On two morphologically different cysticercoids of the genus *Eurycestus* (Cestoda: Dilepididae) in *Artemia franciscana* (Arthropoda: Artemiidae) in a hypersaline pond in Dubai, United Arab Emirates*

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**Summary**

During a survey on tapeworm larval stages in *Artemia franciscana* from an artificial pond in Dubai, United Arab Emirates, a high prevalence of *Eurycestus avoceti*-like cysticercoids was established. Adult male and female crustaceans showed a prevalence of 61.9 and 62.7 %, respectively. The intensity ranged from one to four and one to three cyst, respectively. Out of 215 examined cysticercoids, 207 specimens had morphological features matching with *E. avoceti*. The flaky structure of the surrounding capsule, the elongated shape of the cysticercoid and the larger number of hooklets on the suckers suggest that the eight further larval cestodes belonged to another species of the genus *Eurycestus*.

**Keywords**: Brine shrimps; *Artemia franciscana*; cysticercoids; *Eurycestus*; United Arab Emirates

**Introduction**

Brine shrimps of the genus *Artemia* are aquatic crustaceans that live in hypersaline environments. The genus *Artemia* consists of *A. salina* (Linnaeus, 1758), *A. monica* Verrill, 1869, *A. urmiana* Günther, 1899, *A. franciscana* Kellogg, 1906, *A. persimilis* Piccinelli & Prosdocimi, 1968, *A. sinica* Cai, 1989, *A. tibetiana* Abatzopoulos, Zhang & Sorgeloos, 1998 and parthenogenetic populations called *A. parthenogenetica* (Asem et al. 2010). Serving as food for flamingos, waders, gulls and ducks, brine shrimps act as intermediate host for a number of avian cestodes of the Hymenolepididae family (*Aploparaksis paralifum* Gasowska, 1932, *Brachiopodataenia gyozevi* Maksimova, 1988, *Confluaria podicipina*, (Szymanski, 1905), *Fimbriaruioides tadornae* Maksimova, 1976, *Flamingolepis caroli* (Parona, 1887), *F. flamingo* Skrjabin 1914, *F. liguloides* Gervais, 1847, *F. tengizi* Gvozdev & Maksimova, 1968, *Hymenolepis californicus* Young, 1950, *Wardium fusca* (Krabbe, 1869) and *W. stellorae* Deblock, Biguet et Capron, 1960), the Dilepididae family (*Eurycestus avoceti* Clark, 1954, *Anomolepis averini* Spassky & Yurpalova, 1967, *Anomotaenia tringae* (Burt, 1940) and *A. microphallus* (Krabbe, 1869) and the Progynoteniidae family *Gynandotaenia stammeri* Fuhrmann, 1936 and *Gynandrotaenia* sp. Redón et al., 2015b – a so far undetermined further species of this genus) (Schuster 2018).

One of the cysticercoids that was found in numerous studies was *E. avoceti* (Table 1). The description of its larval stage is based only on small numbers of cysticercoids. In a recent study on the location of cestode larvae in the body of *A. franciscana*, we examined a larger number of *Eurycestus* cysticercoids showing the existence of two morphologically different types.

**Materials and Methods**

Collection site of *A. franciscana*

The Godolphin lakes in the Al Quoz district of Dubai are small ponds of 2.5 and 2.9 ha, respectively and were created as satellite wetland to attract wader birds. A detailed description of this habitat was given by Sivakumar et al. (2018).

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* – This paper is dedicated to the 90th birthday of my teacher, Prof. Dr. Dr. h.c. mult. Theodor Hiepe, former director of the Parasitological Institute of the Humboldt-University of Berlin.
Examination of shrimps

Brine shrimps of the species *A. franciscana* were caught by net in the Godolphin lakes in Dubai, in May 2018 for a study of the location of cysticercoids in the body of the shrimps. Shrimps were killed in hot 70 % alcohol and 300 adult specimens were randomly selected. Prior to examination, they were placed for 5 days on a slide in a drop of glycerin and were covered with a cover slip. Glycerin cleared the body of the shrimps and made the parasites visible. Examination for the presence of cysticercoids was carried out at low magnification (40 – 100x). Special attention was paid to cysts surrounded by a brown capsule as well as to those with a transparent capsule and suckers exhibiting hooklets. Measurements of the outer capsule were taken at a magnification of 400x. Shrimps were then dissected and cestode larvae were individually placed into a drop of glycerin. Prior to putting a cover slip, the capsule surrounding the cysticercoid was destroyed by fine preparation needles. At a magnification of 600x, the following parameters of each cysticercoid matching the description of the genus *Eurycestus* were determined: length and width of the cysticercoid, width of the scolex at the level of suckers, length and width of suckers, distribution, number and length of hooklets on suckers, length and width of the rostellum, number and length of rostellar hooks. In order to determine the exact length of sucker hooklets and rostellar hooks as well as the number of rostellar hooks most of the cysticercoids had to be squashed by pressing on the cover slip. Measurements were taken using an OLYMPUS BX51 microscope connected to an OLYMPUS DP27 camera with the software OLYMPUS cellSens Dimension.

