

NOBANIS - Marine invasive species in Nordic waters - Fact Sheet

Acartia tonsa

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Species description

Species name

Acartia tonsa, Dana, 1849 – a planktonic copepod

Synonyms

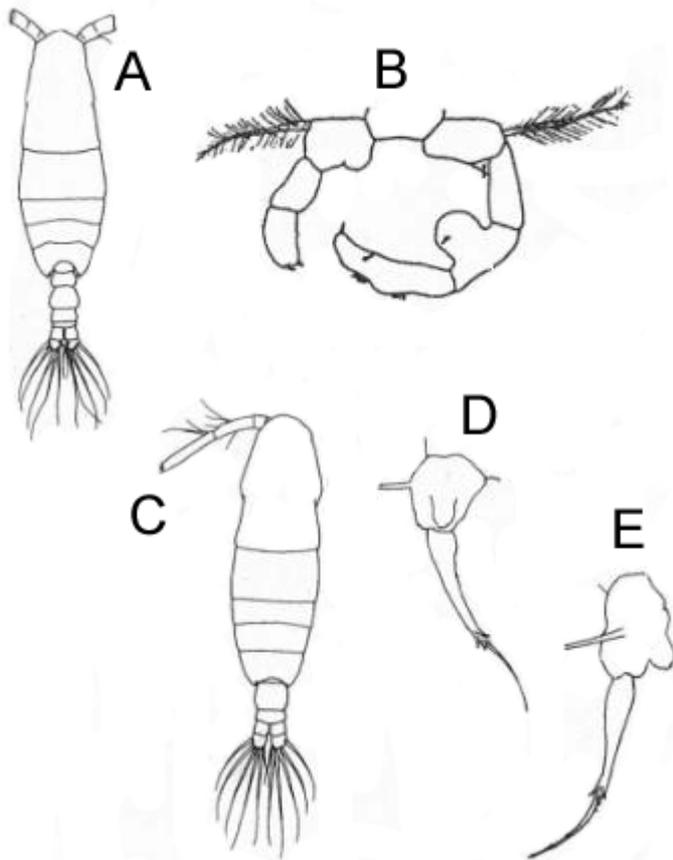
Acartia (Acanthacartia) tonsa; *Acartia giesbrechti* Dahl, 1894; *Acartia bermudensis* Esterly, 1911; *Acartia floridana* Davis, 1948; *Acartia gracilis* Herrick, 1887; *Acartia tonsa cryophylla* Björnberg, 1963.

Common names

Aerjas tömbik (tulnuk-tömbik) (EE), Hankajalkaisyriäinen (FI), Hoppkräfta (SE), Acartia, akartsia (RU)

Identification

Several similar species occur in the area: *Acartia clausi* Giesbrecht, 1889, *A. longiremis* (Liljeborg, 1853) and *A. bifilosa* (Giesbrecht, 1881). The latter species prefers low salinity waters (David et al., 2007), like *A. tonsa*, whereas *A. clausi* prefers high salinities (Calliari et al., 2006). *A. longiremis* has a northern boreal-arctic distribution (Lee & McAlice, 1979), whereas *A. clausi* is widespread in warmer waters including the Mediterranean and Black Sea (Gubanova, 2000). *Acartia tonsa* is usually about 1 mm long (up to 1.5 mm) (Garmew et al., 1994; Belmonte et al., 1994; Marcus & Wilcox, 2007) and hence a microscope is required for identification. It has a relatively short abdomen, and relative body width is higher than in sympatric congeners. Females are only slightly larger than males, whereas in *A. clausi* females are significantly larger than males. Females of *A. tonsa* can be distinguished from female *A. bifilosa* by the shape of the exopod of the 5th pair of legs, which in *A. tonsa* is elongate with several spinules about half way to the tip, whereas *A. bifilosa* has a swollen base and fine spinules along the distal half (Redeke, 1934). However, it is very difficult to distinguish the species of *Acartia*, and so far no molecular method has been developed.



