Short Communication

The genus *Artemia* Leach, 1819 (Crustacea: Branchiopoda).
I. True and false taxonomical descriptions

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ABSTRACT. The brine shrimp *Artemia* is important for aquaculture since it is highly nutritious. It is also used widely in biological studies because it is easy to culture. The aim of the present study is to review the literature on the taxonomical nomenclature of *Artemia*. The present study indicates the existence of seven species: three living in the Americas, one in Europe, and three in Asia.

Keywords: *Artemia*, saline lakes, morphology, species, taxonomy.

El género *Artemia* Leach, 1819 (Crustacea: Branchiopoda). I. Descripciones taxonómicas verdaderas y falsas

RESUMEN. El camarón de salmuera *Artemia* es importante para la acuicultura por su alta calidad nutricional y es muy utilizado para estudios biológicos por ser de fácil cultivo. El objetivo del presente estudio es revisar la literatura sobre la nomenclatura taxonómica de *Artemia*. Se determina la existencia de siete especies; tres de ellas viven en América, una en Europa y tres en Asia.

Palabras clave: *Artemia*, lagos salinos, morfología, especies, taxonomía.

The brine shrimp *Artemia* is one of the most important aquatic animals used in aquaculture industry. It was first reported from Urmia Lake in 982 by an unknown Iranian geographer (Asem, 2008), and then in 1756 Schlösser pictured both sexes clearly. Linnaeus (1758) described it as *Cancer salinus* but 61 years later, Leach (1819) transferred it to *Artemia salina*.

The taxonomic status of the genus *Artemia* is as follows (Martin & Davis, 2001):

Subphylum: Crustacea Brünnich, 1772
Class: Branchiopoda Latreille, 1817
Subclass: Sarsostraca Tasch, 1969
Order: Anostraca Sars, 1867
Family: Artemiidae Grochowski, 1896
Genus: *Artemia* Leach, 1819
- *A. salina* (Linnaeus, 1758): Mediterranean area
- *A. monica* Verrill, 1869: USA (Mono Lake; California)
- *A. urmiana* Günther, 1899: Iran (Urmia Lake; West Azerbaijan Province)
- *A. franciscana* Kellogg, 1906: America, Caribbean and Pacific islands
- *A. persimilis* Piccinelli & Prosdocimi, 1968: South America
- *A. sinica* Cai, 1989: Central and Eastern Asia
- *A. tibetiana* Abatzopoulos, Zhang & Sor-geloos, 1998: China (Tibet)
- *Artemia* sp. Pilla & Beardmore, 1994: Kazakhstan
- Parthenogenetic population(s) of *Artemia*: Europe, Africa, Asia and Australia

Taxonomists are still confused about the systematic and phylogenetic relationships of the *Artemia* species (Triantaphyllidis et al., 1997) and there are different opinions about its biosystematics. For example, there are two views for *A. franciscana*...
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The "comma" must be used between the name of the author and date [Art. 22; (ICZN, 2000)].
- 1, 2, 3, 4: The genus *Artemia* was described by Leach in 1819 not Linnaeus.
- 5: Leach described *Artemia* so parentheses should not be used.
- 6: Leach had described the genus *Artemia* in 1819 so it should be depicted as: *Artemia* Leach, 1819
- 7, 8: Although Linnaeus (1758) described the brine shrimp as *Cancer salinus* and Leach has corrected its status as *Artemia salina* in 1819, according to Article 22: 22A.3. (ICZN 2000) the only true status will be: *Artemia salina* (L., 1758) or *Artemia salina* (Linnaeus, 1758). Use of parentheses around author's name shows Linnaeus had described this species in a different genus in 1758 and then it has been changed into *Artemia salina*.
- 9, 10: Although the rule of Article 22: 22A.3. (ICZN, 2000) is respected but punctuation mark "( )" is absent. Because Linnaeus had used a different name for *Artemia* therefore according to Article 22: 22A.3. (ICZN, 2000), Linnaeus and its date must be put in parenthesis.
- 11, 12: These two expressions conform that Linnaeus had considered *Artemia salina* in another genus and was corrected afterward. So, use of parentheses around author name and date is necessary.
- 13: Verrill is the original describer of *Artemia monica* therefore use of parentheses is incorrect.
- 14: Verrill is the original describer of *Artemia monica* therefore the name is: *Artemia monica* Verrill, 1869
- 15, 16: Although there is debate about *Artemia* in Mono Lake being a biological or sibling species, trinomial nomenclature is used only for subspecies (see Article 4.; ICZN, 2000). So the proper name is: *Artemia monica* Verrill, 1869
- 17, 18, 19, 20, 21, 22: Günther (1899, not 1900) is the original describer of *Artemia urmiana* so use of parentheses around author name and date is incorrect.
- 23: Kellogg had reported and described *Artemia franciscana* from San Francisco Bay in 1906 so there is no need for parentheses.
- 24: Kellogg is the original describer of therefore the proper name is: *Artemia franciscana* Kellogg, 1906
- 25: Though even *Artemia* from San Francisco Bay is accepted as sibling species its name will be: *Artemia franciscana* Kellogg, 1906 because “Trinomial Nomenclature” used only for subspecies (see Article 4; ICZN, 2000).
- 26: Sibling species are defined under the “Binomial Nomenclature” system (see Article 4.; ICZN, 2000).
- 27, 28: The asexual populations had been named such as biological species; *Artemia parthenogenetica* by Barigozzi in 1974 (Browne & Bowen, 1991). Since their reproductive
mechanism is via parthenogenesis and the males seldom are produced in these populations. Therefore, they are introduced as "parthenogenetic Artemia populations" (Abatzopoulos et al., 2002)

