *Cultellus cultellus.*

Sinonovacula constricta (Lamarck, 1818)

This species was reported by Anonymous (1986) and Kazmi *et al*. (2018) from Pakistan coast. It is reported to be found on intertidal sand and mud. It is commonly known as Chinese razor clam and is a commercially important species of bivalve native to the estuaries and mudflats of China and Japan. It is also known from Malaysia, Australia, Taiwan, Korea (EOL, 2018). Bernard *et al.* (1993). It is extensively aquafarmed in China and other countries. The presence of this species is doubtful in Pakistan and require further studies to ascertain its presence in Pakistan.

Family Solecurtidae d'Orbigny, 1846

Azorinus coarctatus (Gmelin, 1791)

It was reported as *Solenocurtus coarctatus* from 80 m depth at Mekran Coast (Melvill and Standen, 1906). It is commonly known as smart short razor and is reported from Andaman Islands, Brunei Darussalam, Kampuchea, China, Hong Kong, Indonesia, Malaysia, Japan, Myanmar, Philippines, Singapore, Taiwan, Thailand, Timor-Leste, Vietnam and Australia (Poutiers, 1998), Qatar (Al-Khayat, 1997), Iran, Oman (Melvill and Standen, 1906), India, Sudan, Red Sea, Gulf of Aden (OBIS, 2006), Djibouti, Vanuatu and Pulau (EOL, 2018).

Solecurtus australis (Dunker, 1862)
(Fig. 5)

Fig. 5. *Solecurtus australis* (Dunker, 1862).

Kazmi *et al*. (2018) reported this species from Pakistan. It is found on sandy or shelly gravel, from the lower shore into the shallow sublittoral. In this species pallial sinus reaches to the beak of umbo. The shell has rectangle in shape.

Solecurtus subcandidus Sturany, 1899
(Fig. 6)

Fig. 6. *Solecurtus subcandidus* Sturany, 1899.

The shell was collected from sandy shores at Ormara (Demi Zur). The shell is rectangle in shape. It is quite hard-shelled white with slight yellowish shading on the outside, pure white on the inside. From the dense concentric striation, a number of growth lines emerge most prominently at the margins of the valves. The weakly pointed umbo is located anteriorly and protrudes little beyond the hinge edge. The pallial sinus is tongue-shaped and reaches

beyond the umbo region into the anterior part of the shell. This species is described from Gulf of Aqaba, Red Sea and known from Persian Gulf (Kuwait and Iran) from Thailand. This species is reported for the first time from Pakistan.

Razor Clam Fisheries of Pakistan

Coastal areas of Pakistan are known to have a well-diversified bivalve fauna (Kazmi *et al*., 2018; Khan and Dastagir, 1970; Melvill and Standen, 1906). Indus Delta, its associated mangroves areas and other sandy and muddy shores along Balochistan coast are specially known for occurrence of bivalves some of which are being commercially exploited which includes clams such as *Marcia recens* (Holten, 1802), *Meretrix casta* (Gmelin, 1791), *Meretrix meretrix* (Linnaeus, 1758), *Protapes cor* (G. B. Sowerby II, 1853), *Tivela stefaninii* (Nardini, 1933), and *Callista umbonella* (Lamarck, 1818) belonging to Family Veneridae and *Solen dactylus* von Cosel, 1989 belonging to Family Solenidae (Moazzam and Ahmed, 1994; Moazzam and Moazzam, 2021). These mollusks inhabit in the intertidal sandy cum muddy areas in mangroves and associated mudflats. These are manually harvested and exported to Southeast Asian countries where these are relished.

Most of the razor clams reported from Pakistan are edible and are now considered as an important exportable seafood commodity. For commercial purposes, finger razor clam (*Solen dactylus*) is harvested individually by either digging or bringing them to surface using some irritants and then collected for processing, packaging and export. *Solen dactylus* is locally known as "maaruree" and is harvested from mudflats of creek system of Indus deltaic area, Miani Hor, Kalmat Khor, Pasni Bay and Gwater Bay (Jiwani).

Fig. 7. Razor clams showing black tinge due to hydrogen sulphide in the sediment.