Acartia tonsa

- A: Male body shape (from Belmonte et al. 1994)
- B: Male, 5th leg (from Belmonte et al. 1994)
- C: Female body shape (from Belmonte et al. 1994)
- D: Female, 5th leg, ventral view (from Redeke 1934)
- E: Female, 5th leg, lateral view (from Redeke 1934)

Distribution

Native area

Acartia tonsa is a cryptogenic species with an almost worldwide distribution in coastal subtropical and temperate waters. The questionable identity of the species listed as synonyms is an indication of this. However, it has also been claimed to be a glacial relict in northeastern North America (McAlicie, 1981). The type locality, i.e., the place where the material for the original description was collected, is Port Jackson in New South Wales, Australia (Redeke, 1934), but this does not mean that Australia is its native area. On the contrary, finding it in a port area indicates human mediated introduction.

Introduced area

Acartia tonsa was first collected in 1916 in the Zuiderzee, at that time a huge brackish water area in the Netherlands. Unfortunately it was not correctly identified, but later examination of samples identified its presence, and it was also determined that it was certainly not present at that locality in

1912 or earlier (Redeke, 1934). The first Danish record is from Ringkøbing Fjord in 1921, and studying plankton samples from previous years showed that it had not been present prior to 1919 (Jespersen, 1933). Presently it is one of the commonest copepods in coastal waters throughout Denmark (Sørensen et al., 2007; Tiselius et al., 2008). In the Baltic it was first recorded in 1924 in the Gulf of Riga. In 1925 it was found in the Gulf of Gdansk, Poland, in the Gulf of Finland in 1934 and in 1939 it had reached the waters around Helsinki (Segerstråle, 1957). It was first recorded in France in 1925, and this was actually the first published record in Europe. More recently, i.e. 1990s to the present, it has become abundant in several estuaries in the Bay of Biscay (David et al., 2007; Aravena et al., 2009) and also in Portugal (Leandro et al., 2006). In Germany it was first found in the estuary of the Weser in 1930 (Redeke, 1934), whereas it apparently did not occur on the Baltic coast till about 1981 (Gollasch & Nehring, 2006). In Sweden the first record is from 1934. Presently it occurs on the Swedish westcoast as well as part of the Baltic coast. It is unknown whether it lives in the Gulf of Bothnia (Främmande Arter, 2006).

Acartia tonsa was first found on the east coast of North America around 1900, where it was found in brackish water. Presently its distribution extends from New Brunswick, Canada to Argentina in the south. On the Pacific coast it was found in San Francisco Bay in 1924 and further south at La Jolla and San Diego before 1905, and also along the Pacific coast of Chile (Redeke, 1934) and Peru (Garmew et al., 1994). Molecular studies have indicated that the species identified as *A. tonsa* on the Pacific coast of North America is a separate species (Caudill & Bucklin, 2004). Also, the high variability both within and between populations on the east coast of the USA is interpreted as indicating that *A. tonsa* has not been introduced by human activities (Caudill & Bucklin, 2004), and the absence of hybrids may indicate that cryptic species are involved (Chen & Hare, 2008).

Acartia tonsa has more recently been found in the Mediterranean, the Black Sea and the Caspian Sea. In the Caspian Sea it was first found in the central part in 1982, and in the northern part in 1983, but it has been suspected that it has been present before, misidentified as *A. clausi* (see [here](#)). *A. tonsa* was first recorded from the Black Sea in 1990 (Belmonte et al., 1994), but examination of older plankton samples showed that it was present in 1976 but not in 1968. It was not reported from the Mediterranean until 1985, which indicates that it was introduced to the Black Sea with ballast water (Gubanova, 2000). This is further supported by the fact that population density of *A. tonsa* is 25 times lower in the Marmara than in the Black Sea (Hubareva et al., 2008). It seems to be still spreading in the Mediterranean (Sei & Ferrari, 2006).

Vector

Ballast water seems to be the most likely means of transferring this species (Gubanova, 2000), or its eggs between coastal waters of different continents. The fact that *A. tonsa* can produce highly resistant diapause eggs as well as eggs that can be induced into quiescence has probably played an important role for its wide distribution. However, it cannot be ruled out that its presence in the western North Atlantic is natural (McAlice, 1981).

