



The Role of *Artemia* spp (Branchiopoda: Artemiidae) as Intermediate Hosts for Avian Cestodes



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Abstract

Brine shrimps of the genus *Artemia* can tolerate hyper saline aquatic environments and thus, are able to occupy ecological niches. These brachiopod crustaceans play an important role as food source for flamingos and other waders and act as intermediate hosts for a variety of cestodes. Comparison of scolex structures of adult tapeworms with those of the cysticercoids in *Artemia* spp gave evidence that brine shrimps act as intermediate hosts for *Aploparaksis parafilum*, *Brachiopodaenia gvozdev*, *Confluaria podicipina*, *Fimbriaroides tadornae*, *Flamingolepis caroli*, *F. flamingo*, *F. liguloides*, *F. tengizi*, *Hymenolepis californicus*, *Wardium fusca* and *W. stellorae* of the Hymenolepididae family, *Anomolepis averini*, *Anomotaenia tringae* and *A. microphallus* of the Dilepididae family and *Gynandotaenia stammeri* and *Gynandrotaenia* spp. a so far undetermined further species of this genus of the Progyotaeniidae family.

Keywords: Artemia; Brachiopoda; Cysticercoids; Hymenolepididae; Dilepididae; Progyotaeniidae

Introduction

Brine shrimps or *Artemia* is a phylogenetically old genus of aquatic crustaceans contains of sibling species and super species defined by the criterion of reproductive isolation. The species inventory of the genus is disputed but according to Asem et al. [1] it consists of *Artemia salina*, *A. monica*, *A. urmiana*, *A. franciscana*, *A. sinica*, *A. tibetiana* and parthenogenetic populations called *A. parthenogenetica*. Brine shrimps can tolerate saline (2.5%) to hyper-saline (25%) waters with an optimum range of 6 -10% salinity and occur world-wide in inland salt waters and thus, occupy ecological niches that protect them from predators such as fish. Under normal conditions female brine shrimps are ovo-viviparous and naupilus larvae usually hatch immediately after placement of eggs while unfavorable conditions (low oxygen, rising temperatures, desiccation of pools) led to the production of floating, thick shelled, metabolically inactive brown cysts that can survive for up to two years in dry conditions and hatch when hydrated under optimal conditions [2]. Naupuli of brine shrimps are among the most widely used live diet in the larviculture of fish and shellfish and over 2000 metric tons of dry *Artemia* cysts are marked world-wide [3]. Brine shrimps are also a major compound in the diet of flamingos and a number of waders occurring in subsequent habitats and during evolution a relationship between these birds, their cestodes and brine shrimps acting as intermediate hosts has been established.

Cestodes using brine shrimps as intermediate hosts

Hymenolepis californicus was the first species that was detected in its larval stage in brine shrimps of Mono lake and salt pools near Chula Vista in California. To establish the relationship of this cestode larvae with the adult tapeworm Young [4] fed laboratory hatched California gulls and proved the identity of cysticercoids and adult cestodes grown in the gulls. Starting in the 1970th, scientists of the Zoological Institute in Almaty started ecological studies in the in the lake Tengiz in the Tselinograd district of northern Kazakhstan. This undrained lake is fed by the river Nura and occupies a territory of 1,950km². Tengiz is the largest saline lake in Kazakhstan and its shore and surroundings of the Korgalzhin National Park is home to the most northern population of greater flamingos and more than 300 other birds. The occurrence of *A. salina* on a massive scale in the Tengiz Lake gave reason to investigate its role as possible intermediate hosts for avian cestodes since eight different species of tapeworms were found in greater flamingos originating from that place [5]. Out of 36.500 brine shrimps collected between July and October 1971 2.235 (=6.1%) specimens were infected with 10 different cysticercoids. Amongst them were three representatives of the family Hymenolepididae: *Flamingolepis dolgushini*, *F. tengizi* and *Aploparaksis parafilum* in prevalence of 3.0%, 0.13%, and 0.033% respectively [6].

