International Journal of Advanced Research in Arts, Science, Engineering & Management (IJARASEM)

| ISSN: 2395-7852 | www.ijarasem.com | Peer Reviewed & Referred Journal |

| Volume 5, Issue 2, March 2018 |

Pearl Culture-Process, Methods, Significance

Dr. Hema Bhasin

Dept. of Zoology, B.B.D. Govt. College, Chimanpura, Jaipur, Rajasthan, India

ABSTRACT: Theoretically any shelled mollusc can produce some sort of a pearl. However only those mollusks which have a pearl lining or nacre on the interior of the shell surface can produce lustrous pearls. It is an abnormal process in the normal biological system of the animal. The mantle with its outer epithelial cells is the tissue responsible for producing pearl nacre. When an external stimulus such as accidental trapping of a hard foreign body or a parasite or a lesion occurs in the outer epithelium of the mantle tissue, it leads foreign body resulting in a pearl. Initially, the epithelial cell of the mantle forms a pearl -sac surrounding the irritant foreign body forming the cellular basis for crystallization of calcium carbonate. This process of pearl formation well known to the scientific community as 'Pearl Sac Theory'. This abnormal response to a foreign body in the normal biological processes that build up the shell in certain mollusks constituted the base for pearl culture operations. The shape of the pearl is governed by the irritant foreign body and its quality by the nature of secretions of the pearl sac. Thus the outer epithelium of the mantle tissue is the 'key- note' in the "orchestra" of bio-mineralization of a pearl.

KEYWORDS: pearl, culture, shell, mollusc, commercial, mantle, cavity, secretions, sac, biomineralization

I.INTRODUCTION

The process of pearl culture includes the following steps which are very crucial for obtaining high grade of pearls with good commercial value.

Step 1: Construction of pearl farm

Construction of a pearl farm includes three steps. They are,

- Selection of farm site
- Construction of farm
- Well-planned work schedule[1]

Selection of farm site: This step determines the type of pearls produced, and the oyster survival rate. Some of the points to be noted while selecting the site are:

* Natural features like mountains and reefs are needed to protect the farm from winds, currents, storms, etc.
* Constant regularity of temperature
* Type of sea bed, such as rocky or sandy.
* Gentle currents are essential for the survival of the oysters as they bring food and oxygen.

Construction of pearl farm: The whole pearl farm system is based on series of floating wooden rafts. Ten units of wooden rafts are used. Each raft consists of two to five pieces of wood making the total length to 20 ft. The raft is covered with wire mesh baskets, each of which house 10 oysters[2].

Well-planned work schedule: A typical work schedule plays a very critical role in pearl culture. The timing for collecting and seeding the oysters must be scheduled and followed strictly.

Step 2: Collecting oysters

After the construction of pearl farm, the divers set out to the bottom of the sea, to collect the oysters. Divers are pulled by large lugger boats in the direction of the tidal flow. Oysters are generally located on a flat rock bottom and are usually covered with marine animals and a thin layer of silt. Therefore, it is often very difficult for divers to recognise them. The shells collected, are cleaned, sized, and placed into baskets for storage until they are transferred to the pearl farm[3].

Step 3: Seeding

Two-three year old healthy oysters are considered for surgical implantation known as seeding. This is a very delicate operation and involves three stages:

| ISSN: 2395-7852 | www.ijarasem.com | Peer Reviewed & Referred Journal |

| Volume 5, Issue 2, March 2018 |

Preparation of the graft: A donor oyster is sacrificed to obtain mantle. Mantle is needed by the host oyster to accept the nucleus. The mantle is located on the outer section of the oyster and Mantle produces the nacre which forms pearl. Before a graft is taken from the mantle, the oysters are starved for several days to slow down the metabolism of the oyster. This helps to decrease the risk of core rejection and open the oyster easily.[4]

Attaching the graft: The oyster is opened with special wedges and pliers, then a scalpel slit is made in the soft tissue near the reproductive organ and a graft of living mantle is inserted into the slit.
Inserting the core: A nucleus is placed in the scalpel slit and the oyster is then returned back to the water. The inserted core irritates the oyster, provoking it to gradually coat the core with thin layers of mother of pearl nacre. After some time, the oysters are collected, and x-rayed to see whether the implants have been accepted. Oysters which have rejected the implant are returned to the water and are once again operated. The oysters which have accepted the implant are transferred to the pearl farm.[5]
The person who is seeding must be extremely careful not to harm the tiny pea-crab which lives unharmed within every healthy oyster. It is presumed that the crab assists the oyster by keeping it clean and by sharing the debris which the oyster sucks in.

