

First record of living fossil tadpole shrimp *Triops numidicus* (Grube, 1865 , resurrected by Naganawa) in the desert of Al-Najaf

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*The study conducted to survey the existence of tadpole shrimp in ephemeral ponds and streams of the desert of Al-Najaf. Out of 13 ponds, the tadpole shrimps were occur in 5 only including terminal part of Abu-Talah valley, archaeological basin of Um Groon castle ,first part of Wier valley, Rejlat Al-Ziana and Sharaf wells. All samples were identified morphologically as *Triops numidicus* (Grube, 1865 , resurrected by Naganawa), the controversial synonymy, morphological and morphometrical features are discussed.*

Abstract

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Introduction

Triopsidae members are freshwater crustaceans, usually called tadpole shrimp due to morphological similarity with frog larvae (Martin and Boyce, 2005). The first record of *Triops* fossil was discovered in Germany up to Devonian period, with very close morphological features to *T. cancriformis*, therefore it referred to “living fossil” (Mantovani et al., 2008). Thus, it is considered as a constant example of evolutionary stasis. *Triops* spp. especially present in warm temporary freshwater ponds particularly in arid and semiarid regions and hot climates (Rzoska, 1984; Thiéry, 1991; Williams, 2006). Although it is not yet known how these Notostraca transported between ephemeral ponds, they distributed in all continents except Antarctica (Philip, 2012). Due

to plasticity of morphological features of Notostraca, the taxonomist often describe new (Brendonck, 1996). Among two genera of Triopsidae; *Triops* and *Lepidurus*, Four species are recorded in the Middle East including *Triops canacriformis* from Yemen and Iran in addition to *Lepidurus couesii* from Syria, *Triops numidicus* from Saudi Arabia and Oman (Thiéry, 1991), *Triops cancriformis* and *Lepidurus apuslubbocki* from Israel (Kuller and Gasith, 1996) and *Triops granarius* from Iraq (Longhurst, 1955). Longhurst (1955) mentioned that the Iraqi specimens collected from saline ponds from Imara and Baghdad provinces without any more information, therefore the present study is designed to survey the desert of Al-Najaf to reveal occurrence of Notostraca in this expected suitable habitats.

Material and Methods

Study area The Najaf desert is an extension of the northern plateau of the Arabian Peninsula and is part of the southern desert of Iraq. In general, the Najaf desert area is flat with an obvious rise towards the south, reaching its highest height near the Iraqi-Saudi border (300-400msl). The majority of the landscape is a plateau that is dissected by a large number of valleys of different lengths, which are drained rain water towards the north eastern part. Depressions are a distinctive feature of the Najaf desert, and they are either the result of erosional or solutional (krast), their sizes and shapes differ. They are circular, oval, or longitudinal, and some of them collect rain water to be green meadow in spring season called locally Faidah, another may hold rain water for several months, which forms a large water body in addition to some ephemeral water ponds occur due to water stagnation in base of some ephemeral streams (Ma'ala, 2009).

Sampling

During the rainy season in March 2020, the presence of tadpole shrimps in the temporary ponds was investigated, as 13 ponds were examined in different places of the Najaf desert. The presence of tadpole revealed by careful observation to detect either tadpole shrimp swimming or dead bodies on the edge of the basin, sometimes and during night visits the spotlight is highlighted on the basin to attract the swimming individuals. Samples were collected from the habitat using plankton net and immediately transferred to container with absolute ethanol. Specimens were identified using appropriate taxonomic references (Longhurst, 1955; Alonso, 1985, 1996; Kuller and Gasith, 1996). Fifty individuals were examined for morphometrical characteristics using a stereomicroscope.

Results and discussion

Occurrence of tadpole shrimp

The tadpole shrimp are reported in temporary ponds distributed in 5 areas (map1) including:

Site 1: (figure 1, A) terminal part of Abu- Talh valley (31.660497 N,44.309093E). It is a small temporary pond about 6 × 2.5 m with 0.62m depth. The bottom of pond covered with flat rocks with muddy edges. This pond was crowded with alive tadpole shrimps

