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Mechanism of survival of arthropods to saline-water habitat, osmoregulation habit

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Abstract
Objectives: Insects arose in the terrestrial environment. Some species eventually evolved forms that could take advantage of freshwater habitats particularly in the larval stage. The numbers of species capable of surviving in saline is rare. Salinity and certain ions such as sodium and sulphate challenges for insects are important. Other somatically active osmolytes occur in the blood of many insect. The evolutionary advantages of flight for mating and dispersal led more species to retain terrestrial or aerial adult stage. This creates substantial physiological problem for freshwater and terrestrial animals. The insects got around this problem by reducing the amount of sodium in the body to an essential minimum. From a water hardness/salinity perspective, arthropods occupy very soft water up to salt lakes twice as concentrated as seawater.
Materials and Methods: Reliable data on academic resources such as Google Scholar, Scopus, Web of Science, Springer, Pro Quest, Wiley Online, Science Direct, Research Gate, PubMed, Sage, and SID were used.
Results: Only a limited number of species thrive in saline lakes, including some fairy shrimp and brine and shore flies such as *Ephydra hians*.
Discussion: Mechanisms of survival of *Ephydra hians* is a guideline for environmental and ecosphere creatures for adaptation.

Keywords: *Ephyda hians,* environment adaptation, osmoregulation habit

Introduction
Insects capable of surviving in saline water intensively studied are: Culicidae (mosquitoes) and Ephydridae (brine flies). Brine fly is classified in Phylum: Arthropoda, Class: Insecta, Order: Diptera, Family: Ephydridae, Genus: Ephydra, Species: *Ephydra hians. Ephydra hians*, commonly known as the alkali fly.
Both salinity and desiccation lead to dehydration and osmotic stress, which is a critical problem at the cellular level (Bradley, 2009; Cohen, 2012; Evans, 2008) [1, 4, 6]. Therefore, salinity and desiccation stress in insects trigger common physiological mechanisms, mainly aimed at increasing water content (e.g. drinking from the medium), avoiding its loss (e.g. control of cuticle permeability) and maintaining ionic homeostasis (e.g. activity of Malpighian tubules and specialized parts of) (Bradley, 2009; Dow and Davies, 2006; Gibbs and Rajpurohit, 2010; Larsen *et al.*, 2014) [1, 5, 8, 11].

Ecology of Brine fly
Among aquatic insects, members of the shore fly family Ephydridae are well-known for their tolerance of severe environmental conditions. High temperatures and salinities, acid and alkaline pH, anoxia and ephemeral waters are among the factors to which a variety of ephydrids have become adapted. Hot springs, tidal splash pools, salt evaporation ponds, hypersaline desert lakes, and even crude petroleum have been described as larval habitats Collection records for species in the genus Ephydra, which are common in saline waters, indicate a wide range in chemical composition and salinity is tolerated by this group, but that any one species tends to be restricted to a particular type of habitat water chemistry (Bradley (2009) [1]; Brock and Brock (1968) [2], Foley and White (1989) [7], Herbst (1988) [9].
The adults flies live 3-5 days, during which they eat algae and lay eggs in the hypersaline water. (Fig.1) lay eggs in saline water (Fig.2). The larvae are important for their capacity to survive in highly saline water (Fig.3).

Concretions of calcium carbonate in the Malpigian tubules make the larvae more dense and allow them to stay on the beneath of the water. The haemolymph had a total osmotic concentration of about 300mOsm. The osmotic concentration of the lake was well over 1500 mOsm. It follow that the larvae must lose water across the cuticle. The larvae drink the external medium. The very high concentration sodium, carbonate and sulphate in lake. The lime gland acts like a kidney, by removing carbonate ions from the blood. Inside the glands carbonate is mixed with calcium to form a limestone (Fig.5). Saline water larvae drink equal to about their body volume every 10 hours.

Table 1 shows different ions in the heamolymph of larvae in comparison to Mono lake water. Eggs of the genus *Ephydra* are attached to an algae mat. The main food sources of adults and larvae are algae, some bacteria, and protozoa.

