



## Aquatic Invasions Records

## An overlooked and unexpected introduction? Occurrence of the spotted scat *Scatophagus argus* (Linnaeus, 1766) (Osteichthyes: Scatophagidae) in the Maltese Islands

Edwin Zammit and Patrick J. Schembri\*

Department of Biology, University of Malta, Msida 2080, Malta

E-mail: [patrick.j.schembri@um.edu.mt](mailto:patrick.j.schembri@um.edu.mt) (PJS), [ezam0002@um.edu.mt](mailto:ezam0002@um.edu.mt) (EZ)

\*Corresponding author

Received: 6 May 2011 / Accepted: 21 June 2011 / Published online: 20 July 2011

### Abstract

The spotted scat *Scatophagus argus* (Linnaeus, 1766) is recorded for the first time from Malta and the Mediterranean from fish offered for sale at a Maltese fish market. Interviews with fish sellers and fishermen showed that this fish is caught occasionally in small numbers in trammel nets from shallows on seagrass meadows in the southeast of Malta and that it has been present since at least 2007. The native range of the species is the Indian Ocean and the tropical to warm temperate Pacific but the species is commercially available as a brackish water aquarium fish. Given that this species has also been regularly imported into Malta by the aquarium trade since at least 1986, an escape or deliberate release by an aquarist seem to be the most probably mode of introduction. It is surprising that this euryhaline species which requires brackish water to complete its life cycle should have become established in Malta where there is a dearth of such habitats.

**Key words:** Malta, central Mediterranean, alien species, aquarium trade, brackish water

### Introduction

The number of non-indigenous fishes recorded from the Mediterranean shows an increasing trend with time and the tally is presently some 149 species (Zenetos et al. 2010). Much work has been done on the origins of this non-native fauna. The picture that has emerged is that most species have entered autochthonously from the Red Sea via the Suez Canal and from the NE Atlantic via the Strait of Gibraltar, and that once inside the Mediterranean, some have expanded their range, driven by a warming trend of the Mediterranean surface waters, in some cases assisted by human-mediated dispersal (Galil 2008, 2009; Ben Rais Lasram and Mouillot 2009; Occhipinti-Ambrogi and Galil 2010; Zenetos et al. 2010). However, for some species, it is not always clear how they arrived in the Mediterranean. For example, *Omobranchus punctatus* (Valenciennes, 1836) is an Indo-Pacific blenny that does not occur in the Red Sea but a single specimen was recorded from the port of Ashdod, Israel in 2003 (Golani 2004); it is possible that this species reached the Suez Canal through ship-mediated transport (Bath 1980) and

thence the Mediterranean. Similarly, the circumtropical *Bregmaceros atlanticus* Goode and Bean, 1886 was first recorded as a single specimen from the Strait of Sicily in 1965, then in 2004 and 2006 from off the coasts of Turkey and Israel in numbers; Goren and Galil (2006) speculate that, given its wide distribution, *B. atlanticus* may occur as yet undiscovered populations in the Red Sea from where it entered the Mediterranean, or else it may have been introduced with ballast water.

For some non-indigenous species, it is almost certain that access to the Mediterranean was gained through human introduction (Galil 2009). Particularly clear cut examples are those where the species in question do not occur anywhere near the two entry points to the Mediterranean, and therefore the possibility of autochthonous introduction is remote. Examples of such species are the single specimen of *Epinephelus merra* Bloch, 1793 from the Indo-Pacific excluding the Red Sea, captured off the coast of Île des Embiez, France in 2004 (Lelong 2005), the single specimen of *Elates ransonnetti* (Steindachner, 1876) from the Western Central Pacific, introduced to the Gulf of Taranto, Italy in 2005 (Mastrototaro et al. 2007), *Tridentiger*

*trigonocephalus* (Gill, 1859) from the North West Pacific, recorded in 2006 from Ashdod Harbor, Israel, where it occurs in groups (Goren et al. 2009), and most recently, *Oplegnathus fasciatus* (Temminck et Schlegel, 1844) from the North West and Eastern Central Pacific, recorded from two specimens from Malta in 2009 (Schembri et al. 2010).

