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FIRST RECORDS OF THE CALICO SCALLOP *ARGOPECTEN GIBBUS* (L.) AND THE TRANSVERSE ARK CLAM *ANADARA TRANSVERSA* (SAY, 1822) (MOLLUSCA: BIVALVIA) FROM IRISH WATERS

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Abstract

On 18 July 2016, eight Calico Scallops *Argopecten gibbus* (L.) and one Transverse Ark Clam *Anadara transversa* (Say, 1822) were found inside the hull of a plastic toy boat stranded on Fanore Beach, County Clare, on the west coast of Ireland. The *A. gibbus* specimens represent the first records from European and NE Atlantic waters, while the *A. transversa* specimen represents the first record from Irish waters and the most northerly European Atlantic record to date. The distribution of both species within the Atlantic Ocean, and their potential invasiveness in Irish waters is reviewed.

Key words: *Argopecten gibbus*, *Anadara transversa*, non-native species, first records, Ireland.

Introduction

Many species have undoubtedly been dispersing by rafting on natural flotsam (e.g. wood, algae, seeds, animal remains, ice and volcanic pumice) and stranding on foreign shores for millennia, long before the recent worldwide increase in anthropogenic rafting substrates (e.g. plastics and tar) discarded by humans (Thiel and Gutow, 2005a, b; Thiel and Haye, 2006; Kiessling *et al*., 2015). The increasing volume of plastic rafting substrates in the oceans are likely to contribute to propagule pressure, and combined with the effects of both natural and/or human induced climatic change, may facilitate the successful establishment of an increasing number of non-native species well beyond their current natural ranges (Barnes, 2002; Barnes and Milner, 2005; Gregory, 2009; Cozar *et al*., 2014; Rech *et al*., 2016, 2018a, b; Therriault *et al*., 2018). Although several species of non-native marine mollusca have been recorded on various anthropogenic rafting substrates in Irish and U.K. waters, none of them appear to have become established (Minchin *et al*., 2013; Holmes *et al*., 2015; Quigley and Hill, 2015a).

On 18 July 2016, LMN discovered a plastic toy boat (Plate 1) stranded on Fanore Beach (M0140080; 53.1049°N, 09.2955°W), County Clare, on the west coast of Ireland. Eight Calico Scallops *Argopecten gibbus* (L.) and one Transverse Ark Clam *Anadara transversa* (Say, 1822) were found inside the hull of the vessel (Plate 2). Although all of the specimens were dead (Plate 3), the shells were intact (Plates 4-5), and each contained the remains of desiccated muscle tissue (Plates 6-7) which suggests that they were all probably still alive when stranded.

It is thought that the bivalves probably gained entry as pelagic larvae into the flooded hull of the boat *via circa* 1mm gaps around the superstructure retaining clips. The pelagic larvae of *A. gibbus* and *A. transversa* are known to settle at a shell length of 235-270µ (Costello *et al*., 1973) and 240-260µ (Loosanoff and Davis, 1963) respectively, a larval size range that could easily fit through the superstructure gaps.

The external surface of the deck superstructure was largely covered by a bryozoan colony (*Membranipora* sp.), whereas there was no epibiont growth on the external flat surface of the keel. This suggests that the boat had been drifting for a relatively long period in a capsized position. Indeed, when flooded with water, it is likely that the submerged external deck superstructure would have provided keel-like stability. The flooded internal structure of the deck superstructure compartments would also have provided further ballast-like stability and a more stable foothold for the subsequently entombed bivalves.

Various estimates have been made regarding the expected time interval for passive eastward long-range dispersal of drift objects from the south-eastern U.S.A. to Western Europe, ranging from 14-18 months (Quigley *et al*., 2014 and references therein), which is well within the estimated maximum 24-month life span of both *A. gibbus* (Costello *et al*., 1973) and *A. transversa* (EOL, 2018).

Details on shell morphometrics are summarized in Table 1. According to Broom (1976), *A. gibbus* attains a maximum shell length of 80mm, and reaches sexual maturity at four months of age, at a shell length of 19mm. The length range of the *A. gibbus* shells was 12-24mm (mean 17mm), which suggests that at least two specimens (>19mm) were probably mature. According to Walker and Power (2003), *A. transversa* attains a maximum shell length of 38mm, and reaches sexual maturity at a shell length of 10mm (Walker and Power, 2003). The shell length of the single *A. transversa* specimen was 8mm, which suggests that it was probably immature.