Ecology

Acartia tonsa is a coastal and estuarine species. It is erythermic, euryhaline, eurytrophic, etc., and thus well adapted for low salinity and highly eutrophic waters. It has been used extensively for experimental studies on eutrophication, competition, etc., in many regions (e.g. Tiselius et al., 1995, 2008) and also it has been used as food for suspension-feeding organisms in laboratory experiments

and for fish larvae in aquaculture (Holmstrup et al., 2006) as well as for toxicity-tests (Nielsen et al., 1990; Kusk & Petersen, 1997; Bielmyer et al., 2006). Also, its physiology and reproduction have been studied in the laboratory (e.g., Gonzales, 1974; Kiørboe et al., 1985; Thor, 2003). *Acartia tonsa* is often a dominating species in coastal and estuarine plankton samples (Cervetto et al., 1995; Cubbage et al., 1999; Leandro et al., 2006; Sørensen et al., 2007; Tiselius et al., 2008). *Acartia tonsa* feeds on nauplii of other copepods (Tackx & Polk, 1982) and on phytoplankton, including diatoms as well as flagellates. Cyanobacteria, however, are not eaten in measurable amounts (Schmidt & Jónasdóttir, 1997). It can switch between two different feeding methods, suspension feeding on non-motile prey, and actively capturing motile prey. When phytoplankton concentration is high, suspension feeding dominates (Kiørboe et al., 1996), but they strongly prefer motile prey such as ciliates and flagellates to non-motile prey such as diatoms (Sommer, 2009). The lower size limit for captured and ingested particles is about 2-4 μm (Berggreen et al., 1988).

In the northern parts of its range *A. tonsa* has one population peak in the fall (August-September), but in southern parts there is also a spring peak in May (David et al., 2007). In the northern Baltic it only occurs in the plankton in late summer and fall, and spends the rest of the year as “resting eggs”, which are intermediate between diapause eggs and regular eggs (Katajisto, 2006).

Reproduction

Males pack their sperm into spermatophores that are attached to the females precisely at the genital opening (Hammer, 1978). Mates are detected by hydromechanical signals rather than pheromones (Kiørboe & Bagøien, 2005). Development time varies from 40 days at 10° C to 9 days at 22° C (Leandro et al., 2006). Optimal temperature for hatching in a Baltic population was 22-23° C, and optimal salinity was 25 ppt (Holste & Peck, 2006). Development time also depends on food availability (Berggreen et al., 1988). Egg production of individual females goes on for about 3-4 weeks (Rodríguez-Graña et al., 2010), and each female produces 20-30 eggs per day (Sørensen et al., 2007), 18-50 per brood every 5 days (Marcus & Wilcox, 2007), or 37-53 eggs per day (Rodríguez-Graña et al., 2010). Eggs have a diameter of about 70-75 μm and are covered with short spines (Belmonte, 1998). They are slightly heavier than seawater (Marcus & Wilcox, 2007), which means that they sink towards the bottom after spawning. *A. tonsa* goes through 6 nauplius stages and 5 copepodite stages before they reach the sexually mature stage (Berggreen et al., 1988). At 25° C hatching of the first nauplius takes about 48 hours after spawning (Marcus & Wilcox, 2007). In its northern range, i.e., north of New Jersey, USA, *A. tonsa* produces benthic diapause eggs, which survive the winter and hatch in the spring when temperature reaches 10° C (McAlice, 1981; Caudill & Bucklin, 2004), but further south reproduction may take place all year round (Hammer, 1978). Reproduction remains low between 10 and 16° C (McAlice, 1981). Populations in the Limfjord, Denmark did not produce diapause eggs even if winter temperature is much lower than 10° C (Sørensen et al., 2007). However, the “normal” eggs may enter a quiescence state under adverse conditions (Højgaard et al., 2008). In the Gulf of Maine *A. tonsa* produces three generations per season between May and December (Lee & McAlice, 1979).

Impacts

Competition with other [copepods](#), especially congeners appears to be the only documented impact of *A. tonsa*. In the Black Sea it has replaced the native, stenothermic *A. latisetosa* (Kritchagin, 1873) during the 1970s (Gubanov, 2000). In southwestern France it is seasonally replacing *A. bifilosa* in low salinity waters (David et al., 2007). This was attributed to intrusion of saline water

plus increased water temperature in connection with a nuclear power plant, and furthermore, the change in zooplankton composition was suspected to impact production of shrimp and fish production. In a Spanish estuary with relatively high salinity, *A. tonsa* had a negative impact on *A. clausi* (Aravena et al., 2009). Grazing impact of *A. tonsa* appears minor; in a Mediterranean lagoon it consumed less than 1% of the phytoplankton production (Cervetta et al., 1995). A positive impact is that *A. tonsa* has been used to produce live feed for aquaculture organisms (Marcus & Wilcox 2007; Sørensen et al., 2007).