Here we report on another species of Pacific fish that has been introduced into the Maltese Islands. What is interesting about this record is that this species was apparently introduced since at least 2007 and that it may have become established in Maltese waters, even though initially it would seem an unlikely candidate for colonization given that it is a euryhaline species.

### Records

The fish first came to our attention on 14 March 2011 when a colleague spotted unfamiliar fish offered for sale at the Marsaxlokk Sunday fish market. The seller had four such fish ranging in size from 64mm TL to 127mm TL. On being questioned, the seller stated that the fish were caught locally but he did not know what they were or where they were caught. Unfortunately, at the time, our informant did not acquire any of the fish; however, a specimen (Figure 1) was recovered later the same day from a pile of fish discards left by the fish sellers at the end of the market day. This species was identified by us as *Scatophagus argus* (Linnaeus, 1766). Subsequent visits to the Marsaxlokk fish market over the next few weeks did not result in observing any more specimens. However, three of four fish sellers at the market, when shown a photograph of the fish, recognized it as one they had offered for sale in the past. According to these sellers, this species had only recently appeared and two of them stated that it was caught in gill nets but they did not know from where and neither could they tell us which fishermen had supplied them. Next we interviewed fishermen. One remembered catching a similar fish he did not recognize in a trammel net on 17 February 2011; fortunately however, a photograph of the fish had been taken and this too was identified as *S. argus*. Another fisherman immediately recognised the fish as one he occasionally catches in trammel nets from depths of around 1.5m on seagrass (*Posidonia oceanica*) meadows in the southeast of Malta from Zurrieq to Xrobb l-Ghagin. The fisher did not recall when the fish

first appeared but he had caught it since at least 2007, as he remembered catching the fish in numbers in that year. According to our informant, at the time, the fish occurred in small groups of individuals of length ca 8-10cm; subsequently the fish became rare and at present he only catches one or two fish, which are however of larger size (ca 25cm length). He now mainly catches these fish in the Xrobb l-Ghagin area of southern Malta.

### Remarks and discussion

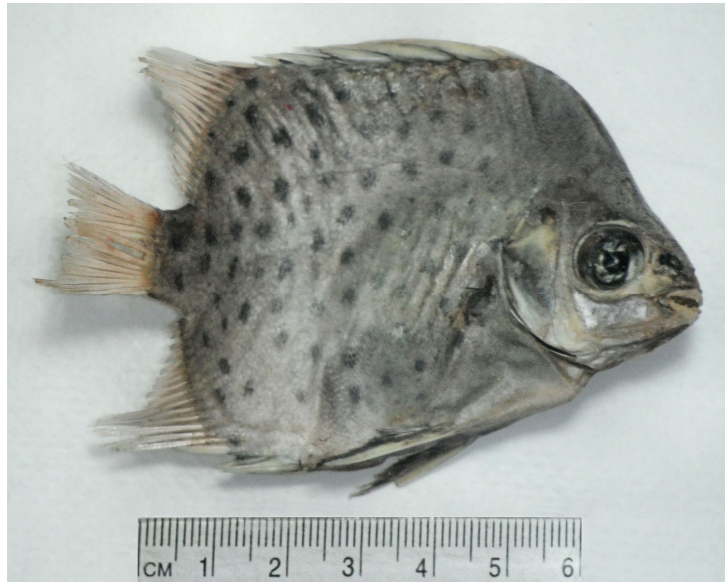
We have no reason to doubt that *Scatophagus argus* is being caught in local waters in small numbers and all indications point to this species having established a breeding population since at least 2007, but has been overlooked until now. This is therefore a new addition to the non-indigenous fish fauna of the Maltese Islands, and as far as we are aware, also the first report of this species occurring in the wild in the Mediterranean. This is an unexpected occurrence.

The spotted scat has a native range that includes practically the whole of the coastal area of the Indian Ocean and the tropical, subtropical and warm temperate Pacific, with a few rare records from as far north as the southern Kuril Islands (references in Kharin and Milovankin 2008); however it does not seem to occur in the Red Sea (Froese and Pauly 2011). A single individual was collected off Cedar Key, Levy County, Florida, in 1992 (Schofield 2009).