Step 4: Caring the oyster
The shells which have been collected and transferred to the pearl farm are placed in baskets or panels which are attached to long lines connected to the floating rafts. The rafts are dropped down into the ocean with the oyster securely inside the basket, where they remain until they become operated on for further seeding.[6]
The oyster can produce more than one pearl in its lifetime. Regular cleaning of the shells to remove seaweed results in better pearls plus makes them easier to handle. The cleaning is done by a machine which uses water jets and brushes to clean off any seaweed. The oysters need very tender loving care so as to be productive when harvested.

II.METHODS IN PEARL CULTURE

Harvesting
After 2-3 years, the oysters are harvested. It is necessary to make a trial harvest to determine whether the pearls have a sufficient coating. If it is not sufficient then an additional six months to a year of culturing is necessary. The oysters are split open and pearl bags are cut by the scalpel to remove the pearls. Collected pearls should be thoroughly dried after the harvest to prevent loss of luster.[7]

| ISSN: 2395-7852 | www.ijarasem.com | Peer Reviewed & Referred Journal |

| Volume 5, Issue 2, March 2018 |

Sorting pearls

There are many different steps involved with the sorting of pearls. Firstly, the pearls are sorted according to whether they can be used for the cultured pearl industry or not.

These are categorised into three sections:

- Unmarked pearls
- Pearls with one major blemish
- Pearls with more than one major blemish[8]

III.DISCUSSION

In India the common species used in freshwater environment in pearl culture operations are *Lamellidens marginalis*, *L.corrianus*, and *P.corrugata*. A summary of the steps involved are given below:

1. Collection of Mussels
2. Pre-operative conditioning
3. Implantation of Grafits & nuclei
4. Post operative care of Mussels
5. Pond Culture of implanted Mussels
6. Harvest of Mussels & Pearls[9]

Methods of freshwater pearl culture vary depending on the surgery done in the internal structure of the pearl mussel and the type of pearl products targeted. A shell bead constitutes the essential input in the pearl culture operations. Certain locally available, inexpensive and bio-compatible acrylic material can be employed as nuclei in fresh water pearl culture. It has been observed that the pearl mussels of the size 8 to 10 cm in shell length and weight of 50gm and above are ideal for pearl

culture operation. Farming practice of the freshwater pearl culture operation involves six major steps sequentially *viz*., collection of mussels, pre-operative conditioning, surgery, post-operative care, pond culture and harvesting of pearls.

Collection of mussels

The healthy mussels are collected from the freshwater bodies like pond, river etc. They are collected manually and kept in buckets or containers with water. The ideal mussel size used for pearl culture is over 8 cm in anterior-posterior length.[10]

Pre-operative conditioning

The collected mussels are kept for pre-operative conditioning for 2 to 3 days by keeping them in crowded condition in captivity with aged tap water at a stocking density of 1 mussel/l Pre-operative conditioning helps in weakening of adductor muscles, which helps in easy handling during surgery.

Mussel surgery

Depending on the place of surgery the implantation is of three types *viz*., mantle cavity, mantle tissue and gonadal implantations. The key materials required during the surgical implantations are beads or nuclei, which are usually made from mollusc shell or other calcareous materials.

Mantle cavity implantation: In this procedure round (4-6 mm diameter) or designed (images of Ganesh, Buddha, etc.) beads are inserted into the mantle cavity region of mussel after opening the two valves (without causing injury to mussels at both ends) of animal and separating carefully the mantles of anterior sides from the shell with the help of surgical set. Implantation could be done in mantle cavities of both the valves. In case of implantation of designed beads care is taken such a way that the design portion faces the mantle. After placing the beads in desired place the gaps created during implantation are closed just by pushing the mantle onto the shell.[11]

Mantle tissue implantation: Here the mussels are divided into two groups; the donor and the recipient mussels. The first step in this procedure is preparation of graft (small pieces of mantle tissue). This is done by preparing a mantle ribbon (a strip of mantle along the ventral side of the mussel) from a donor mussel, which is sacrificed, and cutting that into small pieces (2 x 2 mm). The implantation is done on recipient mussels, which is of two types *viz*., non-nucleated and nucleated. In the former, only the graft pieces are introduced into the pockets created at the inner side of posterior pallial mantle present at the ventral region of the mussel. In the nucleated method, a graft piece followed by a small nucleus (2 mm dia) is introduced in the pockets. In both the procedures care is taken so that graft or nucleus does not come out of the pocket. Implantations could be done at mantle ribbons of both valves.[12]

Gonadal implantation: This procedure also involves preparation of grafts as described earlier (mantle tissue method). First a cut is made at the edge of the gonad of the mussel. Then a graft is inserted into the gonad followed by nucleus (2-4 mm dia) so that the nucleus and graft should be in close contact. Care is taken such a way that nucleus touches the outer epithelial layer of the graft and the intestine is not cut during the surgery.