References

- Andersen Borg, M. 2009. Non-indigenous zooplankton – the role of predatory cladocerans and of copepods in trophic dynamics. Ph.D. thesis, University of Stockholm, Sweden, 53pp.
- Aravena, G., Villate, F., Uriarte, I., Iriarte, A. and Ibáñez, B. 2009. Response of *Acartia* populations to environmental variability and effects of invasive congeners in the estuary of Bilbao, Bay of Biscay. *Estuarine, Coastal and Shelf Science* 83: 621-628.
- Belmonte, G. 1998. The egg morphology of 7 Acartiidae species: a preliminary survey of the ootaxonomy of calanoids. *Journal of Marine Systems* 15: 35-39.
- Belmonte, G., Mazzocchi, M.G., Prusova, I.Y. and Shadrin, N.V. 1994. *Acartia tonsa*: a species new for the Black Sea fauna. In: *Ecology and Morphology of Copepods* (F.D. Ferrari and B.P. Bradley, eds.). *Hydrobiologia* 292/293: 9-15.
- Berggreen, U., Hansen, B. and Kiørboe, T. 1988. Food size spectra, ingestion and growth of the copepod *Acartia tonsa* during development: implications for determination of copepod production. *Marine Biology* 99: 341-352.
- Bielmyer, G.K., Grosell, M. and Brix, K.V. 2006. Toxicity of silver, zinc, copper, and nickel to the copepod *Acartia tonsa* exposed via a phytoplankton diet. *Environmental Science and Technology* 40(6): 2063-2068.
- Calliari, D., Andersen, C.M., Thor, P., Gorokhova, E. and Tiselius, P. 2006. Salinity modulates the energy balance and reproductive success of co-occurring copepods *Acartia tonsa* and *A. clausi* in different ways. *Marine Ecology Progress Series* 312: 177-188.
- Calliari, D., Andersen Borg, M.C., Thor, P., Gorokhova, E. and Tiselius, P. 2008. Instantaneous salinity reductions affect the survival and feeding rates of the co-occurring copepods *Acartia tonsa* Dana and *A. clausi* Giesbrecht differently. *Journal of Experimental Marine Biology and Ecology* 362: 18-25.
- Caudill, C.C. and Bucklin, A. 2004. Molecular phylogeography and evolutionary history of the estuarine copepod, *Acartia tonsa*, on the Northwest Atlantic coast. *Hydrobiologia* 511: 91-102.
- Cervetto, G., Pagano, M. and Gaudy, R. 1995. Feeding behavior and migrations in a natural population of the copepod *Acartia tonsa*. *Hydrobiologia* 300/301: 237-248.
- Chen, G. and Hare, M.P. 2008. Cryptic ecological diversification of a planktonic estuarine copepod, *Acartia tonsa*. *Molecular Ecology* 17: 1451-1468.
- Cubbage, A., Lawrence, D., Tomasky, G. and Valiela, I. 1999. Relationship of reproductive output in *Acartia tonsa*, chlorophyll concentration, and land-derived nitrogen loads in estuaries of Waquoit Bay, Massachusetts. *Biological Bulletin* 197: 294-295.