The fish is euryhaline and eurytopic and has been reported from such diverse freshwater, brackish and marine habitats as the lower reaches of rivers, estuaries, mangrove swamps, the surf zone of beaches, coastal mudflats and harbours (Barry and Fast 1992; Ghandi 2002; Yoshimura et al. 2003).

The fish has a reputation for being coprophagous (hence the generic name), however this does not seem to be the case since Barry and Fast (1992) report it to be herbivorous on algae on the basis of stomach content analysis of freshly captured fish, while Ghandi (2002) reports it feeding mainly on multicellular algae and detritus but also opportunistically taking other food including small benthic invertebrates. Wongchinawit and Paphavasit (2009) consider the feeding strategy to change as the fish ages, with the larvae feeding on phytoplankton near the surface, juvenile fish feeding on benthic diatoms, zooplankton, benthic invertebrates and

**Figure 1.** Specimen of *Scatophagus argus* recovered from the Marsaxlokk fish market, Malta on 14 March 2011. Photograph by Edwin Zammit.



detritus, and the adults being mainly detritivorous and opportunistic predators on benthic invertebrates.

Barry and Fast (1992) report fish to attain sexual maturity at 14cm SL for females and 12cm SL for males; females may reach a size of 28cm SL and males 27cm SL (Barry and Fast 1992), however fish as large as 33.4cm TL have been caught (Khan 1979). In the Philippines, the fish spawn in June, coincident with the onset of the monsoon rains, and recruitment peaks in August (Barry and Fast 1992).

The spotted scat is considered a trash fish in some parts of its range but as an important food species in others, for example, southern and south-eastern Asia (Barry and Fast 1992). It has been introduced as an aquaculture species in Taiwan, however, it is of minor importance (Liao et al. 2001). The species is of commercial importance as a brackish water aquarium fish and juveniles are collected in numbers from the wild for the aquarium trade (Barry and Fast 1992; Froese and Pauly 2011; The Aquarium Wiki 2011) There do not seem to be any reports of aquarists breeding this fish, a situation attributed to the apparent need of the species for different ambient salinities during ontogeny; it seems that the fry and juveniles live in brackish water (Barry and Fast 1992) but adults need full strength seawater to breed (Hering 2000).

The obvious question that arises is how did the fish reach the Maltese Islands. Since there are no reports of this species occurring in the wild in the Mediterranean, it does not seem likely that the fish arrived in Malta from elsewhere in the Mediterranean through dispersal or introduction from an established population. Given its natural habitat, neither does it seem likely that the fish was transported by shipping or other maritime transport from outside the Mediterranean in the manner that *Oplegnathus fasciatus* has reached Malta from the Pacific (Schembri et al. 2010). Introduction via aquaculture is also ruled out. Given that this fish is a popular aquarium species, the most probable mode of introduction is the aquarium trade. Consequently we checked importation records and visited aquarium shops to enquire about availability of the species.

Records of imports from non-European Union countries show that since 2007, *Scatophagus argus*, '*Scatophagus rubrifrons*' and unspecified *Scatophagus* spp. have been imported into Malta from Indonesia, Thailand, Singapore and Malaysia by different importers under a 'freshwater fish' licence. There may have been additional imports from EU member states, but since no import licence is required for intra-EU movement of goods, there are no records of such. Species of *Scatophagus* have been imported for

years before 2007 (Joseph Abela Medici, personal communication, 2011). Visits to three large aquarium shops showed that all either had the fish on display or on order from Indonesia or 'Asia'. The species in question were given as 'Green scat *Scatophagus argus*', 'Red scat *Scatophagus argus atromaculatus*', and 'Red tiger scat *Scatophagus tetracanthus*', all in the size range 2–6.5cm. Searches in the archives of Maltese on-line aquarium forums revealed correspondence that showed that some correspondents had been keeping species of *Scatophagus* (reported as *S. atromaculatus* or *Scatophagus 'rubrifrons'*) since at least 1986.