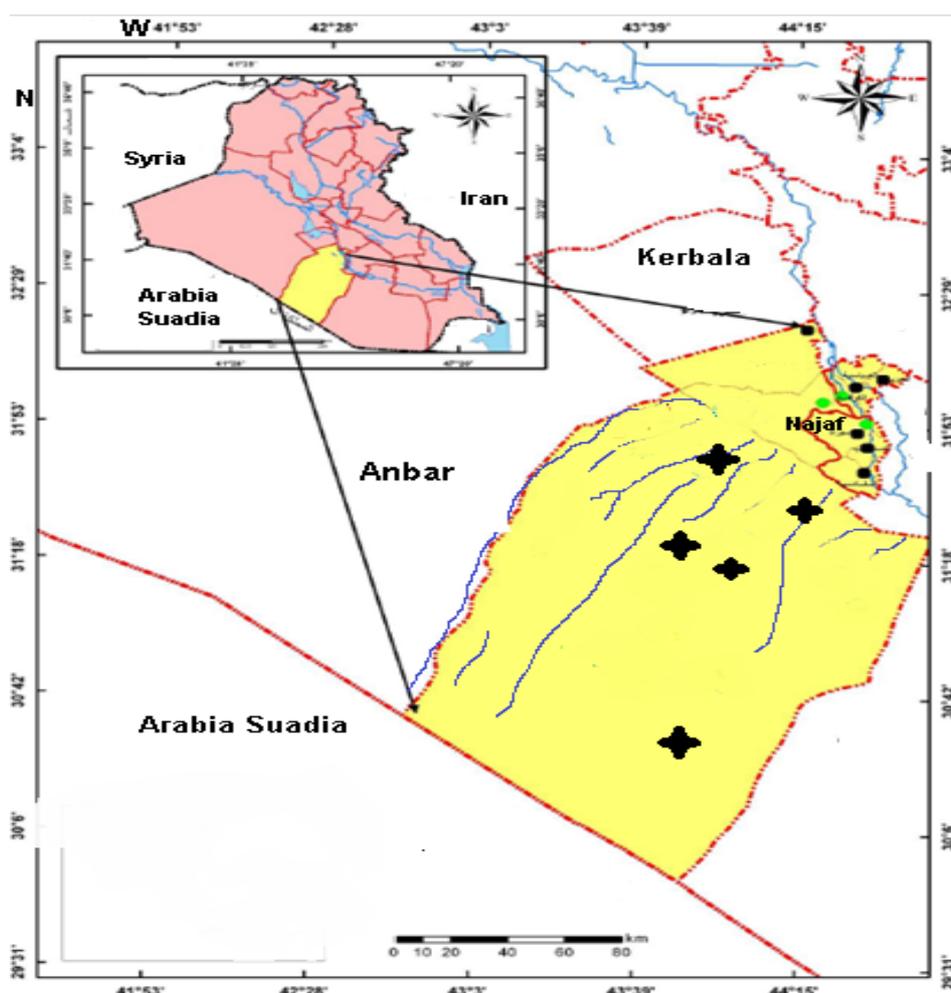
with many dead bodies around it. The salinity and pH of water were 0.03% and 8.27 respectively.

Site 2: It is a part of an archaeological cistern (31.537703N, 44.229974E) dedicated to collecting rain water. The surface area of the basin is about 2000m² and with a maximum depth of 70cm, the floor of basin covered with thick clay layer. The salinity and pH of water were 0.01% and 8.04 respectively.

Site 3: first part of Wier valley (31.61941N,44.226857). It is a small temporary shallow pond of 0.7m depth measured 7 × 0.75 m. The pond was crowded with alive tadpole shrimps with many dead bodies at edges. The salinity and pH of water were 0.1% and 8.77 respectively.

Site 4: Artificially engraved large pond at Rejlat Al-Ziana (31.625125N,43.985908E) about 40 × 8m. The tadpole shrimps was observed only at night by attracting them by spot light. The salinity and pH of water were 0.1% and 7.7 respectively..

Site 5: Sharaf wells: They are a large group of holes of 1-1.5m diameter engraved in a rocky layer dedicated to collecting rain water (30.621343N,43.741711E). Most of these wells are filled with mud except two, both of which contain tadpole shrimps. The salinity and pH of water were 0.09% and 8.1 respectively.



