First record of the invasive apple snail *Pomacea canaliculata* (Lamarck, 1822) (Gastropoda: Ampullariidae) in Shatt Al-Arab River, Southern Iraq with some ecological aspects

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Abstract

The present study dealt with record the invasion of the freshwater snail *Pomacea canaliculata* to Shatt Al-Arab River during 2014. Occurrence of *P. canaliculata* was studied from April 2014 to March 2015. Occurrence and abundance of the invasive snail with six native gastropod snails were recorded during this study from Shatt al- Arab River. The mean population density of *P. canaliculata* in Shatt Al-Arab were ranged from 2-26 ind./m² during December and July, respectively. Some morphological features were measured.

Key wards: Ampullariidae, Invasion, Shatt Al-Arab River, *Pomacea canaliculata*

Introduction

The Ampullariidae (Gastropoda) is a family of freshwater prosobranchs that are widely distributed in Asia, Africa, and South America (Perera and Walls, 1996).

The apple snail *Pomacea canaliculata* is a freshwater snail of the Ampullaridae family (Cowie, 2002). It is indigenous to south America (Yusa, 2001), and formerly found also in Central America, West Indies and the southern USA (Michelson, 1961). It recognized from California and Arizona, and there are two other species of *Pomacea* also occurred in the same locality, *P. insularum* from Florida, Texas and Giorgia and *P. hausrum* from Florida (Rawlings *et al*., 2007).

The snail *P. canaliculata* was introduced to Taiwan for commercial purposes in 1979 (Chang, 1985), and through irrigation channels it spread into different water streams and now become widely distributed in Taiwan (Wu *et al*., 2011). Since 1980s, the snail was distributed in many tropical, subtropical and temperate regions (Halwart, 1994). It spread to many locations such as Philippines in 1980 (Mochida, 1991; Anderson, 1993 and Halwart, 1994), Japan in 1981 (Fujio *et al*., 1991), Korea in 1986, Malaysia in 1987, Indonesian and Viet Nam in 1989 (Cowie, 2002), Hawaii in 1989 (Acosta and Pullin, 1991; Lach and Cowie,1999 and Mochida, 1991), then into others Asian countries.

The apple snails are of one group of freshwater gastropods which can feeding on diverse food by using different mechanisms including shredding, scraping and collecting (Saveanu and Martin, 2013).

In general, channeled apple snails represent a major risk to ecosystem and agriculture in native wetland (Rawlings *et al*., 2007). After invasion to many Asian countries, *P. canaliculata* has the worst pests of rice (Mochida, 1991; Halwart, 1994; Naylor, 1996; Yusa, 2001; Cowie, 2002 and Baloch *et al*., 2012) and causes serious damages to different aquatic crops (Cowie *et al*., 2006 and Wu *et al*., 2011) such as *Colocasia esculenta* (Taro), *Ipomoea aquatica, Nelumbo nucifera, Juncus decipiens, Cyperus monophyllus,* and others (Mochida, 1991) and it also causes damages to other submersed macrophytes

(Saveanu and Martin, 2013). On the other hand the snail *P. canaliculata* serve as intermediate host of the rat lungworm causing eosinophilic meningoencephalitis in human in countries of Taiwan and Japan (Mochida, 1991).The introduced *Pomacea* snails are serve as host for some parasites that threaten human health directly (Cowie, 2002).

P. canaliculata infest large areas in many countries estimated in Taiwan in 1986 as 171425 ha, in Japan in 1989 as 16196 ha and in Philippines in 1989 as 400000 ha (Mochida, 1991). In Singapore, this species was introduced via the aquarium trade, and was currently well-established in the reservoirs and other water bodies (Yeo & Chia, 2010). The reproduction seasons in south America extended from Spring to Summer (Andrews, 1964) While extend much wider in Taiwan (Wu *et al*., 2011). *Pomacea* snails lay their egg masses on the plants stems (Yusa, 2001) and on the objects that protruding above the water surface (Teo, 2004). As well as, these snails chracteristic with high fecundity and fast growth (Cowie, 2002).