*Chaetodon atromaculatus* Bennett, 1830 is a junior synonym of *S. argus* and is considered a colour morph of *S. argus* often also referred to as *Scatopagus argus 'rubrifrons'*; Barry and Fast (1992) are of the opinion that '*rubrifrons*' is a juvenile stage in the development of *S. argus* and these fish develop the adult brownish-green coloration with dark spots as they grow older. Nonetheless, there seem to be regional differences in the colour pattern of juvenile fish (Kottelat 2001). *Scatophagus tetracanthus* (Lacepède, 1802) is a valid species that is easily distinguished from *S. argus* by its vertical dark bars.

Therefore, there has been ample scope for introduction of the spotted scat into Maltese marine waters through the aquarium trade. We speculate that this most likely happened when fish being kept in a home aquarium became too large for the tank and were released into the sea. Online aquarist forums frequently warn that the fish grow rapidly to a size (20–30cm) that requires large holding tanks, which are probably beyond what most home aquarists can cope with. The single record of an alien *S. argus* from Florida is also attributed to an aquarium release (Schofield 2009).

What is surprising given the requirement for brackish water as part of the life cycle of the fish, is that the species may have managed to establish a breeding population in spite of the lack of any rivers or even streams in the Maltese Islands or of any brackish water anywhere in the vicinity of the area where the fish are reportedly caught from. There is always the possibility that the repeated capture of specimens of *S. argus* is due to multiple releases over time, but this seems unlikely.

We wish to sound a note of caution concerning assessment of potential impact of the importation of non-indigenous fish for the

aquarium trade on local biodiversity. One of us (PJS) has often participated in such assessments and given the natural area of distribution of *S. argus*, the mostly subtropical to tropical climates in which the fish occurs, the reported temperature range (20–28°C; Froese and Pauly 2011) relative to Maltese sea surface temperatures, and the reported requirement for brackish water habitats in relation to the dearth of such habitats in the Maltese Islands, this species would have been assessed as of low risk of establishment. Nonetheless, *S. argus* seems to have established itself in Maltese waters, suggesting that such risk assessments are not foolproof.

### Acknowledgements

We thank Franky Scerri and Jonathan Sammut for bringing the fish to our attention and for collecting the specimen; we also thank fishermen J. Abela and J. Caruana for providing us with information on the occurrence of the species in Maltese waters. We are grateful to the numerous persons who helped us in the preparation of this paper by generously providing information, especially Mark Gatt (Agriculture and Fisheries Regulation Department, Malta) for a photograph of the juvenile fish, and Joseph Abela Medici (Malta Environment and Planning Authority, Malta) for information on importation and aquarium culture of the species. An anonymous referee suggested improvements to an earlier draft of this paper, for which we are thankful.

### References

- Barry TP, Fast AW (1992) Biology of the spotted scat (*Scatophagus argus*) in the Philippines. *Asian Fisheries Science* 5: 163–179
- Bath H (1980) *Omobranchus punctatus* (Valenciennes 1836) neu im Suez-Kanal (Pisces: Blenniidae). *Senckenbergiana Biologia* 60: 317–319
- Ben Rais Lasram F, Mouillot D (2009) Increasing southern invasion enhances congruence between endemic and exotic Mediterranean fish fauna. *Biological Invasions* 11: 697–711, doi:10.1007/s10530-008-9284-4
- Froese R, Pauly D (eds) (2011) FishBase. World Wide Web electronic publication, <http://www.fishbase.org>, version (02/2011) (Accessed 30 April 2011)
- Galil BS (2008) Alien species in the Mediterranean Sea— which, when, where, why? *Hydrobiologia* 606: 105–116, doi:10.1007/s10750-008-9342-z
- Galil BS (2009) Taking stock: inventory of alien species in the Mediterranean Sea. *Biological Invasions* 11: 359–372, doi:10.1007/s10530-008-9253-y
- Gandhi V (2002) Studies on the food and feeding habits of cultivable butterfish *Scatophagus argus* (Cuv. and Val.). *Journal of the Marine Biological Association of India* 44 (1-2): 115–121
- Golani D (2004) First record of the muzzled blenny (Osteichthyes: Blenniidae: *Omobranchus punctatus*) from the Mediterranean, with remarks on ship-mediated fish introduction. *Journal of the Marine Biological Association of the United Kingdom* 84: 851–852, doi:10.1017/S0025315404010057h