- David, V., Sautour, B. and Chardy, P. 2007. Successful colonization of the calanoid copepod *Acartia tonsa* in the oligo-mesohaline area of the Gironde estuary (SW France) – Natural or anthropogenic forcing? *Estuarine, Coastal and Shelf Science* 71: 429-442.
- Engström, J., Koski, M., Viitasalo, M., Reinikainen, M., Repka, S. and Sivonen, K. 2000. Feeding interactions of the copepods *Eurytemora affinis* and *Acartia bifilosa* with the cyanobacteria *Nodularia* sp. *Journal of Plankton Research* 22(7): 1403-1409.
- Främmande Arter 2006. *Acartia tonsa* fact-sheet. [Available as pdf](#) (accessed on 10 August 2009).
- Garmew, T.G., Hammond, S., Mercantini, A., Morgan, J., Neunert, C. and Fornshell, J.A. 1994. Morphological variability of geographically distinct populations of the estuarine copepod *Acartia tonsa*. In: *Ecology and Morphology of Copepods* (F.D. Ferrari and B.P. Bradley, eds.). *Hydrobiologia* 292/293: 149-156.
- Gifford, D.J. and Dagg, M.J. 1988. Feeding of the estuarine copepod *Acartia tonsa* Dana: Carnivory vs. Herbivory in natural microplankton assemblages. *Bulletin of Marine Science* 43(3): 458-468.
- Gollasch, S. and Nehring, S. 2006. National checklist for aquatic alien species in Germany. *Aquatic Invasions* 1(4): 245-269.
- González, J.G. 1974. Critical thermal maxima and upper lethal temperatures for the calanoid copepods *Acartia tonsa* and *A. clausi*. *Marine Biology* 27(3): 219-223.
- Gubanova, A. 2000. Occurrence of *Acartia tonsa* Dana in the Black Sea. Was it introduced from the Mediterranean? *Mediterranean Marine Science* 1(1): 105-109.
- Hammer, R.M. 1978. Scanning electron microscope study of the spermatophore of *Acartia tonsa* (Copepoda: Calanoida). *Transactions of the American Microscopical Society* 97(3): 386-389.
- Højgaard, J.K., Jepsen, P.M. and Hansen, B.W. 2008. Salinity-induced quiescence in eggs of the calanoid copepod *Acartia tonsa* (Dana): a simple method for egg storage. *Aquaculture Research* 39(8): 828-836.
- Holmstrup, M., Overgaard, J., Sørensen, T.F., Drillet, G., Hansen, B.W., Ramløv, H. and Engell-Sørensen, K. 2006. Influence of storage conditions on viability of quiescent copepod eggs (*Acartia tonsa* Dana): effects of temperature, salinity and anoxia. *Aquaculture Research* 37(6): 625-631.
- Holste, L. and Peck, M.A. 2006. The effects of temperature and salinity on egg production and hatching success of Baltic *Acartia tonsa* (Copepoda: Calanoida): a laboratory investigation. *Marine Biology* 148(5): 1061-1070.
- Hubareva, E., Svetlichny, L., Kideys, A. and Isinibilir, M. 2008. Fate of the Black Sea *Acartia clausi* and *Acartia tonsa* (Copepoda) penetrating into the Marmara Sea through the Bosphorus. *Estuarine, Coastal and Shelf Science* 76(1): 131-140.
- Jespersen, P. 1933. Planktonfaunaen i Ringkøbing Fjord og Nymindestrømmen 1914-30. [The plankton fauna in Ringkøbing Fjord and the Nyminde Inlet.] In: R. Spärck (ed.) 1933-1936. *Ringkøbing Fjords Naturhistorie i Brakvandsperioden 1915-31*, pp. 49-61. [in Danish with English summary]
- Katajisto, T. 2006. Benthic resting eggs in the life cycles of calanoid copepods in the northern Baltic Sea. *Walter and André de Nottbeck Foundation Scientific Reports No. 29*, Helsinki, Finland, 46pp. [Available as pdf](#) (accessed 26 February 2010).
- Katajisto, T., Viitasalo, M. and Koski, M. 1998. Seasonal occurrence and hatching of calanoid eggs in sediments of the northern Baltic Sea. *Marine Ecology Progress Series* 163: 133-143.