The examination of the helminthofauna of the shelduck led to the description of a new hymenolepidid cestode, *Fimbriaroides tadornae*. Eggs of this tapeworm were fed to *A. salina* and the development of the cysticercoïd was monitored. Under conditions of 6.5% salinity and a constant temperature of 22 °C the development were completed at day 12 to 13 after infection. Out of 140 brine shrimps used 76 (=54.3%) became infected and harbored up to 13 cysticercoïds. No information on the natural infection of *A. salina* in the lake Tengiz was given [7]. Cysticercoïds of *Anomolepis averini* was found in *A. salina* in high prevalence of 5.3-9.1% in the bays of the Tengiz lake while in collecting places that were located at a far distance from the shore prevalence was much lower and reached only 0.4-0.86%. *Branchinella spinosa*, another brachiopod harbored also *Anopolepis* cysticercoïds but in low prevalence of 0.22% [8]. The adult tapeworm of this dilepidid cestode was found in numbers of 1-15 in intestines of the red necked phalaropes in a prevalence of 13.7%. *Gynandotaenia stammeri* of the Progynotaeniidae family was present in 0.04% of examined shrimps [9]. The presence of *G. stammeri* in brine shrimps in the French Camargue was also mentioned by Gabrion & Mac Donald [10]. *Confluaria podicipina*, a hymenolepidid cestode originally described from grebes northern America was also detected in black necked, great crested and in red-necked grebes in Kazakhstan [11-13].

Larval stages with eight aploparaksoïd hooks on the scolex matching in size and shape with those found of *C. podicipina* in grebes were present in *A. salina* from Lake Tengiz in a prevalence of 0.05-0.35% [14]. Further research was dedicated to hymenolepidid cestodes of the genus *Wardium* that parasites the intestines of gulls and subsequent cysticercoïds that were seen in *A. salina* originating from Tengiz lake. These were *Wardium stellorae* [15] and *W. fusca* [16]. Among the *Wardium* species from gulls of the lake Tengiz was a so far undescribed new species, *W. gvozdevi* that occurred in a high prevalence in slender billed gulls. Experimental infections of *A. salina* carried out at 22-24 °C showed that the development of cysticercoïds of *W. gvozdevi* is completed within 12-15 days [17]. A cysticercoïd scolex structures of which matched with those of the cestode *Wardium manubriatum* of the slender billed gull was detected in a single fairy shrimp (*Branchinella spinosa*) collected in the lake Tengiz [18]. The cysticercoïd of *Eurycestus avoceti*, a dilepidid cestode of the avocet was originally described from *Artemia* sp. from Camargue, a wetland in southern France in a paper by Gabrion & MacDonald [10]. This cysticercoïd was also found in low prevalence of 0.03-0.5% in *A. salina* from Tengiz lake [19]. The author mentioned also findings of the adult tapeworm in avocets but saw scolices and strobila fragments of *E. avoceti* in juvenile flamingos as well.

The larval stage of two further members of the *Flamingolepis* genus was described in *Artemia* sp. from Camargue wetlands. Cysticercoïds of both *F. caroli* and *F. flamingo* were detected in a very low prevalence of 0.074% and only single cysticercoïds were found in infected shrimps [20]. A survey on cysticercoïds in *Artemia parthenogenetica* originating from the Odiel Marshes in Andalusia in Spain revealed the presence of 8 different species, amongst

them *Anomotaenia tringae* and an *Anomotaenia* species with 26-30 rostellar hooks. Scolex structures of the latter species showed some similarities with *A. microphallus* an euryxenous cestode of waders. However, none of the descriptions of *A. microphallus* reported more than 24 rostellar hooks. Other species found in this study were *F. liguloides*, *F. flamingo*, *C. podicipina*, *W. stellorae*, *E. avoceti* and *G. stammeri* [21].