The current specimens were donated to the National Museum of Ireland – Natural History Division (NMINH). The *A. gibbus* specimens (NMINH: 2017.3.1) represent the first records from European and NE Atlantic waters, while the *A. transversa* specimen (NMINH: 2017.4.1) represents the first record from Irish waters and the most northerly European Atlantic record to date.

Calico Scallops *Argopecten gibbus* (L.) (Bivalvia: Pectinidae)

Argopecten gibbus is native to the western North Atlantic, ranging from Delaware Bay, U.S.A. (39°N) southwards to the Gulf of Mexico (20°N), where it commonly occurs at depths of

10-400m (Abbott, 1974; Hill, 2005; Turgeon *et al.*, 2009; Geiger *et al.*, 2015). However, records on the Global Biodiversity Information Framework (GBIF, 2018) indicate that the species is not uncommon further southwards (to 5.1°N, 52.0°W), particularly in the Caribbean Sea (Cuba, Puerto Rico, Virgin Islands and Guadeloupe), and along the northern coast of South America (Columbia, Venezuela, Guyana, Suriname and French Guiana). Rios (2009) noted that *A. gibbus* has been recorded from Brazil, ranging from Amapá (in the north) to Bahia (in the northeast).

GBIF (2018) also list a number of dubious records of *A. gibbus* from locations well outside the species native range, including SW Brazil (Guarapari Reserve, Espirito Santo, 20.8°S, 40.1°W; GBIF 1435832524; UFRJ 15725), Western Australia (Gladstone, Queensland, 23.9°S, 151.3°E; GBIF 1272231399; WAM S28942), and NW Africa, including two preserved specimens from the Azores (38.6°N, 28.5°W; GBIF 1056175263; NHMUK: 1887.2.9.3261), which were taken during the Challenger Expedition (Station No. 75) at a depth of 823m on 2 July 1873, and one undated preserved specimen from Senegal (GBIF 1038160884; LMD: 262759). The Azorean and Senegalese specimens are listed as *Pecten gibbus* (L.) *sensu* Philippi, 1836 in the original NHMUK and LMD registers (Tom White and Stefan Curth pers. comm.). *P. gibbus* is a junior synonym of *Aequipecten commutatus* (Monterosato, 1875) which ranges from the Mediterranean Sea and adjacent region of the Atlantic (Portugal) southwards to Senegal, including the Azores, Selvagens, Madeira, Canaries, and Cape Verde Islands, usually at depths of 15-300m, but occasionally down to 2700m (Poppe and Goto, 2000; Dijkstra and Goud, 2002). Indeed, Wagner (1985, 1991) concluded that the genus *Argopecten* was not represented in Europe, and Adrovini and Cossignani (2004) did not include the genus in their list of West African Seashells. Goninon (pers. comm.) confirmed that *A. gibbus* is not established in Western Australia, and Dias Passos (pers. comm.) remarked that the species has not been recorded from either the southeastern or the southern coasts of Brazil.

In laboratory experiments, successful spawning was induced in *A. gibbus* at water temperatures of 20-25°C, and the pelagic larval stage persisted for 16 days prior to settlement (Costello *et al.*, 1973), typically on hard substrata. In another experiment, the species did not survive 48-hour exposure to water temperatures of 10°C (Vernberg and Verenberg, 1970).

Transverse Ark Clam *Anadara transversa* (Say, 1822) (Bivalvia: Arcidae)

Anadara transversa is native to the western North Atlantic where it commonly occurs in coastal waters at depths ≤ 161m from Cape Cod, Massachusetts, U.S.A. (41.7°N, 70.3°W) southwards to the Yucatan, Mexico (*circa* 20.7°N, 89.1°W) (Abbott, 1974; Turgeon *et al.*, 2009; GBIF, 2018).

GBIF (2018) also list a number of dubious records of *A transversa* from various locations well outside the species native range, including Canada (Bay of Fundy, *circa* 44.9°N, 65.4°W; GBIF 113843145; HMSC 9952157), Bahama Islands, Caribbean Sea (Puerto Rico and Antigua), Panama (*circa* 9.3°N, 79.9°W), Brazil (Praia das Charitas, Niteroi, *circa* 22.9°S, 43.1°S; GBIF 476902591; MCZ: 164885), Argentina (Puerto Madryn, Bahia Nuveva, Patagonia, *circa* 42.8°S, 65.1°W; GBIF 215644411; ANSP 170441), and Western Australia (Turkey Beach, Rodds Bay, S of Gladstone, Queensland, *circa* 24.1°S, 151.6°E; GBIF 899493190; UFIS 340148). Goodwin (pers. comm.) verified that the undated Canadian specimen (HMSC 9952157) was recorded in mud below low water at Sandy Point, St Croix River, in the vicinity of St Andrews, New Brunswick, and not in Nova Scotia as the GBIF co-ordinates indicate. Callomon (pers. comm.) confirmed that the Argentinian specimens (ANSP 170441) are not *A. transversa*. Zelaya (2016) did not include the species in his list of Argentinian marine bivalves, and confirmed that the species is not extant in Argentina (Zelaya pers. comm.). Dias Passos (pers. comm.) confirmed that there are no known records of *A. transversa* from Brazil and Goninon (pers. comm.) remarked that the species is not established in Western Australia.