Post-operative care

Implanted mussels are kept in post-operative care unit in nylon bags for 10 days with antibiotic treatment and supply of natural food. The units are examined daily with removal of dead mussels and the ones that reject the nucleus.[13]

Pond culture

After post-operative care the implanted mussels are stocked in the ponds. The mussels are kept in nylon bags (1 cm mesh-12 sq. cm) at the rate of 2 mussels per bag and are hung from bamboo or PVC pipes and placed in ponds at 1 m depth. The mussels can be placed at deeper zones (up to 2.0m) during hot summer months to avoid surface heating. The mussels are cultured at stocking density of 20,000 -30,000/ha.

The implantations in pearl culture operations are carried out throughout the year, except during hot summer months (May and June) for minimizing post -operative mussel mortality and rejection rate of implanted graft and nuclei. Ponds (2.5m deep) with clay soil base and slightly alkaline waters are suitable for pearl culture operations. A rectangular shaped pond with proper in - lets and out-lets is ideal for implanted pearl mussel rearing. Ponds without aquatic macrophytes and algal blooms such as Microcystis sp. and Euglena sp. are suitable for pearl culture operations. The ponds are provided with P.V.C tubing (2" dia) platforms (16 x 8 m) as rafts for hanging pearl mussel culture units. The implanted mussels at a density of 50,000 to 75,000/ha are placed in nylon bags (l.0 cm mesh, 12x 14 cm) @ 2 mussel per bag.[14]

The area of the pockets and mesh size in these simple culture units are sufficient for the mussel to open and close their shell valves for feeding and operation. These bags are then tied to the P.V.C floating platform units or bamboo rafts maintained in the culture environment. The ideal hanging depth of the pearl mussel culture units is observed to be 1.5 to 2.0 m deep in

the ponds for good survival and growth of mussels. Alternatively, the mussels can also be placed in plastic crates (0.5 x 0.35 x 0.25 m) @ 20 to 25 mussels per crate. The physico- chemical parameters and water level of the ponds are to be monitored throughout the culture period of the mussels. The optimum temperature regime lies between 25°C to 30° c. The fresh water pearl culture pond environment is generally same as employed for the aquaculture of the carps.[15]

The freshwater mussels constitute the benthic invertebrates in pond ecosystem and hence free dispersal on pond bottom should be ideal in terms of growth and survival. It has been observed that mussels when maintained in bottom- set culture units recorded poor survival (27%) as against surface and column-set units (66%). The reason for poor survival in bottom units may be due to the reduced level of primary production and siltation aggravated by the restricted space in the units. Other important parameters are the extent of macrophyte infestation and movement of water in the culture environment. However pond bottom distribution of the operated mussels has certain problems in sampling and harvesting of mussels for pearls.[16]

The ponds are fertilised with organic and inorganic fertiliser periodically to sustain the plankton productivity. Addition of green water (Chlorococcum sp. and Scenedesmus sp.) at regular intervals into the pearl culture ponds as direct mussel feed is observed to be an ideal practice for proper up- keep of the pearl bearing mussel standing crop.

The green feed is developed by 'open culture method' in a series of Ferro- cement tanks (200 liter) arranged all along the pond bundh[17]. The water in the tanks are fertilised as given below:

- Cowdung : 1000kg/ha/yr. (in twelve equal installments)
- Urea : 100kg/ha/yr. (in twelve equal installments)
- Single super phosphate: 100kg/ha/yr.(in twelve equal installments)

Once the fertilizer degrades (7 to 10 days), the green water develops. The algal enriched water is lead into the pearl culture ponds. The mussels by virtue of being mucoid filter feeders can accept a variety of particular organic materials feed. The pearl mussels in captive culture conditions can be maintained on a diet of powdered rice bran and groundnut oil cake (1:1 ratio) at 1% of the weight of the mussels provided on alternate day basis.