Before 2014, *P. canaliculata* had not been reported from Iraq. However, early in that year, individuals of the snail *P. canaliculata* started to appear frequently in benthic samples from the Shatt Al-Arab River and in some its shallow branches. The purpose of the present study is to confirming record of the apple snail *p. canaliculata* from Shatt Al-Arab River for the first time in addition to evaluate the variability of the population density of this invasive snail compared with the other native snails live near it.

Materials and Methods

The samples for the population density purposes were collected by using the quadrate (30 X 30 cm) from shallow water bank between two sites along about 5 km sector of Shatt Al-Arab River (Fig. 1), during the period from April 2014 to March 2015 by monthly intervals. For the identification and measurement studies, different sizes of live specimens of *Pomacea canaliculata* were collected by hand picking. All specimens were brought to the laboratory and kept live in glass aquarium for further study.

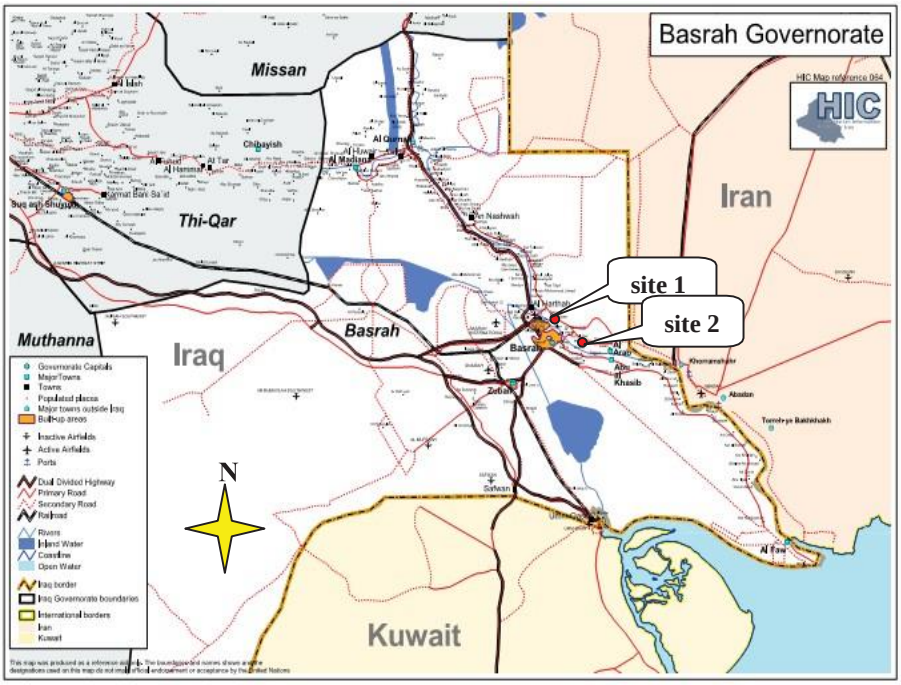

Figure 1: Map showing the study sites

The shell length, width and height and the aperture of the snail P. canaliculata were measured by using digital vernier caliper (Fig. 2). While the weight of the animals was measured by using Metler electric balance. Some of the physical and chemical parameters of the water in addition to the air temperature were measured in site. The identification of specimens was conducted by using several references (Clench, 1976 and Baloch et al., 2012).

Figure 2. Body measurements of *P. canaliculata*. a: S.L= shell length, b: S.W= shell width, c: A.L= aperture length, d: A.W=aperture width

Results

The values of dissolve oxygen, salinity, pH, as well as water and air temperatures were measured in site, during the period from April 2014 to March 2015 at the study area of Shatt Al-Arab River. The values of dissolved oxygen, salinity and pH ranged between 5-11.5 mg/L, 1.2-2.8 psu and 7.6-8.9 respectively. While the water and air temperatures ranged from 14.7-29ºC and 18-39 ºC, respectively (Table, 1).