- Goren M, Galil BS (2006) Additional records of *Bregmaceros atlanticus* in the eastern Mediterranean – an invasion through the Suez Canal or in ballast water? *Marine Biodiversity Records* 1e 42: 1–3
- Goren M, Gayer K, Lazarus N (2009) First record of the Far East chameleon goby *Tridentiger trigonocephalus* (Gill, 1859) in the Mediterranean Sea. *Aquatic Invasions* 4: 413–415, doi:10.3391/ai.2009.4.2.22
- Hering W (2000) *Scatophagus argus* - how long can you keep them? Calypso Fish and Aquaria Club, London, England. Aquarticles, [http://www.aquarticles.com/articles/breeding/hering\\_Scats.html](http://www.aquarticles.com/articles/breeding/hering_Scats.html) (Accessed 30 April 2011)
- Khan MZ (1979) A note on the occurrence of a large sized spotted butterflyfish *Scatophagus argus* (Linnaeus) at Rajpara (Gujarat). *Journal of the Marine Biological Association of India* 21(1-2): 193–194
- Kharin VE, Milovankin PG (2008) A new finding of rare species *Scatophagus argus* (Scatophagidae) in Russian waters. *Journal of Ichthyology* 48(9): 822–824, doi:10.1134/S0032945208090130
- Kottelat M (2001) Scatophagidae. In: Carpenter KE, Niem VH (eds) (2001) FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Volume 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine mammals. FAO, Rome, pp 3623–3626
- Lelong P (2005) Capture d'un macabite, *Epinephelus merra* Bloch, 1793 (Poisson, Serranidae), en Méditerranée nord-occidentale. *Marine Life* 15(1-2): 63–66
- Liao CI, Su HM, Chang EY (2001) Techniques in finfish larviculture in Taiwan. *Aquaculture* 200: 1–31, doi:10.1016/S0044-8486(01)00692-5
- Mastrototaro F, Carlucci R, Capezzuto F, Sion L (2007). First record of dwarf flathead *Elates ransonnetii* (Platycephalidae) in the Mediterranean Sea (North-Western Ionian Sea). *Cybius* 31(3): 393–394
- Occhipinti-Ambrogi A, Galil B (2010) Marine alien species as an aspect of global change. *Advances in Oceanography and Limnology* 1(1): 143–156, doi:10.1080/19475721003743876
- Schembri PJ, Bodilis P, Evans J, Francour P (2010) Occurrence of *Oplegnathus fasciatus* (Temminck et Schlegel, 1844) (Actinopterygii: Perciformes: Oplegnathidae) in Malta (Central Mediterranean) with a discussion on possible modes of entry. *Acta Ichthyologica et Piscatoria* 40(2): 101–104, doi:10.3750/AIP2010.40.2.01
- Schofield PJ (2009) *Scatophagus argus*. USGS Non-indigenous Aquatic Species Database, Gainesville, FL, Revision Date: 4/27/2009. <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=945> (Accessed 30 April 2011)
- The Aquarium Wiki (2011) Green Scat (*Scatophagus argus*), last modified on 23 February, 11. [http://theaquariumwiki.com/Scatophagus\\_argus](http://theaquariumwiki.com/Scatophagus_argus) (Accessed 30 April 2011)
- Wongchinawit S, Paphavasit N (2009) Ontogenetic niche shift in the spotted scat, *Scatophagus argus*, in Pak Phanang estuary, Nakhon Si Thammarat province, Thailand. *The Natural History Journal of Chulalongkorn University* 9(2): 143–169
- Yoshimura K, Yamane T, Utsugi K, Kohno H (2003) Seasonal occurrence and abundance of the spotted scat, *Scatophagus argus*, in surf zones and rivers of the northern coast of Bali, Indonesia. *Mer* 41 (2–3): 82–85
- Zenetos A, Gofas S, Verlaque M, Inar ME, García Raso E, Bianchi CN, Morri C, Azzurro E, Bilecenoglu M, Froggia C, Siokou I, Violanti D, Sfriso A, San Martín G, Giangrande A, Katağan T, Ballesteros E, Ramos-Esplá A, Mastrototaro F, Ocaña O, Zingone A, Gambi MC, Streftaris N (2010) Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. *Mediterranean Marine Science* 11(2): 381–493