Map 1: the study area at the desert of Al-Najaf, southwestern Iraq

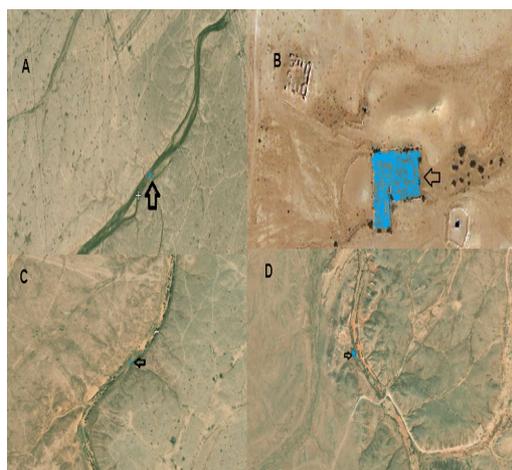


Figure 1: sites of ephemeral ponds contain tadpole shrimps, A: Abu Talah valley; B: Um Groon castle basin ; C: Wier valley ; D: Rejlat Al-Ziana

All sites mentioned above are suitable to live and reproduction of tadpole shrimps, Pennak (1978) indicated that the characteristic habitat of Notostracans consists of muddy, alkaline pools which dry completely in the warm months. This type of intermittent habitat is usually found in the desert of Al-Najaf. Tadpole shrimp is one of the most important animals in ephemeral wetlands and even the surrounding landscape, where they strongly affect faunal structure (Yee et al., 2005). The genus *Triops* occurs in temporary wetlands in arid areas worldwide, spanning periods of drought by laying desiccation-resistant eggs (or cysts) that can lay dormant and viable for years in unflooded soil (Brendonck and de Meester, 2003; Brendonck et al., 2008). Soon after re-immersion in water, a portion of the eggs hatch, and within a few weeks adult tadpole shrimp deposit hundreds to thousands of eggs before the ephemeral water-bodies dry again (Brendonck, 1996). It is not yet known how the tadpole moves between the temporary basins in the arid desert, although some researchers have indicated that it is likely to be transported by waterfowl, car's tires, and boots (Brochet et al., 2010; Waterkeyn et al., 2010). In the present study, the sites 1-4 are connected to a temporary watercourse network where rainwater runs during the flood season.

Identification: all samples are identified as following:

Family Triopsidae Keilhack, 1909

Genus *Triops* Schrank, 1803

Triops numidicus (Grube, 1865), resurrected by Naganawa

Synonyms

The scientific designation and its synonyms are still controversial and it summarized as following:

non *Apus granarius* Lucas, 1864

non *Apus numidicus* var. *dybowski* Braem, 1893

non *Apus numidicus* in Uéno (1925)

non *Apus numidicus* var. *sinensis* Uéno, 1925
non *Triops granarius* in Longhurst, 1955 [in part]
non *Apus dispar* in Forró and Brtek (1984)
non *Triops granaries dispar* in Forró and Brtek (1984)
= *Apus numidicus* Grube, 1865
= *Apus dispar* Brauer, 1877
= *Apus dukianus* Day, 1880
= *Apus numidicus* in Simon (1886) [in part]
= *Apus numidicus* var. *strauchii* Braem, 1893
= *Apus somalicus* Wedenissow, 1895
= *Apus bottegoi* Del Prato, 1896
= *Apus numidicus* in G. O. Sars (1898)
= *Apus bottegoi* in Bouvier (1899) [non 1898]
= *Apus numidicus* in G. O. Sars (1899)
= *Apus trachyaspis* G. O. Sars, 1899
= *Apus numidicus* in G. O. Sars (1905)
= *Apus numidicus* in Stebbing (1910)
= *Apus trachyaspis* Stebbing (1910)
= *Apus zanoni* Colosi, 1920
= *Proterothriops zanoni* in Ghigi (1921)
= *Proterothriops somalicus* in Colosi (1923)
= *Apus numidicus* in Barnard (1924) [in part]
= *Apus numidicus* in Gurney (1924)
= *Apus numidicus* in Pérès (1939)
= *Triops* cf. *granarius* (sp.3) from Tunisia in Naganawa (2018)

Synonymy complex; however, in the light of current scientific standards, Barnard's (1929) synonymy is the most reliable one. Since Longhurst's (1955) revision, this species has been confused under the name of "*Triops granarius*" for many years, e.g., *Triops numidicus* and *Triops granaries* s.str. are being used for the same populations by different authors. These are, however, genetically independent each other (Naganawa, 2018). *Triops numidicus* is the species originated from Africa; whereas *Triops granaries* s.str. (Redefined by Naganawa) is the species distributing in East Asia only. The former is by far the commonest and the most widely distributed *Triops* species throughout Africa, and partly reaches over the Arabian Peninsula, but not confirmed in more east than Afghanistan, therefore, Naganawa (2018) suggests herein the binomen "*Triops granarius*" be restricted to the population in East Asia. This suggestion is not an option under the International Code of Zoological Nomenclature. Thus, Naganawa (2018) proposes resurrecting this species name of *Triops numidicus*.