During the study period eight species of native Gastropod snails were recorded. Occurrence of all collected gastropod species were calculated, and the results refer that the two snails *Melanoides tuberculata* and *P. canaliculata* only recorded during all the study period with occurrence of 100% (Table,2).

The mean monthly densities of *P. canaliculata* were ranged from 4 ind./m² recorded during six months (October 2014-March 2015) to 26 ind./m² in July 2014 (Table, 3). *P. canaliculata* deposited their eggs in the field on aquatic plants (Fig. 3a, b) and any objects protruding on surface of the water during all months of the year except the three months December 2014-February 2015.

Table 1. Some Physical and Chemical parameters of the water from Shatt Al- Arab River during April 2014 to March 2015.

Parameters	Apr. 2014	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2015	Feb.	Mar.
D.O (mg/L)	8	6.2	7.6	6	5.5	5	7	7.5	9	10.5	11.5	11
Sal (psu)	1.9	1.4	1.2	1.5	2	2.7	2.8	2.6	2.5	2.5	2	2.6
pH	8.4	7.6	8.2	8	8.1	8.2	8.3	8.8	8.7	8.8	8.9	8.8
W.T(ºC**)**	26	29	28.8	28	28	28.1	22.6	22	17.9	15.5	14.7	17
A.T (ºC)	38	39	34.5	38	36	34.5	25	26	18	18	18	21

D.O= Dissolve Oxygen, Sal.= Salinity, W.T= Water Temperature, A. T= Air Temperature.

Table 2. Occurrence of snails collected from Shatt Al-Arab river southern of Iraq during April 2014 to March 2015

species	Apr. 2014	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2015	Feb.	Mar	Abundance
Bellamya bengalensis	+	-	-	-	-	-	-	-	+	-	-	-	16.6%
Melanopsis praemorsa	+	-	-	-	-	-	-	-	-	-	-	-	8.4%
Melanoides tuberculata	+	+	+	+	+	+	+	+	+	+	+	+	100%
Melanopsis nodosa	-	-	-	-	-	-	+	-	+	-	-	-	16.6%
Neritina violacea	-	+	-	-	-	-	-	-	-	-	-	-	8.4%
Pomacea canaliculata	+	+	+	+	+	+	+	+	+	+	+	+	100%
Radex auricularia	-	+	+	+	+	-	-	-	-	-	-	-	33.3%
Theodoxus jordani	+	-	+	-	-	+	+	+	+	+	-	+	66.6%

Table 3. Mean monthly densities (ind./m²) of the snail *Pomacea canaliculata* from banks of Shatt Al-Arab river southern of Iraq during April 2014 to March 2015

species	Apr. 2014	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2015	Feb.	Mar.
***Pomacea canaliculata* (Lamarck, 1822)**	7	7	22	26	15	11	4	4	4	4	4	4

Description:

The shell was bright to dark brown in color with dark horizontal lines, and these lines were more obvious in the younger animals. The body (soft tissues) was bright yellow to orange in color with some black or brown spot. The shell was rounded with six whorls and the sixth one was very small (Fig. 2) The snail depositing round pinkish eggs up to 2.8 mm in diametre (Fig. 3).

Measurements

The shell length of the collected individuals varied between 27 to 82 mm, while the width was ranged from 42-76 mm. The snail weight increases advanced in the age from 4.39 g of 27 mm length to 56.17 g of 62 mm length. The concentrically operculum (Fig. 1c) was oval and ranged between 18-48 mm in length, while reached 13-35 mm in width (Table, 4).

Figure 3: Different age stages of the snail *Pomacea canaliculata*. (Scale= 30 mm).