The shell of this razor clam is pure white to drab colour, however, in some areas the shell have black coloration because of presence of hydrogen sulphide in the sediments (Fig. 7). The cream-colored muscular foot protrudes from the shell when extended. The hole in the shell from which the syphon protrudes, has a unique keyhole shape. The razor clam is well adapted for living in soft sandy sum muddy habitat. When the tide goes out, it burrows quickly into deeper sand. The foot of the razor clam is larger and more agile than that of other clams. To burrow, the razor clam pushes its narrow foot down deep into the substrate, then expands the foot as an anchor and pulls the body and shell deeper into the sand. They are extremely strong and almost impossible to remove from their substrate in one piece, as the shell can pull free from the body.

Distribution of Razor Clams along Pakistan Coast

Razor clams is abundantly found on sandy cum muddy shore along the coast of Pakistan. Most of the razor clams belong to genera *Solen, Azorinus, Sinonovacula* and *Ensiculus* are predominantly occur on sandy-cum-muddy coasts in the mangrove areas and associated mudflats. Members of genus *Siliqua* are found on sandy shores along Pakistan coast facing open coastlines. *Solen dactylus* is most abundant species of razor clams found in Pakistan mainly in the creek areas of the Indus Delta (Fig. 8). These are also found in mudflats in Miani Hor, Kalmat Khor, Bandri and Panwan (Jiwani). Limited population of this clam is found on the mouth of a few

ephemeral rivers along Balochistan coast such as Hub River, Phor River, Hingol River, Basul River, Shadi Khor River, Raini Hor, Sur River and Shabi (Akara Khor). It used to found abundantly on the muddy shore in Karachi Port including Baba Island, Bhit Island, Salehabad, Shamspir and Nawa Nar area but because of pollution, razor clams are no more found in Karachi Port area. Holotype of *S. dactylus* was collected from Baba Island (von Cosel, 1989).

Fig. 8. Razor clam grounds on mudflats along Pakistan coast.

Gizri Creek, Korangi Creek and a part of Phitti Creek is also heavily polluted, therefore, the population of razor clam has vanished from some parts of these creek system (Fig. 9). Previously dense population of razor clams used to be occurring in Salt Factory, Ibrahim Hayderi and Kaprianwala Island (Ahmed, 1988). In Gizri, Korangi and Phitti Creeks system, only Bundal Island has dense population of razor clam on Northern and North-western parts (Ahmed, 1988; Moazzam and Moazzam, 2021).

In the Indus Delta, major razor clams bed are located in Gharo Creek, Waddi Khuddi Creek, Khai Creek, Pitiani Creek, Dhabbo Creek, Hajamro Creek, Khobbar Creek, Khajar Creek, Turshian Creek and most other creeks in Thatta, Sujawal and Badin Districts in Sindh. Miani Hor, Kalmat Khor, Shadi Khor and Jiwani are main razor clam bed harvesting is being done along Balochistan coast.

Fig. 9. Razor clam grounds on mudflats along Bundal Island mentioned in Ahmed (1988).

Along Pakistan coast population of razor clams was observed to extremely dense in the intertidal areas on major sandy-cum-muddy beaches in the mangrove associated ecosystem. von Cosel (1989) has also reported dense concentration of *Solen dactylus* in Kuwait. Ahmed (1988) reported that the razor clams are not evenly distributed on

the intertidal area and their density mainly depends upon texture of the sand, as well on the tidal level. The study indicated that *Solen dactylus* prefers a compact sandy-muddy substrate and no clam was found on the soft clay. The data for Bundal Island razor clam bed was extrapolated taking into account patchy distribution and their confinement only to sandy cum mudflat to determine their available stocks which were calculated to be between 45 million and 65 million, most of these clams confined to neap tide zone (Ahmed, 1988). Apparently the number seems to be high but as compared to Kuwait Bay it seems to low as the density reported by von Cosel (1989) was 250 specimens per meter whereas at Bundal island it was only 125. Moazzam and Moazzam (2021) reported a density of 231 per square meter in the lower littoral Zone in Darya Pir area. Ahmed (1988) have studied the intertidal distribution of razor clams on Bundal Island and observed that it occurs between mangrove line to upper margin of lower littoral zone. Razor clams were not evenly distributed on the intertidal area of Bundal Island depending mainly upon texture of the sand, as well on the tidal level. This species prefers a compact sandy-muddy substrate and no clam was found on the soft clay (Ahmed, 1988).