In laboratory experiments, successful spawning was induced in *A. transversa* at water temperatures of 27-28°C and at 20°C the pelagic larval stage lasted 27-37 days (Loosanoff and Davis, 1963). *A. transversa* settles on rocky hard and muddy/sandy-muddy substrates and is particularly tolerant of polluted habitats (Fernandez-Rodriguez *et al*., 2016). Baker and Mann (1997) noted that post-larval *A. transversa* use a specialized drogue-like byssus to facilitate an extended period of planktonic drifting and thus increase their dispersal ability. Indeed, they suggested that post-larval drifting was probably an integral part of the species life cycle.

A. transversa was first recorded in European waters during 1972 from the Bay of Izmir (*circa* 38.4°N, 27.1°E), Turkey, Aegean Sea, NE Mediterranean. Since then, the species has become established throughout many parts of the Mediterranean (Nerlovic *et al*., 2012; Albano *et al*., 2018), and live specimens were recently discovered in the NE Atlantic as epibionts on intertidally cultivated Pacific Oysters *Magallana* (*Crassostrea*) *gigas* (Thunberg, 1793) in the Villaviciosa and Eo estuaries (*circa* 43.5°N), Cantabrian Sea, NW Spain (Fernandez-Rodriguez *et al*., 2016).

Albano *et al*. (2018) hypothesized that *A. transversa* was probably initially introduced into the Bay of Izmir *via* shipping, either in ballast water and/or as fouling epibionts. Its subsequent spread and establishment throughout the Mediterranean and its occurrence in NW Spain is thought to have been facilitated by the unintentional co-transport of larvae and/or juveniles with aquaculturally produced translocated bivalves (Fernandez-Rodriguez *et al*., 2016; Banon Diaz pers. comm.).

Discussion

Although the remains of desiccated muscle tissue in the *Argopecten gibbus* and *Anadara transversa* shells suggests that they were probably still alive when stranded, it is unlikely that either species could establish self-sustaining populations in Irish waters based on their relatively high sea water temperature requirements for spawning (>20°C). Although surface sea water temperatures (SST) around Ireland are about 7-8°C warmer than the global average at equivalent latitudes, primarily due to the North-Atlantic drift which transports warm water from the Gulf of Mexico to NW Europe (Anon, 2018a), they are still too low to support the survival of *A. gibbus* and *A. transversa*. The average SST on the west and south of Ireland ranges from 8-10°C in February-March and from 14-17°C in August, and is a couple of degrees colder on the north and east. The annual average SST at Fanore is 11.6 (range: 7.6-16.3°C) (Anon, 2018b). However, if current and predicted future increases in climatic warming continue (Hiscock *et al*., 2004; Boelens *et al*., 2005), it is possible that some passively rafting non-native warm-water species may eventually become established in Irish and other NW European waters.

A number of GBIF distributional records of *A. gibbus* and *A. transversa* were discovered to be erroneous. However, such errors are not surprising considering the historical and on-going difficulties concerning bivalve taxonomies (Bieler *et al*., 2010). Indeed, Maldonado *et al*. (2015) cautioned that all records on public biodiversity databases should be critically assessed and validated prior to being accepted as authentic.

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TABLE 1. Morphometrics of *Argopecten gibbus* and *Anadara transversa* shells.

Species	Length (mm)	Width (mm)	Depth (mm)
Argopecten gibbus	24	22	10
Argopecten gibbus	20	19	8
Argopecten gibbus	18	17	6
Argopecten gibbus	17	16	6
Argopecten gibbus	17	16	6
Argopecten gibbus	15	14	6
Argopecten gibbus	14	13	5
Argopecten gibbus	12	12	4
Mean	17	16	6
Range	12-24	12-22	4-10
Anadara transversa	8	5	4

PLATE 1. Plastic toy boat.