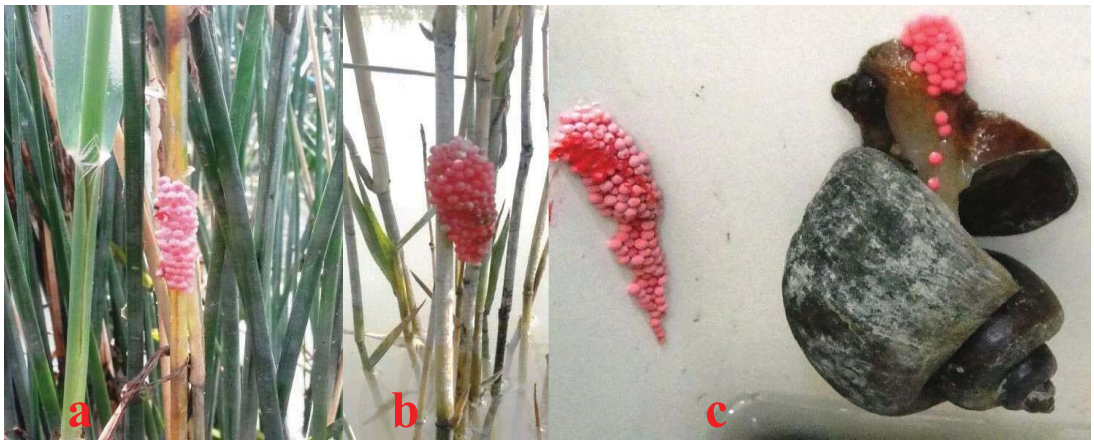

Figure 4: Pinkish eggs depositing by the snail *Pomacea canaliculata* on some costal plants of Shatt Al-Arab River (a, b) and in the aquarium in the laboratory (c).

Table 4. Body measurements of the snail *Pomacea canaliculata* from Shatt Al-Arab River southern of Iraq

No.	W	S. L	S. W	A. L	A. W
1	4.39	27	24	19	15
2	4.93	27	22	18	13
3	8.5	32	29	20	15
4	11.76	38	35	26	21
5	12.53	39	36	27	22
6	22.44	45	42	29	22
7	23.78	47	43	32	25
8	25.36	49	45	37	28
9	27.26	48	45	33	25
10	33.28	53	46	33	25
11	37	55	52	35	28
12	56.17	62	58	42	30
13	-	82	76	48	35

W= Snail weight, S.L= Shell length, S.W= Shell width, A.L= Aperture length, A. W= Aperture width

Discussion

The sources by which the snail *Pomacea canaliculata* enters to the Shatt Al-Arab river are unknown, but the invasion to this new environment may be through the negligence or escape from the commercial ornamental fish aquarium or by ships came from different Asian countries to the Basrah ports at Shatt Al-Arab River. The minimum size of sexually

maturated females and produced eggs was 25mm (Estebenet and Cazzaniga, 1992; Tanaka *et al*., 1999). The sizes of *P. canaliculata* which collected during the study period indicated that the snail have produced many generations after the invasion of the region, and occurred in the region may began before more than two years. *P. canaliculata* lays its eggs masses on any object prominent above the water surface not only on the aquatic plant stems. Wu *et al.* (2011) record the egg masses on a cement wall, the egg masses were measured in general as 12-30 mm long and 9-15 mm width, and the clutch sizes ranged from 14-327 eggs, also report that the eggs were 2.57 ± 0.25 mm in diameter which corresponds what was recorded in our study (2.8 mm).

The temperature was effective factor on biological activities of different species of snails (Cowie, 2002; Khalaf, 2011 and Al-Khazali, 2012). The mean monthly densities of the snail *P. canaliculata* that recorded by our study refer that the snail could spread in the study area and reproduce at rates as well as that recorded in other countries e.g. Kwong and Dudgeon (2010) from different wetlands in Hong Kong which ranged between 25.6 ± 4.6 to 42.7 ± 7.35 ind./m² depending on variation in water temperature. We also believe that temperature may be plays an important role in the reproduction activity then in

the density of this species, and the high densities during the months of June-August 2014 may reflect its willingness to pass the next winter season. Temperature is an important limiting factor for growth and reproduction in apple snails (Cowie, 2002 and Estebenet and Martín, 2002). In the present study, the snail *P. canaliculata* was inactive, Breeding stopped during the period December 2014 to February 2015).