Periodical checking of mussels with removal of dead ones and cleaning of bags is required throughout the culture period of 12-18 months.[18]

Food and Feeding

Algae being the predominant component of the first trophic level in aquatic food chain have got much importance in aquaculture systems. Some species of algae belonging to Chlorophyta (green algae), Bacillariophyta (Diatoms) and Cyanophyta (blue green algae) are normally used as feed by the freshwater mussels. The commonly preferred algal species by the freshwater mussel *Lamellidens marginalis* are diatoms green algae (*Chlorella chlorococcum*, *Scenedesmus* etc.) and blue green algae (Spirulina). Culture vessels and tanks of desired capacities are to be selected prior to algal culture. Suitable medium should be prepared well in advance for different species to be cultured.

The pond culture of operated mussels varies from six month or more depending upon the size and number of nuclei implanted, the health of the mussels and the condition of the pond environment. The culture units require periodic cleaning of accumulated silt and other fouling fauna, finding entry in to the units.[19]

Pearl harvest

At the end of the culture period the mussels are harvested. The mussels are either crushed following by sieving to extract pearl or the mussel is individually is sacrificed, or individually pearls are taken out from the pearl sac of the live mussels without sacrificing. The latter method, through difficult, is desirable to prevent depletion stocks of mussels in the natural environment.

In mantle cavity insertion method, the culture period is generally about 6 to 12 months, depending on the size and number of nuclei implanted. In this method the mussel at the end of the culture period is sacrificed.[20] The mussels are opened one by one and the half round or design, shell attached pearls are cut out of the shell valves. Two to five attached pearls are obtained in this method, depending on the number of nuclei inserted. As on the attached side of the pearl, nacre cannot be deposited, it is ground off and cemented with a piece of mother of pearl layer obtained from the shell interior. The success rate is about 60 - 70% of the mussels implanted.[21]

The culture period in mantle tissue implanted mussel is generally from 12 months to 18 months. In this method the mussels after the culture period are carefully and the pearls are removed one by one from the pearl sacs. Four to eight pearls are obtained per mussel depending on the size of the mussel and the number of correct implantations done. The same mussel can again be used for the next operation. Alive graft piece or even a small nucleus (less than 2mm dia) if implanted into the

s me pearl sac may result into a pearl in less time. In this method non- nucleated, solid, unattached, and irregular to oval pearls (2 to 3mm size)or round, unattached cultured pearls (2mm dia. Approx.) are obtained. The success rate in this procedure is about 60 to 70% of the mussels implanted. The culture period of gonadal implanted mussel is generally 12 months. The mussel after the culture period are opened carefully and the position of the pearl is felt by touching the area close to the incision scar. By a pair of scissors, fine forceps and needle the pearl formed is carefully removed without cutting or damaging the intestine or other internal tissues. The mussel may also be sacrificed to extract a gonadal pearl. The layers of the gonad are cut open and the pearl is removed easily. In this process regular, round (3.5 - 5.5 mm dia) unattached pearls are obtained.[22]

IV.RESULTS

Pearl is a natural gem and is produced by a mollusc. The pearl is both mystic and beautiful with its soft colour and cool luster. While the demand of pearls in India and elsewhere is increasing, their supplies from nature have reduced due to over exploitation and pollution. India is importing a large amount of cultured pearls every year from international market to meet the domestic demand.

Scientifically a pearl can be defined in three ways. In simple chemical language, the composition of a pearl is about 82-86% aragonite crystals of calcium carbonate;10 to 14% organic matrix, a scleroprotein termed as concholin and 2 -4% water. In physical terms, a pearl has 3.5 to 4.5 hardness on Moh's scale with a specific gravity of 2.7. Biologically, a pearl is more or less similar to the inner shining layer called 'mother of pearl layer' or nacre of shells.

In nature, a pearl is formed when a foreign particle *viz*., piece of sand, insects, etc. by chance enters into the body of mussel and the mussel can not reject that out and instead makes a shiny coating on the particle layer by layer. This simple phenomenon is being exploited in pearl culture practices.[23]

Types of pearls

Pearl are produced by certain oysters in the marine and some mussels in the freshwater environments. The pearls available in the market could be broadly classified into three types - artificial, natural or cultured.

Artificial or Imitation Pearls:

Artificial or imitation pearls are not pearls but pearl-like materials that simply contain a rigid, round core or base and an outer pearly coating. The coating can vary from inexpensive shining paints to synthetic pearl essences to natural essences obtained from certain fish scales.