Further research on the role of brine shrimps as intermediate hosts of avian cestodes was done in saline lakes in Algeria [22], in the Western Mediterranean coasts of Spain and France [23]. Extension of research work on *A. salina* and *A. parthenogenetica* in the Odiel Marshes in Spain showed the presence of 9 already known cestode larval stages and revealed a so far undescribed cysticercoïd that was allocated to the genus *Gynandrotænia* [24]. A further *Artemia* species occurring in the Odiel Marshes is the neozoon *A. franciscana*. This species originates from San Francisco Bay and Great Salt Lakes in North America and was introduced to Spain in the 1980th. Apart from cysticercoïds of *F. liguloides*, *F. flamingo*, *E. avoceti* and *G. stammeri* *A. franciscana* was also infected with nematode larvae of the Acuariidae family. Redon et al. [25] studied parasite development stages of *A. franciscana* in the Great Salt Lake in Utah and found infections with four different cestodes (*C. podicipina*, *H. californicus*, *Wardium* sp. and *Fuhrmannolepis averini*) along with larval stages of a nematode belonging to the Acuariidae family [26-30].

Conclusion

Artemia spp. in their inland saltwater habitats play an important role as food source for wader birds. Feeding on plankton, brine shrimps ingest also helminth eggs and had become intermediate hosts for avian cestodes. So far, cysticercoïds of 16 different species of the Hymenolepididae, Dilepididae and Progynotaeniidae were found in *Artemia* spp.

References

1. Asem A, Rastegar PN, de los Rios EP (2010) The genus *Artemia* Leach, 1819 (Crustacea: Branchipoda) 1 true and false taxonomical descriptions. Lat Am J Aquat Res 38: 501-506.
2. Van Strappen G (1996) Introduction, biology and ecology of *Artemia*. In: Lavens P & Sorgeloos P (Eds.), Manual on the production and use of live food for aquaculture. FAO, Italy, pp. 79-123.
3. Greaves PM (2012) An introduction to the branchipod crustaceans. Quekett J Microsc 41: 679-694.
4. Young RT (1952) The larva of *Hymenolepis californicus* in the brine shrimp (*Artemia salina*). J Washington Acad Sci 42(12): 385-388.
5. Gvozdev EV, Maksimova AP (1971) The Helminth fauna of the greater flamingo (*Phoenicopterus roseus* Pall) in Kazakhstan (in Russian). Trud Inst Zool AN Kaz SSR 31: 41-45.
6. Maksimova AP (1973) Branchiopods-intermediate hosts of cestodes of the family Hymenolepididae (in Russian). Parazitologiya 7: 349-351.
7. Maksimova AP (1976) A new cestode, *Fimbriaroides tadornae* sp and its development. In the intermediate host (in Russian). Parazitologiya 10: 16-24.
8. Maksimova AP (1977) Branchiopods-intermediate hosts of the cestode *Anomolepis verini* (Cestoda: Dilepididae). Parazitologiya 11: 77-79.