- 29: Piccinelli & Prosdocimi are the original describers of *Artemia persimilis* in 1968 so parentheses are not needed.


- 30: The proper name is: *Artemia persimilis* Piccinelli & Prosdocimi, 1968

- 31: Cai is original describer of *Artemia sinica* in 1989 from China so parentheses are not needed.


- 32: Yaneng is the first name of Cai; but sometimes *Artemia sinica* is cited and referred by Yaneng which it will be false.

- 33: The proper name is: *Artemia sinica* Cai, 1989

- 34, 35: *Artemia sinica* had been described by Cai and Zhou et al. has been introduced as two subspecies. New subspecies must be expressed as: *Artemia sinica sinica* Cai, 1989, because Zhou et al., 2003 has done nothing but change the rank.

- 36, 37: Abatzopoulos et al. have introduced *Artemia tibetiana* in 1998 from Tibet so use of parentheses around author name and date won't be true status. Its right status only will be: *Artemia tibetiana* Abatzopoulos et al., 1998 or *Artemia tibetiana* Abatzopoulos, Zhang & Sorgeloos, 1998 (See also Recommendation 51C; ICZN, 2000)


and *A. monica*. *Artemia monica*, from Mono Lake, cannot be crossed with *A. franciscana* because of the inability of the two species to tolerate the same water ionic composition (Mono Lake has a mix of Cl$, \text{SO}_4^{2-}$ and CO$_3^-$ ions). *A. monica* is therefore thought to be effectively debarred from exchanging gene with *A. franciscana* so these two species are known as two different "biological species" (Clark & Bowen, 1976). According to others (Abreu-Grobois & Beardmore, 1982; Triantaphyllidis *et al*., 1998), *A. monica* may be ecologically separated from *A. franciscana*, but the genetic distance between these two taxa is less than the distance between other *Artemia* taxa; therefore they can be described as sibling species. Furthermore, there are no taxonomic identification keys for the genus due to a lack of reliable morphological characters, so different methods have been used for species characterization. The most relevant methods are comparison of biometric characteristics, electrophoretic patterns of different allozymes, cross-fertility tests and microscopic survey of the morphology such as frontal knob and gonopod (Abreu-Grobois & Beardmore, 1982; Mura, 1990; Hontoria & Amat, 1992; Triantaphyllidis *et al*., 1997; De los Ríos & Zúñiga, 2000; Torrentera & Belk, 2002; De los Ríos & Asem, 2008).

Seeing that *Artemia* was an economically important species this has led to a decline of basic studies on this taxon, with wide use of "*Artemia salina*" as a trade name. There are numerous published data on biochemical, mutational, toxicological and others aspects of *Artemia*, all using the name *Artemia salina* for any population in this genus (Abreu-Grobois & Beardmore, 1982; Gajardo *et al*., 2002). As a result, the brine shrimp *Artemia* is used in many aquaculture studies and for experimental models but its basic taxonomy is not considered by many authors resulting in taxonomical confusion (Table 1), with the mistakes and respective corrections about systematic nomenclature.

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**REFERENCES**


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