Based on the data reported by Ahmed (1988) a kite diagram was developed (Fig. 10) which reveals that distribution of *Solen dactylus* is restricted between the mangrove line in the neap tide zone. Highest density was observed to be 95/m^2 razor clams at 300 m from mangrove lines. The density of razor clams decreases to 86/m^2 at 400 m from mangrove line and gradually tapers to about 10 m^2 at 600 m whereas no razor clam was found below a distance of 700 from mangrove line. No razor clam was found in the subtidal areas below infra-littoral zone and above mangrove line. Local variations were observed at other localities on Bundal Island from the generalized distribution given in the kite distribution (Fig. 10). On other mudflat in other creeks a similar pattern of distribution pattern with local variation was observed during present study.

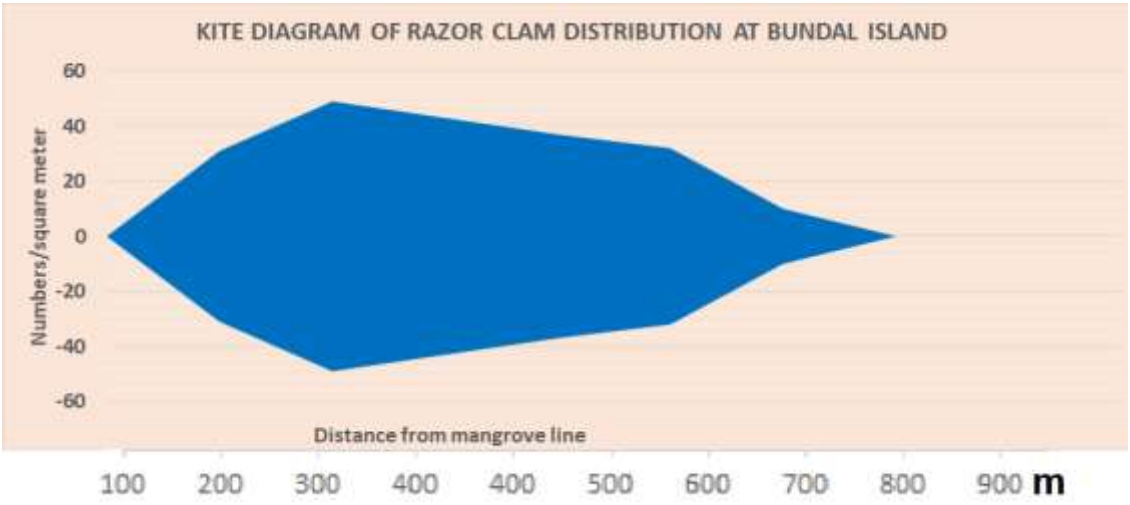

Fig. 10. Kite diagram of *Solen dactylus* at Bundal Island based on data collected by Ahmed (1988).

Studies carried out by Ahmed (1988) revealed that razor clams are found throughout the year (Fig. 11). Their abundance, however, varies seasonally. Highest density of razor clams was observed in October. April and January when a density of 445, 434 and 411 razor clams were observed respectively in 6 m^2 (counted after every 100 m) in the intertidal area between mangrove line and lower littoral zone. Lowest density was observed during February, September and August when 381, 385 and 391 razor clams were respectively observed in 6 m^2 (counted after every 100 m).

Ahmed (1988) and Pirzado and Mahar (2021) have studies the sizes of razor clams which was reported to vary between 3 cm to 13 cm and weigh between 3.20 g to 40.0 g (Table-1). Ahmed (1988) reported razor clams of large sizes (8-13 cm) are heavier as compared to weights reported for the same size group by Pirzado and Mahar (2021) whereas in case of smaller size group (3 to 8 cm) the specimens reported by Pirzado and Mahar (2021) are heavier. It is worth mentioning that razor clams of size group 6 cm to 13 cm are considered to be of commercial importance and exported from Pakistan.

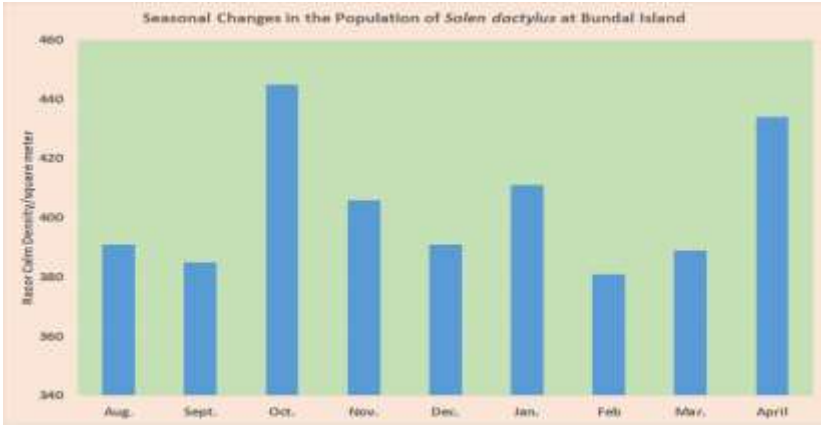

Fig. 11. Seasonal abundance of *Solen dactylus* at Bundal Island (after Ahmed, 1988).