Majority of imitation pearl give smooth feeling when rubbed against teeth and when a pin is pressed into the surface,it easily leaves a scratch or indent unlike genuine natural or cultured pearls.[24]

Natural pearls:

The core or nucleus of the natural pearl is minute with fairly thick crystalline pearl nacre. Generally a natural pearl is small in size and irregular in shape.The surface of a natural pearl gives a rough feeling which is due to the edges of the overlapping crystals of aragonite. This is a very useful character in determining the genuineness of a pearl.
When a foreign matter, sand, small s tone or creatures are trapped between the outer shell and the body or any other part, in order to avoid the unbearable pressure the nacre cells membrane will start to .grow on the foreign body. The aragonated secretion (a form of calcium carbonate) produced by the nacre cells will cover the foreign body and later transformed into pearl.The shape of the pearl will depend upon the foreign body trapped inside. If it is trapped between the outer shell and mantle it will be shapeless and flat and have pearl cover only on one side. If it is inside the flesh the pearl will be round. The pearl is a precious creation and blessing of nature.[25]

Cultured pearls:

A cultured pearl is also a natural pearl, the only difference being the human intervention in surgical implantation of a live mantle graft and nucleus for hastening pearl formation to the desired size,shape, colour, and lustre. In India, three species of commonly available freshwater mussels *viz*., *Lamellidens marginalis*, *L. corrianus* and *Parreysia corrugata* are found to produce good quality pearls.[26]

Design cultured pearls
When images designed by man is intentionally placed between the mantle and outer cover of the shell, to avoid unbearable pressure nacre cells will start growing around the foreign matter (cab). Gradually the cab will transform into pearl. In one way it is a natural pearl only. Only thing is that it is not accidental but due to human intervention. This design-cultured pearl will stay as the symbol of beauty forever. Only upper part of the bead will have pearl covering and when it covers completely the remaining part is cut from the outer shell. The cab inside the removed part is removed and a special type of cement is filled in place. This type of pearl is used in necklace and earrings and will certainly increase the beauty of the wearer. In Bristol pearl one side is flat. If the pearl have any other design instead of hemisphere it can be called as a design pearl. The colour of the pearl will depend on the food given and the type of mussel. Usually pearl made from fresh water shells are seen in pure white, cream, pink, green, steel grey, gold rose and peacock blue.[27]

| ISSN: 2395-7852 | www.ijarasem.com | Peer Reviewed & Referred Journal |

| Volume 5, Issue 2, March 2018 |

V.CONCLUSIONS

For many cultured pearl dealers and wholesalers, the preferred weight measure used for loose pearls and pearl strands is the momme. Momme is a weight measure used by the Japanese for centuries. Today, momme weight is still the standard unit of measure used by most pearl dealers to communicate with pearl producers and wholesalers. One momme corresponds to 1/1000 kan. Reluctant to give up tradition, the Japanese government formalized the kan measure in 1891 as being exactly 3.75 kilograms or 8.28 pounds. Hence, 1 momme = 3.75 grams or 3750 milligrams.

In the United States, during the 19th and 20th centuries, through trade with Japan in silk cloth the momme became a unit indicating the quality of silk cloth.[27]

Though millimeter size range is typically the first factor in determining a cultured pearl necklace's value, the momme weight of pearl necklace will allow the buyer to quickly determine if the necklace is properly proportioned. This is especially true when comparing the larger south sea and Tahitian pearl necklaces. The value of the pearls in jewelry is determined by a combination of the luster, color, size, lack of surface flaw and symmetry that are appropriate for the type of pearl under consideration. Among those attributes, luster is the most important differentiator of pearl quality according to jewelers.

All factors being equal, however, the larger the pearl the more valuable it is. Large, perfectly round pearls are rare and highly valued. Teardrop-shaped pearls are often used in pendants.[28]