Ethical Approval and/or Informed Consent

All applicable national and institutional guidelines for the care and use of animals were followed.
Results

Of 300 examined *A. franciscana*, 134 were males and 166 were females. A total of 187 (= 62.33 %) of crustacean hosts harbored between one and four *Eurycestus* cysticercoids. There was no sex related difference in prevalence and burden (Table 2). Out of 95 *Eurycestus* cysticercoids in male shrimps, 93 were located in the thorax and each one in the abdomen and phyllopods. Female shrimps contained a total of 120 *Eurycestus* cysticercoids. Of these, 114 were detected in the thorax, four and two were found in head and abdomen, respectively.

The majority (n=207) of the examined 215 cysticercoids was surrounded by a more or less homogenous, transparent to dark brown irregularly rounded capsule (Fig 1). The decapsulated cestode larval stages were heart shaped to oval round (Fig 2.) The anterior margin of the oval suckers was furnished with two layers of hooklets in total numbers between 8 and 15. In most of the cases 12 hooklets were counted (Table 3). Their length was 5 – 7 µm. There were 14 to 16 arcuatoiid rostellar hooks arranged in two circles. Their length varied between 12 to 16 and 14 to 18 µm, respectively.

Eight other *Eurycestus* cysticercoids were surrounded by an irregularly elongated, flaky and very fragile capsule (Fig. 3). The decapsulated cisticercoids were elongated (Fig. 4) and differed from the above mentioned by a larger number of hooklets on the suckers ranging between 24 and 32 (Table 3). Sixteen arcuatoiid rostellar hooks arranged in two circles measured 11 – 14 and 17 – 19 µm, respectively.

Discussion

While previous publications reported prevalence data of *Eurycestus* cysticercoids in *Artemia* spp. between 0.09 and 30.0 % (Table 1), the current study revealed an unusually high prevalence of 62.33 %. The reasons for this might be the small size of the habitat, a large number of birds visiting the ponds and a specific moment in time for the collection when *Artemia* population was in full bloom in the month of May.

The species inventory of the genus *Eurycestus* consists so far of three species. In addition to the description of *E. avoceti* from its final host, the American avocet (*Recurvirostra americana* Gmelin, 1789) by Clark (1954), Burt (1979) described two further species of the genus *Eurycestus* found in the same final host. *E. falciformis* and *E. latissimus* differed from *E. avoceti* in the shape of strobila, size of cirrus sac, number of testes and armature of the cirrus. All three descriptions were based on strobilae without scolex.

In addition to American and pied avocets from Nebraska and France, respectively, *E. avoceti* was found also in black necked stilts (*Himantopus mexicanus* (Müller, 1776) in Texas (Hinojus & Canaris 1988). Maksimova (1991) mentioned greater flamingos (*Phoenicopterus roseus* Pallas, 1811), black-winged stilts (*Himan-
Table 3. Morphometrical data of two morphologically different *Eurycestus* cysticercoids in *Artemia franciscana* from Godolphin lakes of Dubai.

| Type | Outer capsule | Cysticercoid | Sklex | suckers | Rostellum | Rostellar hooks |
|------|--------------|--------------|-------|---------|-----------|----------------|
|      | length | width | length | width | length | width | n | length | width | n | small | length | large |
| A    | average | 173.7 | 152.2 | 124.1 | 100.1 | 63.8 | 18.6 | 15.5 | 58.1 | 20.1 | 13.8 | 16.2 |
|      | range  | 130 – 246 | 102 – 215 | 100 – 153 | 70 – 146 | 50 – 94 | 14 – 25 | 10 – 20 | 8 – 15 | 5 – 7 | 44 – 88 | 14 – 26 | 14 – 16 | 12 – 16 | 14 – 18 |
| B    | average | 211.5 | 123 | 157.9 | 90.5 | 78 | 22.4 | 20.3 | 7 | 65.8 | 18.8 | 16 | 12 | 17.8 |
|      | range  | 182 – 245 | 93 – 160 | 145 – 186 | 76 – 113 | 63 – 91 | 21 – 24 | 18 – 22 | 24 – 30 | 58 – 78 | 13 – 21 | 11 – 14 | 17 – 19 |
The assignment of E. avoceti to the Anoplocephalidae family by Yamaguti (1959) was proven incorrect after Baer (1968) found whole cestode including scolex in avocets. The bird species was not mentioned in the paper but most probably it was the pied avocet (E. avoceti) to the Anoplocephalidae family by Breme, 1839. The wide spectrum of phylogenetically distant hosts suggests that also other birds that feed on brine shrimps might play a role in the
Eu-rycestus life cycle.

The majority of cestode larval stages (type A in Table 3) seem to belong to the same species, E. avoceti. The second species (type B) comparable to those found Artemia sp. in Carmargue and in A. salina in Tengiz lake remains unnamed until the adult cestode is described.

Conflict of Interest

There is no conflict of interests.

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