Table 1. Average length, total weight, fresh-meat weight and dry- meat weight of razor clam.

[1]Length (cm	[1]Total Weight (g)	[1]Fresh-Meat Weight (g)	[2]Fresh-Meat Weight (g)	[1]Dry-Meat Weight (g)
12-13	40.00	30.10	21.7	3.5
10-12	33.10	25.00	15.6	3.1
8-10	21.00	12.70	11.0	1.8
6-8	10.00	7.30	8.5	1.3
4-6	3.20	2.70	4.8	0.3

After [1]Ahmed (1988); [2]Pirzado and Mahar (2021).

Commercial Fishing of Razor Clam

Considering the potential of exploitation of razor clams based on the information provided by Ahmed (1988) and Moazzam and Ahmed (1994) a number of exporters were approached to start export of this commodity but response was poor because their limited information about razor clam fisheries, harvesting methods, processing, packaging and export market. Through continued persuasion export was started in 2004 when small quantities were harvested from Darya Pir area and exported to Thailand. This opened a new avenue for the export of razor clams from Pakistan and since then, this fisheries is turned into a well-organized and partially managed fisheries of the Indus estuarine area. This fisheries have provided an additional income generation opportunity to coastal communities of the creek areas of the River Indus. Even in Balochistan harvesting of razor clams is being undertaken by same communities of the Indus Delta who move to these areas when stocks showed sign of depletion in the fishing grounds of the Indus Delta.

Initially harvesting of razor clam used to done in the Darya Pir area. With the depletion of this ground fishermen moved to hundreds of mudflats located in other creeks spread almost entire Indus Delta including Keti Bundar area (Khadiwaari, Ghorewaari, Sunahrewaari and Toshawaari), Kharo Chan, Sujjawal, Shah Bundar. Over the period fishermen now undertake harvesting in one particular area and when depletion (mainly in form of reduced harvest or noticeable reduction in the size of the harvested razor clams) is observed they move to another mudflat in the creek areas of the Indus Delta. Usually they return to previous fishing ground after 5 to 10 months which is enough period in which stocks are recovered and razor clam again attain marketable sizes. In Miani Hor, Balochistan, commercial harvesting of razor clams was started in 2019 when families from Keti Bundar area were moved to Damb. The harvesting was done in Safe Dori, Khar Patti and Kichri Dori and other mudflats in the Miani Hor area. After depletion of stock by 2000, these family returned back to the Indus creeks.

Harvesting Method of harvesting Razor Clams

Razor clams are traditionally harvested in most part of the world by using salt as an irritant. It is harvested by pouring table salt into the burrow and stirring it with a thin steel rod or thin twig which make razor clam to come to the surface because of irritation due to high salinity and picked by harvesters. This method is being used since centauries, even in Pakistan. Fishermen communities in coastal area of Balochistan used to use salt for collection razor clams for use them as bait mainly for surf fishing (Moazzam and Ahmed, 1994). Ahmed (1988) used this method for the study of razor clams at Bundal Island.

Table or sea salt is the only input used razor clam fisheries in Pakistan which is carried by fishermen in small plastic containers that holds about ½ kg of salt (Fig. 12). Additional salt is kept in polythene bags by the fishermen, if more is needed during the harvesting operation, especially if harvesting is done in remote areas far from their settlements. Although fishermen prefer to use cheaper quality sea salt but prefer free flowing refined sea salt because of its easier use. After locating a typically elongated hole of razor clam, a pinch of salt is poured in it (Fig. 13) and stirred with the help of a thin steel stick (Fig. 14). Previously a twig of plants used for the purpose but because it required constant replacement of the twig, now it is replaced with steel stick. Since hole of the razor clam can be few feet deep, therefore, stick may be lost in the process, therefore, a plastic cap of cola drink is attached to one side of the steel stick. In this manner, stick is not lost and requires fewer replacement. The razor clam, because of irritation by salt, emerges out from the hole in 10 to 60 seconds and immediately grasped by the harvester. In commercial harvesting, salt can be placed in many holes at the same time and separate steel sticks are also placed in them so that many razor clams can be harvested. Brine is considered more effective in bringing out razor clams from the hole, however, carrying brine in large qualities to the fishing grounds is cumbersome especially carrying load is difficult while dreaming in mud and soft sediments.