Fig 1: Adults of brine fly *(Ephydra hians)*

Fig 2: Egg of brine fly *(Ephydra hians)*

Fig 3: Larvae of brine fly *(Ephydra hians)*

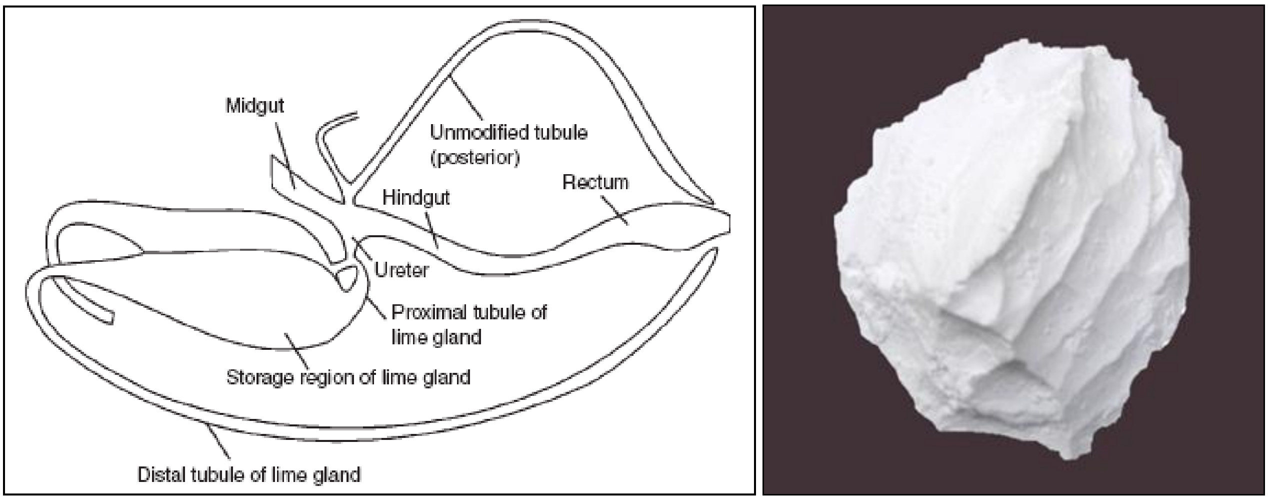

Fig 4: Internal organs of the brine fly *(Ephydra hians)* with limestone

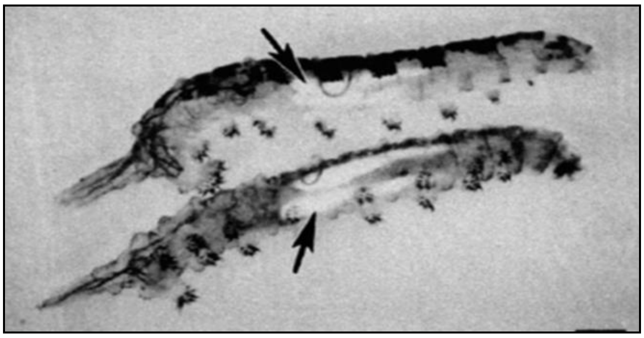

Fig 5: Lime gland of larvae

Table 1: Ionic concentration in the larval haemolymph of *Ephydra hians*

Ion	Concentration in larval haemolymph	Concentration in Mono lake water
Sodium	135.7 ± 1	1224
Potassium	6.9 ± 0.4	18
Calcium	5.6 ± .0.1	≤1
Magnesium	13.2 ± 0.5	≤1
Chloride	120 ± 1.4	627
Sulphate	0.6 ± 0.1	151

Larvae change to the pupae (Fig.6). Pupae are non-feeding, and sequestered from the aquatic environment, Pupae then to the adults. Adults emerge from water in a large population (Fig.7). Birds understand the time of adult emergence and reach the lake for catching them as a food. Many migrating birds stop at Lake during their trips to feed on the brine fly larvae in the lake water (Fig.8).

Fig 6: Pupae of brine fly *(Ephydra hians)*

Fig 7: Emerging of brine fly from saline water lake

Fig 8: Emerging of adult of brine flies as a good food source for immigrant birds

In a research conducted on the mosquitoes, they found that *Aedes albopictus* was the most tolerant species, followed by *Anopheles coluzzii*, *Ae. aegypti*, *Culex. quinquefasciatus*, and *An. gambiae*, in decreasing order. *Cx. pipiens* was the least tolerant species (Kengne *et al*. 2019) [10].
The brine fly *Ephydra urmiana* (Diptera: Ephydridae) has reported from margin of the Urmia Lake, Iran. Breeding and feeding of *E. urmiana* totally depends on the lake. Eggs of the genus *Ephydra* are attached to an algae mat (Foley and White 1989) [7]. The main food sources of adults and larvae are algae, some bacteria, and protozoa (Broke and Brock 1968 [2], Brock *et al.* 1969 [3], Herbst 1988) [9]. Nemenz *et al.* 1963) [12]. had observed adults of *Ephydra cinerea* feeding on masses of algae washed ashore at the Great Salt Lake in Utah, USA.

Conflict of interest: The author declare that there is no conflict of interest.

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Data accessibility statement
The data that support the findings of this study are openly available in the references.

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