ASSOCIATION OF ZOOS & AQUARIUMS

JELLYFISH
(CNIDARIA/CTENOPHORA)
CARE MANUAL

CREATED BY THE
AZA AQUATIC INVERTEBRATE TAXON ADVISORY GROUP
IN ASSOCIATION WITH THE
AZA ANIMAL WELFARE COMMITTEE

Jellyfish Care Manual

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This nutrition chapter is an excerpt from the complete Animal Care Manual available at the

Association of Zoos and Aquariums (AZA)'s website:

http://www.aza.org/animal-care-manuals/

Further information about diets and the nutrition of this and other species can be found at the

AZA's Nutrition Advisory Group (NAG)'s website:

http://nagonline.net

Chapter 5. Nutrition

5.1 Nutritional Requirements

AZA Accreditation Standard

(2.6.2) A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

A formal nutrition program is recommended to meet the nutritional and behavioral needs of all jellyfish (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the Nutrition Scientific Advisory Group (NAG) feeding guidelines (http://www.aza.org/nutrition-advisory-group/), and veterinarians as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plan® (SSP) Programs. Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

In their planktonic environment, sea jellies are opportunistic in their feeding habits. They can and do feed 24 hours a day in the wild. Most sea jellies feed on smaller zooplankton. They can grow very fast in the wild. Some sea jellies get most of their nutrition from symbiotic phytoplankton that inhabits their epidermal tissues called zooxanthellae (Hofmann & Kremer, 1981; Rahat & Adan, 1980). For those jellies, lights with proper wavelengths are critical to keeping them healthy in public displays (see Chapter 1.2). For one of the best overviews on sea jelly nutrition in aquarium settings, please refer to *How to Keep Jellyfish in Aquariums* by Chad Widmer. Chad includes recommended food for many species of sea jellies commonly displayed in public aquariums and zoos.

Although virtually all sea jellies are carnivorous, there are a variety of foods that have been found to work well for culture and display depending upon species. Also, the various life stages of sea jelly development need to be fed food of appropriate size and type.

The scientific literature includes little information on species specific nutrient requirements, but there are some scientific papers that have investigated nutritional composition of enrichments/supplements and potential prey items (Sullivan et al., 1994; Sullivan et al., 1997; Yamamoto, 1996; Bamstedt et al., 2001), metabolic rates which can dictate feeding requirements (Larson, 1987; Schneider, 1989; Bailey et al., 1995), stomach contents (Graham & Kroutil, 2001; Ishii & Tanaka, 2001) and digestion times (Heeger & Miller, 1987; Titleman & Hansson, 2006).

Aquarists have come up with a variety of live and frozen food that have allowed the culture of the many species of jellies commonly exhibited in aquariums. The basic food types include:

- Rotifers
- *Artemia* (brine shrimp) nauplii
- Mysids
- Krill (euphausiid shrimp)
- Blood worms
- Blended fish
- Fish eggs
- Larval fish
- Wild plankton
- Other jellies (commonly moon jellies, chopped to appropriate size.)

All carnivorous sea jellies are planktivores (i.e., they eat plankton) and some are also medusavores (i.e., they eat other jellies). Some medusavores will not grow unless they are fed other jellies. The most commonly used jelly to feed medusavore jellies held in public aquariums is moon jellies (*Aurelia* sp.). There are a few studies that have investigated the nutritional value of moon jellies (Rackmil et al., 2009; Fukuda & Naganuma, 2001; Martinussen & Bamstedt, 1999; Hansson, 1997). For this reason, aquarists that want to display medusavore jellies should have a ready supply of moon jellies to use as food. Medusavore jellies include the genera: *Chrysaora*, *Cyanea* and *Phacellophora*.

The hydrozoan sea jellies are almost all small (1-5mm) and planktivorous. They are fed enriched rotifers, enriched *Artemia* nauplii, and wild plankton. One common hydrozoan sea jelly in public displays is the crystal jelly *Aequorea victoria*. In order for the crystal jelly to display its bioluminescence it needs to be fed food that has the light emitting compound luciferin (Haddock et al., 2001).

The polyp stages of sea jellies are very small (0.2–1.0 cm tall) and they have very small mouths. The preferred foods for polyps are rotifers with occasional enriched *Artemia* nauplii. Many of the medusavore sea jelly polyps will not grow without being fed finely diced pieces of moon jellies (Hiromi et al., 1995).

The idea behind enrichment is to gut load rotifers and *Artemia* nauplii so the metabolized and stored food (mostly lipids or fats) can be consumed by the jelly polyp, ehphyra or medusa. Without enrichment there is very little nutritional value in rotifers and *Artemia* nauplii. The most common enrichment media include live phytoplankton (various species like *Isochrysis* and *Nannochloropsis*) and commercially available media (e.g., Algamac 3050 from Aquafauna or Selco from INVE).