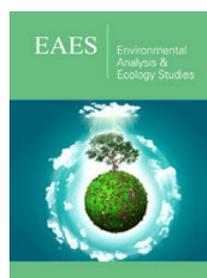
9. Gvozdev EV & Maksimova AP (1979) Morphology and life cycle of *Gynandrotaenia stammeri* (Cestoidea: Cyclophyllidea) parasite of the flamingo (in Russian). *Parazitologiya* 13: 56-60.
10. Gabrion C, Mac Donald G (1980) *Artemia* sp (Crustacea, Anostracea) as intermediate host of *Eurycestus avoceti* Clark, 1954 (Cestoda, Cyclophyllidea). *Ann Parasitol Hum Comp* 55(3): 327-331.
11. Panin VJ (1960) O the helminth fauna of the Lake Zaysan (in Russian). *Trud Inst Zool AN Kaz SSR* 12: 166-172.
12. Gvozdev EV (1964) Cestodes of huntable birds of southern Kazakhstan (in Russian). *Trud Inst Zool AN Kaz SSR* 22: 74-109.
13. Zatkanbaeva D (1968) Helminths of fish-eating birds of Kazakhstan. Thesis Institute of Zoology of the Academy of Science of Kazakhstan, Asia, pp. 24.
14. Maksimova AP (1981) Morphology and life cycle of the cestode *Confluaria podicipina* (Cestoda: Hymenolepididae) (in Russian). *Parazitologiya* 15: 325-331.
15. Maksimova AP (1986) On the morphology and biology of the cestode *Wardium stellorae* (Cestoda, Hymenolepididae) (in Russian). *Parazitologiya* 20: 487-491.
16. Maksimova AP (1987) On the morphology and life cycle of the cestode *Wardium fusca* (Cestoda, Hymenolepididae) (in Russian). *Parazitologiya* 21: 157-159.
17. Maksimova AP (1988) A new cestode, *Wardium gvozdevi* sp. n. (Cestoda: Hymenolepididae), and its biology. *Folia Parasitol* 35: 217-222.
18. Maksimova AP (1990) *Branchinella spinosa* (Anostraca), an intermediate host of the cestodes of the genus *Wardium* (Cestoda: Hymenolepididae) (in Russian). *Parazitologiya* 24: 89-92.
19. Maksimova AP (1991) On the ecology and biology of *Eurycestus avoceti* (Cestoda: Dilepididae). *Parazitologiya* 25: 73-76.
20. Robert F, Gabrion C (1991) Cestodes of Birds in Camarge. Importance of *Artemia* (Custacea, Anostraca) and meeting strategy between hosts and parasites (in French). *Ann Parasitol Hum Comp* 66(5): 226-235.
21. Georgiev BB, Sanchez MI, Green AJ, Nikolov PN, Vasilieva GP, et al. (2005) Cestodes from *Artemia parthenogenetica* (Crustacea, Branchipoda) in the Odiel Marshes, Spain: a systematic survey of cysticeroids. *Acta Parasitol* 50(2): 105-117.
22. Amarouyache M, Derbal F, Kara MH (2009) The parasitism of *Flamingolepis liguloides* (Gervais, 1847) Cestoda, Hymenolepididae in *Artemia salina* (Crustacea, Branchiopoda) in two saline lakes in Algeria. *Acta Parasitologica* 54(4): 330-334.
23. Vasilieva GP, Redon S, Armat F, Nikolov PN, Sanchez MI, et al. (2009) Records of cysticeroids of *Fimbriarioides tadornae* (Maksimova, 1976) and *Brachiopodataenia gvozdevi* (Maksimova, 1988) (Cyclophyllidea, Hymenolepididae) from brine shrimps at the Mediterranean coasts of Spain and France, with a key to cestodes from *Artemia* spp from the Western Mediterranean. *Acta Parasitol* 54: 143-150.
24. Sanchez MI, Nikolov PN, Georgieva DD, Georgiev BB, Vasilieva GP, et al. (2013) High prevalence of cestodes in *Artemia* spp though out the annual cycle: relationship with abundance of avian final hosts. *Parasitol Res* 112(5): 1913-1923.
25. Redon S, Berthelemy NJ, Mutafchiev Y, Amat Y, Georgiev BB, Vasilieva GP (2015) Helminth parasites of *Artemia franciscana* (Crustacea: Brachiopoda) in the Great Salt Lake, Utah: first data from the native range of this invader of European wetlands. *Folia Parasitol* 62: 1-16.
26. Anonymous (2017) The list of wetlands of international importance.
27. Bondarenko S, Kontrimavicus V (2004a) On *Brachiopodataenia* n g, parasitic in gulls, and its type-species, *B anaticapicirra* n sp (Cestoda: Hymenolepididae). *Syst Parasitol* 57: 119-133.
28. Bondarenko S, Kontrimavicus V (2004b) Life-cycles of cestodes of the genus *Brachiopodataenia* (Cestoda: Hymenolepididae) from gulls in Chukotka. *Syst Parasitol* 57: 191-199.
29. Georgiev BB, Angelov A, Vasilieva GP, Sanchez MI, Hortas F, et al. (2014) Larval helminths in the invasive American brine shrimp *Artemia franciscana* throughout its annual cycle. *Acta Parasitol* 59: 380-389.
30. Spasskij AA, Jurpalova NM, Kornjushin VV (1968) A new dilepidid genus *Anomolepis* n.g. (Cestoda, Cyclophyllidea). *Vestnik Zool* 2(5): 46-51.



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