In addition to our study, there are many studies refer that the reproduction activity stopped during periods of low temperatures. Kwong and Dudgeon (2010) in Hong Kong report that the reproduction and growth processes continued for a period of 7-10 months of the year in the warm, wet areas, on the contrary of the cold dry areas. In southern Japan, apple snails hibernate for 5 months (November-March) (Sugiura and Wada 1999), while the reproduction of *P.canaliculata* in its native South America extend for seven months from October to April (Andrews, 1964).

The apple snails seems to inhabit stand or slow-moving running waters in tropical to warm temperate areas, the snails occur both in clean and polluted waters, they also feed on a wide range of food materials (Andrews, 1965; Lach, *et al*., 2000; Aditya and Raut, 2001; Kwong *et al*., 2009 and Kwong *et al*., 2010). The occurrence of the invasive snail *P. canaliculata* during all the study months compared with the most other recorded snails indicate the ability of this snail to adaptive with limiting factors of the new habitat of Shatt Al-Arab River. On the other hand, the east coast of Shatt A-Arab River was more suitable to inhabit by *P. canaliculata*, probably because characteristic of this habitat with shallow and slow-running water that are warm during most months of the year. In addition to growth of different types of submersible and prominent plants and filaments algae which can uses by this snail as a source of food. The apple snails have the ability to diversify their food intake by several ways such as shredding, scraping and collecting (Saveanu and Martín, 2013). They are also tolerable to starvation, without eating any visible food for five months in the water (Lach *et al*., 2000), taking in account that the snail can feed on vegetal, detrital and animal materials such as dead fish (Cazzaniga amd Estebenet, 1984; Cowie, 2002), and its high fecundity (the most females lay once a week and the clutch contain typically 300-400 eggs (Teo, 2004)) indicates potential competition with other native macroinvertebrate primary consumers (Kwong and Dudgeon, 2010). It could be aestivate underground for more than 10 months (Teo, 2003). They bury themselves in the mud during dry season, to river irrigation and drainage channels. Apple snails able to spread into all parts of freshwater ecosystems as happen in Taiwan (Wu *et al*., 2011). Its control will be almost impossible as postulated by Baloch *et al.* (2012). This snail consider as the only freshwater snail listed as one of the most 100 worst invaders worldwide (Lowe *et al*., 2000; Cowie, 2002). We must act urgently to contain the presence of *P. canaliculata* and immediately to combat them before spreading to rivers and marsh areas in different parts of Iraq, and even to occurred neighboring marshes of Iran, *P. canaliculata* and *M. tuberculata* known as aquarium snails.

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تسجيل أول للقوقع التفاحة الغازي
Pomacea canaliculata (Lamarck, 1822) (Gastropoda: Ampullariidae)
لمياه شط العرب جنوب العراق مع دراسة بعض جوانبه البيئية

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المستخلص

تناولت الدراسة الحالية تسجيل غزو قوقع المياه العذبة *Pomacea canaliculata* الذي لوحظ تواجده في مياه شط العرب منذ بداية عام 2014 . درس ظهور القوقع من شهر نيسان 2014 الى شهر آذار 2015 ، كذلك درس تواجد وكثافة القوقع الغازي مع ستة أنواع من القواقع بطنية القدم المحلية المتواجدة معه في مياه شط العرب. تراوح معدل كثافة الجماعة السكانية للقوقع *P. canaliculata* بين 2 - 26 فرد/م^2 وسجلت خلال شهري كانون الأول وتموز على التوالي. قيست بعض الصفات المظهرية لصدفة للقوقع الغازي خلال الدراسة.