When hatching *Artemia* nauplii, it can be difficult to separate them from the waste cyst material. The cyst capsule pieces can be eaten by jellies, but have no nutritional value. The separation process can be eliminated by subjecting the cysts to a decapsulation process. By decapsulating the cysts, the hard outside covering of the cyst is dissolved. The decapsulated nauplii can be refrigerated for about a month or more and still hatch. Once hatched, the nauplii are put into seawater spiked with the enrichment media. The nauplii are allowed to feed for about 24-hours. They are then rinsed and fed out. The nutritional value of the nauplii diminishes the longer they are out of the enrichment media, as they use the stored food for their own growth and development.

5.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's psychological and behavioral needs (AZA Accreditation Standard 2.6.3). Food should be purchased from reliable, sustainable and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

AZA Accreditation Standard

(2.6.3) Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

Many institutions have fine-tuned their nutritional requirements based upon the response seen in the jellies they keep. Jellies are opportunistic feeders. They catch small prey items on their tentacles either by stinging the prey or the prey being caught up in the discharged nematocyst. In general, jellies need to be fed at least every other day, but most aquariums feed them every day since in the wild they are attempting to feed 24-hours a day. Some feed their jellies twice a day or more.

Jellies are fed multiple food sources depending upon the species. Moon jellies can be kept by just feeding them *Artemia* nauplii. For best results most institutions enrich the *Artemia* nauplii with various media. The most commonly used is Super Selco or algal paste (Nannochloropsis). Some jellies are medusavores in that they eat other jellies. Medusavores are often fed smaller, whole or cut up pieces of moon jellies (*Aurelia* sp.).

Regulations on storage and thawing of seafood also apply to organisms used for jelly diets.

Food preparation must be performed in accordance with all relevant federal, state, or local regulations (AZA Accreditation Standard 2.6.1). Meat processed on site must be processed following all USDA standards. The appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for the taxa or species specified. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines.

AZA Accreditation Standard

(2.6.1) Animal food preparations must meet all local, state/provincial, and federal regulations.

AZA Accreditation Standard

(2.6.4) The institution should assign at least one person to oversee appropriate browse material for the collection.

If browse plants are used within the animal's diet or for enrichment, all plants must be identified and assessed for safety. The responsibility for approval of plants and oversight of the program should be assigned to at least one qualified individual (AZA Accreditation Standard 2.6.4). The program should identify if the plants have been treated with any chemicals or near any point sources of pollution and if the plants are safe for the jellyfish. If animals have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available.

5.3 Nutritional Evaluations

The health of jellies is determined by observations compared to the condition seen in the wild. Some of the abnormalities to look out for are bell flattening, or bell deformities such as curling of the margin, bell everting, flaccid oral arms, pitted bells, holes through the bell, belling abnormally, or sloughing off of exumbrellar surface.

There have been attempts at cryopreservation of gametes of jellies with varying results. More work on this would be beneficial. Jellies are not reliably available from natural sources so robust in-vitro and culturing efforts would ensure jellies to be available to aquariums and zoos for exhibits.

7.3 Pregnancy and Parturition

It is extremely important to understand the physiological and behavioral changes that occur throughout an animal's pregnancy. Jellies do not reproduce in a way that is relevant to parturition approaches.

7.4 Birthing Facilities

As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is "baby-proofed." Jellies do not reproduce in a way that is relevant to parturition approaches.

7.5 Assisted Rearing

Although mothers may successfully give birth, there are times when they are not able to properly care for their offspring, both in the wild and in *ex-situ* populations. Fortunately, animal care staff in AZA-accredited institutions are able to assist with the rearing of these offspring if necessary. Jelly females do not rear their young.

7. 6 Contraception

Many animals cared for in AZA-accredited institutions breed so successfully that contraception techniques are implemented to ensure that the population remains at a healthy size.

Most jellies produce massive numbers of both scyphistomae (polyps) and ephyrae (larval medusae). Those scyphistomae not used in culturing are typically considered fouling organisms and are cleaned from containers or aquaria. Successfully raising ephyrae to adult medusae is very difficult so efforts are usually focused on a relatively few of the ephyrae released. Surplus ephyrae are considered for sharing with other institutions or for food for medusavore jellies.

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Websites

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http://www.biochem.uci.edu – Cnidarian researchers.

http://emedicine.medscape.com/article/769538-overview – Jellyfish sting information.

http://www.lifesci.ucsb.edu/~biolum/ – Bioluminescence and a lot more about gelatinous zooplankton.

http://dockwatch.disl.org/glossary.htm – Jellies in the Gulf of Mexico.

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