Types

None designated in the original description (Grube, 1865). Naganawa (2018) confirmed that no type of this species is deposited at the Natural History Museum Vienna, Austria; but the type of *Apus dispar* Brauer, 1877 is deposited there. [cf. Type of *Apus trachyaspis* G. O. Sars, 1899 is deposited in the South African Museum, Cape Town, South Africa.]

Diagnosis

Dorsal organ depressed and (sub) triangular or trapezoidal. Carapace oval, its length (including the posterior angles) a little greater than its width, more or less arched, usually convex along whole lateral margin to posterior angle. About 30, varying 25-33 in both sexes (figure 2), abdominal segments are uncovered by carapace. Number of apodal (legless) segments normally 13-14 (males) or 10 (females), varying 12-15 (males) or 9-13 (females). Carina lacks spines. Sulcus cut not very deep, on the concave margin about 20-34 denticles (almost small rounded protuberances) on each side (42-63 in total). Fourth endite of 1st leg usually as long as, or a little longer than carapace. Males having strong scales on furcal filaments (caudal rami) as Asian *Triops spp.* Furcal filaments in females are so long, but in males about as long as carapace (including posterior angles) ,figure 2.

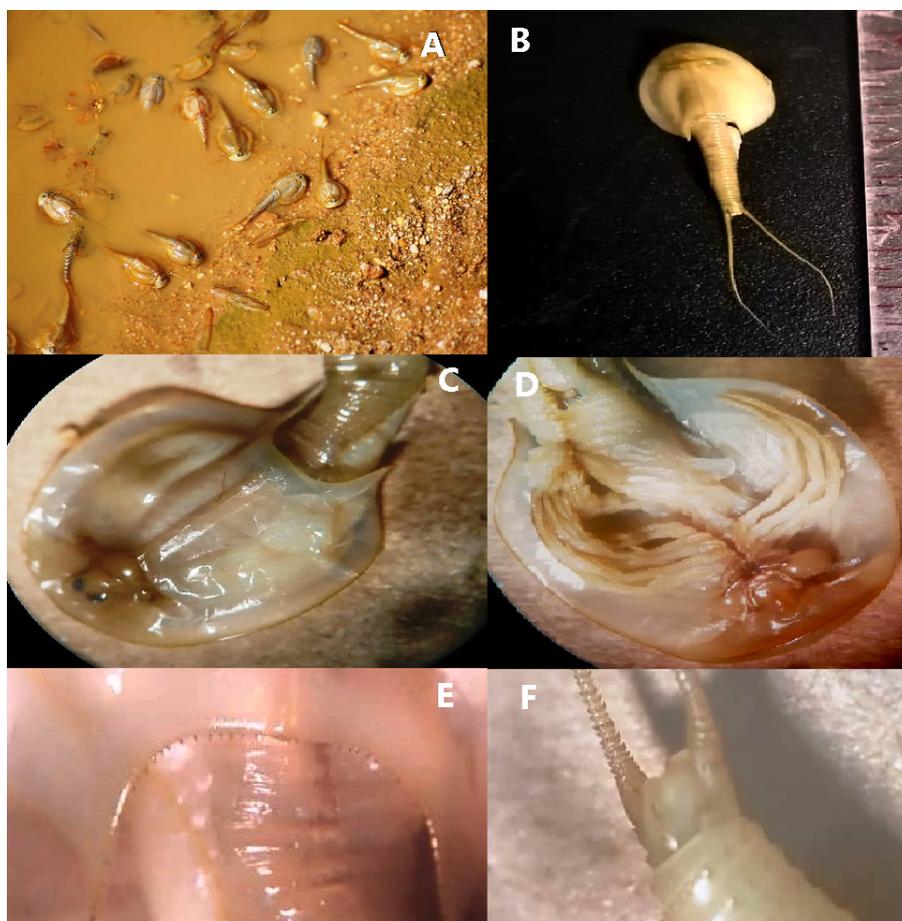


Figure 2: Shows A: *Triops numidicus* swimming in temporary pond at Wier valley ;B: general appearance of *Triops numidicus*; C: dorsal view of Carapace ;D: ventral view of Carapace ;E: posterior margin carapace teeth ; F: dorsal view of telson.

Distribution: North Africa (Sahara Desert: Algeria, Tunisia, Libya, Sudan), East Africa (Somalia, Kenya), South Africa (Namibia, Botswana, South Africa), Arabia, Iraq, Afghanistan.

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