Fig. 12. Salt being carried in plastic containers for extraction of razor clams.

Razor clam species that are found in sandy can be dug out using spade or corers. Many such species are harvested in United States, Canada and many other countries by digging them out, however, in Pakistan and southeast Asian countries, extraction using salt is employed as digging in sandy-cum-muddy environment is difficult and time consuming.

For the commercial harvesting of razor clams fishermen that are dedicatedly involved in this trade. In most cases entire family members including women and small children are engaged in harvesting of razor clams (Fig. 15). Since, now razors clams are exported regularly from Pakistan since last 12 years, therefore, harvesting is carried out throughout the year. Usually razor clams having a size between 8 and >12 cm are harvested; clams smaller than 8 cm do not fetch good prices in local and international markets.

Fig. 13. Salt being poured in the hole of razor clams.

Fig.14. Steel stick (a) used for stirring salt in the hole; (b) plastic cap attached to steel stick.


Fig. 15. Harvesting of razor clam is done by all family members including children.

In most cases operation of razor clam harvesting is started when a head fishermen receive an order for razor clams from an exporter through a middleman. Usually head fishermen scout various mudflats to assess the quantities of razor clams that can be harvested. Considering nature and location of the mudflat, fishermen (harvesters) are deputed to collect razor clams and transport it to a central location. In some cases, entire family is shifted to that island from where harvesting is planned to carried out or to a nearby area where mudflats are known to harvestable stocks of razor clam. Harvesting is done daylight and during low tide period. Major harvesting is done during low tide of spring period (locally known as "jawar"). Although harvesting is done even during low tide of neap period (locally known as "baigi") but since period and area of exposure is limited, therefore, smaller quantities are harvested. An adult person can usually harvest about 10 to 50 kg of razor clams in a day. A young fisherwoman at Khobbar Creek was interviewed who is reported to harvest more than 50 to 70 kg in a day. After collection, the razor clams are washed to get rid of mud by dipping wicker basket or perforated plastic crates in sea. The catch from the area is brought to collection point of middleman in wicker baskets or in perforated plastic crates (Fig. 16). At major fishing grounds, middlemen may bring their vehicles or boats to collect razor clams.

Fig. 16. Razor clams are brought to trading centers in (a) wicker baskets and (perforated plastic crates.

Razor clams from Indus Creek system are brought to 15 major collection centers (Fig. 17) from where these are transported by another set of middlemen who supply the material to processor, packers or exporters (Table-2). After collection of razor clams from the area it is transporter to exporters based in Karachi. Usually one exporter process and pack about 500 kg to 3,000 kg razor clams per day, if exported live (by air) or processor about 20,000 to 25,000 kg if shipment has to be made in frozen form.

Commercial harvested of razor clams from fishing grounds is being undertaken throughout the year. Highest production was observed during summer months whereas in winter and rainy seasons, the commercial production of razor clams is decreased substantially. During rainfall, the holes/burrows of the razor clam get choked with fine silt and debris bought by rain water, making it difficult to harvest the clams. Harvesting of razor clams is seriously affected during such periods and at times leading to their mortality during prolong period of rain. High mortality was also observed during summer months especially those clams living in upper littoral zones are seriously affected by heat waves. During winter production decreases because razor clams, being cold blooded, reduce their biological activities and remain deep in their burrows.

Table 2. Daily landing quantity of Razor clam fishery at major landing centers.

Creek/Harvesting Area	**Landing Centre**	**Quantity (m. tons/day) Minimum**	**Quantity (m. tons/day) Maximum**
Phitti creek	Harjina Bridge Bhambhoor	2	16
Khuddi creek	Darya Peerabad	2	15
Khuddi creek	Katiyar Jo Tar	3	18
Khai creek (Qasuwaro Rail)	Khararo Tarr (Jattan Waro)	2	14
Paitiani creek	Laro Petiani Narr (Samoon Jo Tar)	2	18
Dhambri creek	Bhaghaar Jo Tarr (Kun-Chhan Narr)	4	10
Sapandri creek	Paariro Tarr	3	4
Malh Narr	Paariro Tarr	2	4
Dhabbo creek	Amber	2	11
Chaan creek	Kherani	2	3
Hajamro	Keti Bandar Landing Centre -1	2	15
Hajamro	Keti Bandar Landing Centre -2	1	14
Turshian creek	Ahmed Jatt	2	14
Khobbar creek	Keti Bandar Landing Centre -4	1	16

After Mahar (2018).