REFERENCES

1. Schumann, Walter (2001). Gemstones of the World. Robert Hale. p. 230. ISBN 978-0-7198-0301-7.
2. ^ Lazzarelli, Herve Nicolas (2010). Blue Chart Gem Identification. p. 8. Archived from the original on October 6, 2017.
3. ^ "Pearl". Gemdat.org. Archived from the original on April 4, 2017. Retrieved April 3, 2017.
4. ^ "Guides for the Jewelry, Precious Metals, and Pewter Industries". Ftc.gov. May 30, 1996. Archived from the original on May 28, 2010. Retrieved July 17, 2010.
5. ^ Shorter Oxford English Dictionary (6th ed.), Oxford University Press, 2007, ISBN 978-0-19-920687-2
6. ^ "Margaret". Behind the Name. Retrieved August 25, 2016.
7. ^ "Margaret". Online Etymology Dictionary. Retrieved August 25, 2016.
8. ^ . Wiktionary. Retrieved August 25, 2016.
9. ^ "Freshwater pearl mussel Margaritifera margaritifera". Joint Nature Conservation Committee. Peterborough. Archived from the original on March 8, 2015. Retrieved September 12, 2015.
10. ^ Neil H. Landman, et al. (2001) Pearls: A Natural History, Harry Abrams, Inc., ISBN 0-8109-4495-2
11. ^ "Pearl oyster farming and pearl culture". Fao.org. Archived from the original on March 20, 2008. Retrieved May 17, 2013.
12. ^ Kenneth Scarratt, The Pearl and the Dragon, Houlton; 1st edition (1999) ISBN 0-935681-07-8
13. ^ Farn, Alexander E. (2013). Pearls : Natural, Cultured and Imitation. Burlington: Elsevier Science. pp. 90–108. ISBN 9781483162737.
14. ^ Strack, Elisabeth. "Pearls". Ruhle-Diebener-Verlag, 2006, p. 38 ISBN 3981084802.
15. ^ The Pearl Book, pp. 47–49, 4th edition, Matlins, Antoinette, Gemstone Press, copyright 2008
16. ^ The Pearl Story, Gemstone Adventure Series, volume 2, copyright 2007 America's Collectibles Network,
17. ^ Hanni, H A (June 2006). "Keshi Perlen: Ein Erklarungbedurftiger Begriff (Keshi Pearls: a term in need of explanation)". Zeitschrift der Deutschen Gemmologischen Gesellschaft. DGemG. 55 (1–2): 39–50.
18. ^ Pouvreau, Stéphane; et al. (2000). "Ecophysiological model of growth and reproduction of the black pearl oyster, Pinctada margaritifera: potential applications for pearl farming in French Polynesia" (PDF). Aquaculture. 186 (1–2): 117–144. doi:10.1016/S0044-8486(99)00373-7.
19. ^ Goebel, Marisa; Dirlam, Dona M. (Fall 1989). "Polynesian Black Pearls". Gems & Gemology. 25 (3): 130–148. doi:10.5741/GEMS.25.3.130.
20. ^ "Pinctada Maxima – Harga Mutiara Lombok Di Toko Emas Online Terpercaya Miss Joaquim Menjual Perhiasan Emas Mutiara Butiran Grosir, Kalung Mutiara, Cincin Mutiara, Gelang Mutiara, Liontin Mutiara, Anting Mutiara,

| ISSN: 2395-7852 | www.ijarasem.com | Peer Reviewed & Referred Journal |

| Volume 5, Issue 2, March 2018 |

Giwang Mutiara, Bros, Cincin Kawin, Cincin Emas, Kalung Emas, Gelang Emas, Liontin Emas, Anting Emas, Giwang Emas". missjoaquim.com. Retrieved February 11, 2015.

21. ^ "How To Buy Pearls". nature.berkeley.edu. Retrieved February 11, 2015.
22. ^ Scarratt, Kenneth (2012). "Natural Pearls from Australian Pinctada maxima". Gems & Gemology. 48 (4): 236–261. doi:10.5741/GEMS.48.4.236. S2CID 130970595.
23. ^ "Jewel of the South Sea" (PDF). Archived (PDF) from the original on September 30, 2013.
24. ^ Concha Nacar | The Sea of Cortez Pearl Blog Archived February 25, 2014, at the Wayback Machine. Perlas.com.mx (November 22, 2010). Retrieved on October 14, 2015.
25. ^ "CIBJO 'Pearl Book'" (PDF). Archived from the original (PDF) on July 23, 2011. Retrieved July 30, 2010.
26. ^ "GIA 'Gems & Gemology' magazine news archive". Gia.edu. Archived from the original on January 13, 2009. Retrieved July 30, 2010.
27. ^ "Fisherman hands in giant pearl he kept under the bed for 10 years". The Guardian. Archived from the original on August 24, 2016. Retrieved August 25, 2016.
28. ^ Senaveratna, John M (1930). The story of the Sinhalese: From the most ancient times up to the end of "The Mahavasna", or great dynasty; Vijaya to Maha Sena (B.C. 543 to A.D. 302). W.M.A. Wahid. pp. 16–9, 46, 130, 144–8, 161–3, 213. ISBN 9788120612716. Archived from the original on December 20, 2017.