PLATE 2. *Argopecten gibbus* and *Anadara transversa* shells inside the hull of the plastic toy boat.

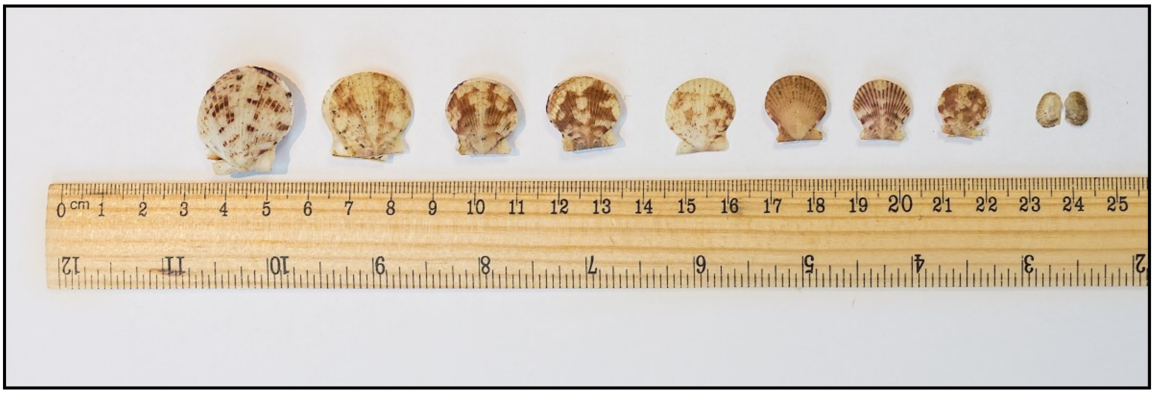

PLATE 3. *Argopecten gibbus* and *Anadara transversa* shells.

PLATE 4. *Argopecten gibbus* (external view of shells).

PLATE 5. *Anadara transversa* (external view of left and right valves).