Fig. 17. Razor clams brought to collection centers in creek areas of Sindh.

Fig. 18. Razor clams are transported to processing plants in plastic crates.

Processing and Packaging

In the processing and packaging facilities, the razor clams upon receipt (Fig. 19) are graded, sorted according to size (Fig. 20) and made into bundles of 1 kg (15 to 30 clams) (Fig. 20). Since razor clams live in burrows, therefore, if these are left as it is, then the shell gape and ultimately razor clam dies, therefore, rubber bands are wrapped around the bundle. About 10-12 bundles of razor clams (1 kg each) are packed in plastic net bags (Fig. 21) which are placed in thermophore boxes with ice (1 frozen bottle of 500 mL) and exported live by air to the China (mainly Shanghai) or Persian Gulf countries.

Fig. 20. In processing plants razor clams are (a) graded and (b) made into bundles of 1 kg.

Frozen razor clams are exported in 5 kg packs (Fig. 21) to China, Thailand, Korea and Taiwan to a lesser extent to Korea. Frozen razor clams are also exported to Malaysia in 1 kg packs. The demand for razor clams is at peak in winter months especially February which coincides with Chinese New Year. In summer, export of live razor clams is difficult because of high ambient temperatures from harvesting to export.

Small quantities of razor clams were exported in frozen form to Australia for use as bait, however, only a few consignments could be sent in 2014. An attempt was made by a processor to export *Siliqua radiata* to Thailand. For the purpose *Siliqua* were harvested from between Do Darya and Village Restaurant, along Clifton Coast Karachi, however, size range was considered small, therefore, only small quantities were exported in one consignment.

The data of export was obtained from Marine Fisheries Department which revealed that export is increasing in the last four years (Fig. 22). It indicates that about 500 m. tons of razor clams in frozen and live forms are exported from Pakistan generating an annual revenues of about 1.0 million.

Management of the Resources of Razor Clams

Because of sedentary nature of razor clams, these are prone to over exploitation which is mainly evident from decreasing size of the clams. It was previously noted the community over-harvest the fishing grounds by catching almost all razor clams including juveniles (less than 5 cm) from the area. With the passage of they now realized that once sustainable harvesting is done in particular area, the fishermen (harvesters) move to other ground and let the stock replenish in 5 to 10 months. In some cases, the important mudflat are allowed to replenish stocks in about in 2 years. This local management strategy has resulted in sustainable exploitation of razor clams in Indus Deltaic creeks and in the areas in Balochistan

Fig. 21. Bundles of razor clams are packed in (a) plastic nettings and exported live in (b) Styrofoam boxes.

Fig. 22. Export of razor clams from Pakistan (Source: Marine Fisheries Department).

Under the Sindh Fisheries Ordinance, 1970 Rule No. 5(3) SO (FISH)/L &A) dated 18 May 2016, minimum size for harvesting was notified to be 10 cm. However, there is no mechanism for monitoring of fisheries of razor clams in Sindh and harvesting is being done unabated. It is worth noting that harvesting of razor clams is ever increasing (Fig. 22), therefore, it is feared that their stocks may be over-exploited and some of the important mudflats may be depleted if uncontrolled harvesting is continued.

CONCLUSION

Razor clams are edible bivalves which are harvested mainly from mudflats in the Indus Delta. Of the 14 species of razor clams known from Pakistan only fingered razor clam (*Solen dactylus*) is harvested using traditional techniques of salt as an irritant. Both live and frozen razor clams are exported to Southeast Asian and Fareast Asian countries whereas small quantities are exported to Gulf countries. Although there is no management regime placed for the harvesting of razor clams in Pakistan, however, fishermen communities involved in this industry keep on switching fishing grounds, one stocks are depleted or major reduction in the size of harvested clams is noticed. Enough period of 5 to 10 month is given for the recovery of fishing ground and again harvesting is started. Harvesting of razor clams was start in2004

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