- Kjørboe, T. and Bagøien, E. 2005. Motility patterns and mate encounter rates in planktonic copepods. *Limnology and Oceanography* 50(6): 1999-2007.
- Kjørboe, T., Møhlenberg, F. and Hamburger, K. 1985. Bioenergetics of the planktonic copepod *Acartia tonsa*: relation between feeding, egg production and respiration, and composition of specific dynamic action. *Marine Ecology Progress Series* 26: 85-97.
- Kusk, K.O. and Petersen, S. 1997. Acute and chronic toxicity of tributyltin and linear alkylbenzene sulfonate to the marine copepod *Acartia tonsa*. *Environmental Toxicology and Chemistry* 16(8): 1629-1633.
- Leandro, S.M., Tiselius, P. and Queiroga, H. 2006. Growth and development of nauplii and copepodites of the estuarine copepod *Acartia tonsa* from southern Europe (Ria de Aveiro, Portugal) under saturating food conditions. *Marine Biology* 150: 121-129.
- Lee, W.Y. and McAlice, B.J. 1979. Seasonal succession and breeding cycles of three species of *Acartia* (Copepoda: Calanoida) in a Maine estuary. *Estuaries* 2(4): 228-235
- Marcus, N.H. and Wilcox, J.A. 2007. A guide to the meso-scale production of the copepod *Acartia tonsa*. Florida Sea Grant. [Available as pdf](#) (accessed on 25 February 2010).
- McAlice, B.J. 1981. On the post-glacial history of *Acartia tonsa* (Copepoda: Calanoida) in the Gulf of Maine and the Gulf of St. Lawrence. *Marine Biology* 64: 267-272.
- Nielsen, T.G., Kjørboe, T. and Bjørnsen, .K. 1990. Effects of a *Chrysochromulina polylepis* subsurface bloom on the planktonic community. *Marine Ecology Progress Series* 62: 21-35.
- Redeke, H.C. 1934. On the occurrence of two pelagic copepods, *Acartia bifilosa* and *Acartia tonsa*, in the brackish waters of the Netherlands. *Journal du Conseil International de l'Exploration de la Mer* 9(1): 39-45.
- Reeve, M.R. and Walter, M.A. 1977. Observations on the existence of lower threshold and upper critical food concentrations for the copepod *Acartia tonsa* Dana. *Journal of Experimental Biology and Ecology* 29: 211-221.
- Rodríguez-Graña, L., Calliari, D., Tiselius, P., Hansen, B.W. and Sköld, H.N. 2010. Gender-specific ageing and non-Mendelian inheritance of oxidative damage in marine copepods. *Marine Ecology Progress Series* 401: 1-13.
- Schallek, W. 1942. The vertical migration of the copepod *Acartia tonsa* under controlled illumination. *Biological Bulletin* 82: 112-126.
- Schmidt, K. and Jónasdóttir, S.H. 1997. Nutritional quality of two cyanobacteria: How rich is 'poor' food? *Marine Ecology Progress Series* 151: 1-10.
- Segerstråle, S.G. 1957. Baltic Sea. In: *Treatise on Marine Ecology and Paleoecology*. Part I. Ecology (Hedgpeth, J.W., ed.). Geological Society of America, Memoir 67, pp. 751-800.
- Sei, S. and Ferrari, I. 2006. First report of the occurrence of *Acartia tonsa* (Copepoda: Calanoida) in the Lesina lagoon (south Adriatic Sea – Mediterranean Sea). *Marine Biodiversity Records* 1: e37 (2pp.).
- Sommer, U. 2009. Copepod growth and diatoms: insensitivity of *Acartia tonsa* to the composition of semi-natural plankton mixtures manipulated by silicon:nitrogen ratios in mesocosms. *Oecologia* 159(1): 207-215.
- Sørensen, T.F., Drillet, G., Engell-Sørensen, K., Hansen, B.W. and Ramløv, H. 2007. Production and biochemical composition of eggs from neritic calanoid copepods reared in large outdoor tanks (Limfjord, Denmark). *Aquaculture* 263: 84-96.

- Tackx, M. and Polk, P. 1982. Feeding of *Acartia tonsa* Dana (Copepoda, Calanoida): predation on nauplii of *Canuella perplexa* T. et A. Scott (Copepoda, Harpacticoida) in the sluice-dock at Ostend. *Hydrobiologia* 94: 131-133.
- Thor, P. 2003. Elevated respiration rates of the neritic copepod *Acartia tonsa* during recovery from starvation. *Journal of Experimental Marine Biology and Ecology* 283: 133-143.
- Tiselius, P. 1992. Behavior of *Acartia tonsa* in patchy food environments. *Limnology and Oceanography* 37(8): 1640-1651.
- Tiselius, P., Andersen Borg, C.M., Hansen, B.W., Hansen, P.J., Nielsen, T.G. and Vismann, B. 2008. High reproduction, but low biomass: mortality estimates of the copepod *Acartia tonsa* in a hyper-eutrophic estuary. *Aquatic Biology* 2: 93-103.
- Tiselius, P., Hansen, B., Jonsson, P., Kiørboe, T., Nielsen, T.G., Piontkovski, S. and Saiz, E. 1995. Can we use laboratory-reared copepods for experiments? A comparison of feeding behaviour and reproduction between a field and a laboratory population of *Acartia tonsa*. *ICES Journal of Marine Science* 52(3-4): 369-376