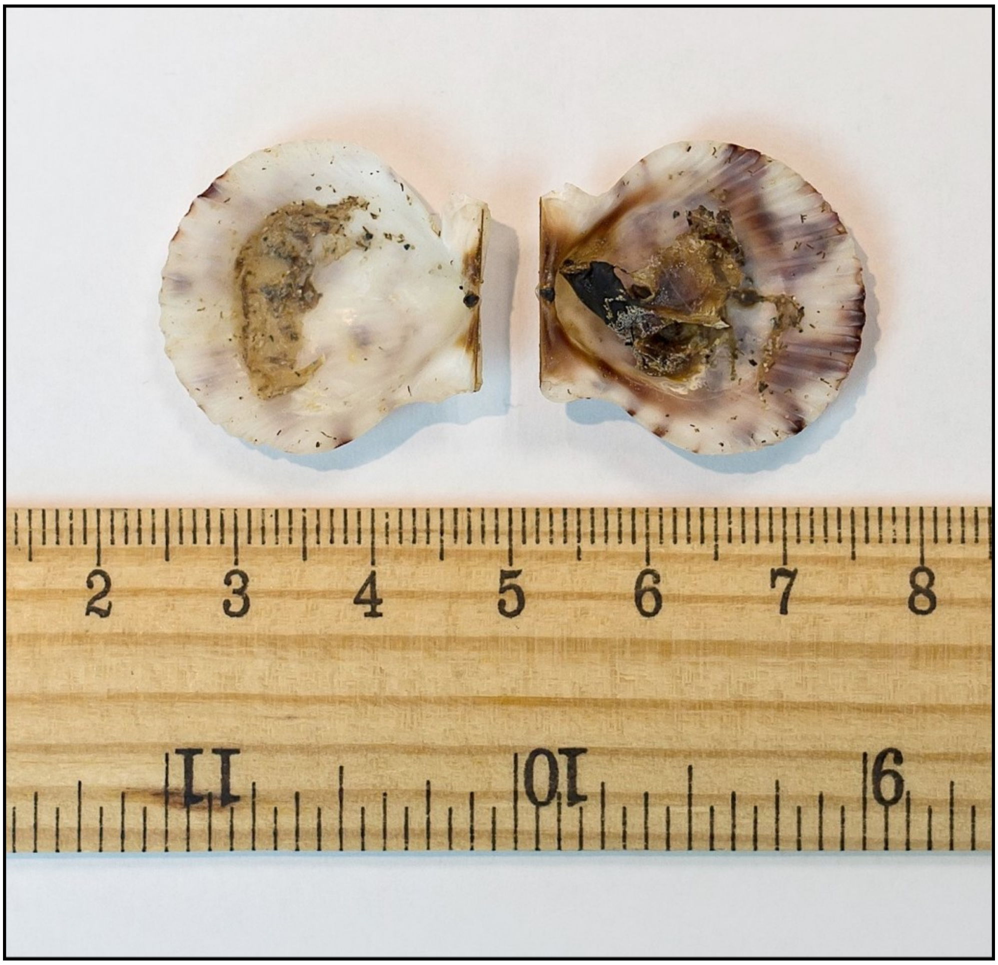

PLATE 6. *Argopecten gibbus* (showing tissue remains inside left and right valves).

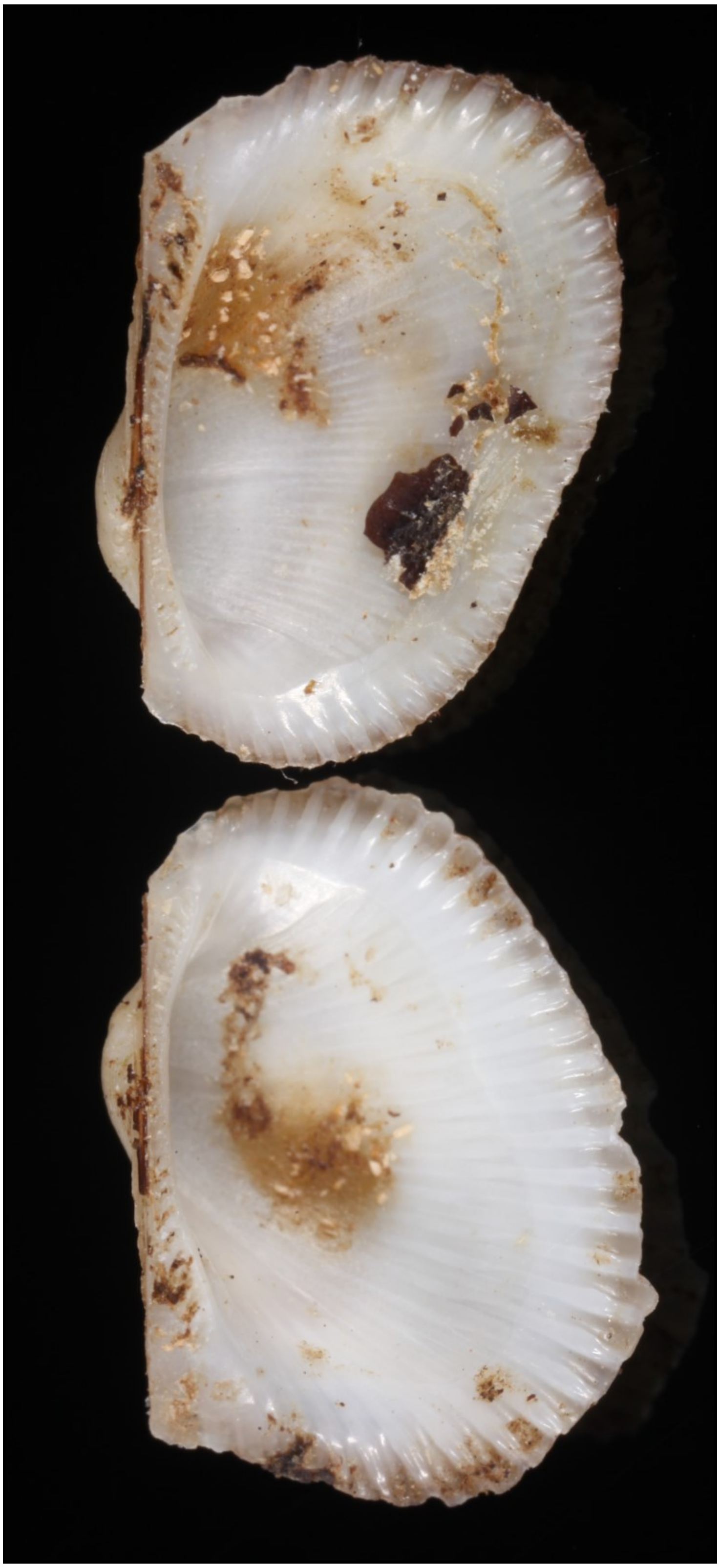

PLATE 7. *Anadara transversa* (showing tissue remains inside left and right valves).