Culture and Values of Sea Urchin

K. Maheshkumar

Introduction

In the developed countries, there is a general consumer shift from meat towards seafood. Seafood is an excellent source of protein, fatty acids, low cholesterols and vitamins and minerals. It is also reported that the consumption of seafood especially fish and fish oil produces brainy child and prevents humans from coronary heart diseases. Now more than one billion people worldwide rely on fish as an important source of animal protein. It contributes 180 cal per capita per day (FAO 2002). The world population has been increasing quickly than the total fish food supply from production; this decreases in global per capita fish supply from 14.6 kg in 1987 to 13.7 kg in 2000 (FAO 2002). This has been evidenced in India also, i.e. the annual per capita was very low at 8 kg against the world average of 13.7 kg (Sugunan and Sinha 2001). To overcome the situation we should develop suitable mariculture technology for fin fish and other cultivable organisms in open seas to supplement capture fishery production.

Sea urchins are members of a large group of marine invertebrates in the phylum Echinodermata (spiny skinned animals) that also include starfish, sea cucumbers, sea lilies and brittle stars. All sea urchins have a hard calcareous shell called a test, which is covered with a thin epithelium and is usually armed with spines. The spines are used for protection and for trapping drifting algae for food. Between the spines, they have tube feet that are used in food capture, in locomotion and for holding on to the substrate. The sea urchins are found all along our coastline usually on shallow rocky bottom, although some species live in deep water or in sandy or silty substratum. They are herbivores grazing on attached marine plant and drifted algal fragments whose primary food is kelp and may limit algal distribution.

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Why Sea Urchin?

Sea urchins were well known to the ancient Greeks and Romans and have been frequently mentioned in their writing as food, together with oysters, snails and other seafood. Even before Aristotle, the echini were well recognized as a food. In recent years, countries like Japan; California, USA; and Spain, Ireland, France and Greece in Europe are having the regular and regulatory fishery for the sea urchins. Among these Japan, Europe and France, are the world's largest consumers and marketers. Sea urchins are harvested for their internal roe. The gonads of both sexes are equally valuable and are referred to as roe or "uni" in Japanese. Uni is known as a delicacy in Japan and sushi bars worldwide. Sea urchin uni is primarily sold fresh rather than

S. Perumal et al. (eds.), *Advances in Marine and Brackishwater Aquaculture*,
DOI 10.1007/978-81-322-2271-2_18, © Springer India 2015

frozen. Uni has a very sweet flavour as it melts in your mouth.

The riped ova of edible species of sea urchins are prized food items in Japan, approximately ¥14,000/kg, making it one of the most valuable sea foods in the world. Frozen roe pieces are available either in bulk bags or plastic trays. A first-quality A-grade roe costs $15/80 g. In the Tokyo market fresh roe of Chinese, North Korean and US origin cost ¥3,600–3,300, ¥1,700–1,300 and ¥3,600–1,000/tray, respectively, for 280–350 g tray.

Sea urchins that are eaten are distributed among a number of orders of regular echinoids as follows (adapted from Hagen 1996).

Class: Echinoidea
Subclass: Perischoechinoidea
Subclass: Cidaroida
Subclass: Euechinoidea
Infraclass: Echinoturioidea
Order: Diadematoida
Infraclass: Acroechinoidea
Cohort: Diadematacea
Order: Diadematidae
Family: Diadematidae
Genus: *Centrostephanus*
Genus: *Diadema*
Cohort: Echinacea
Superorder: Stirodonta
Order: Phymosomatoida
Family: Arabaciidae
Genus: *Diadema*
Superorder: Camarodonta
Order: Echinoida
Family: Echinidae
Genus: *Echinus*
Genus: *Loxechinus*
Genus: *Paracentrotus*
Genus: *Psammechinus*
Family: Echinometridae
Genus: *Anthocidaris*
Genus: *Colobocentrotus*
Genus: *Echinometra*
Genus: *Evechinus*
Genus: *Heliocidaris*
Family: Strongylocentrotus
Genus: *Hemicentrotus*
Genus: *Strongylocentrotus*
Family: Toxopneustidae
Genus: *Lytechinus*
Genus: *Pseudoboletia*
Genus: *Pseudocentrotus*
Genus: *Toxopneustes*
Genus: *Tripneustes*

The world sea urchin and other echinoderm production were 97,213 t in 2008, whereas the production in Asia was only 25,782 t. The average worldwide landings are still stable but are obviously not sustainable in the near future, since the commercial harvest of sea urchin population for their gonads is steadily increasing worldwide that leads to a decline in their population. Further, the heavy demand for sea urchin gonad has created opportunities for sea urchin culture.

Echinoculture

The term "echinoculture" refers to the cultivation of echinoderms, i.e. to both sea urchin (Echinoidea) and to a lesser extent sea cucumber (Holothuroidea). Nevertheless, sea urchins are more valuable than sea cucumber and their cultivation is more advanced (Hagen 1996). There are two methods of sea urchin culture: the first involves spawning adult brood stock and rearing resultant larvae/juveniles to marketable size and the second involves enhancing the gonads (i.e. increasing yield and/or quality) of wild-caught adults held in captivity by feeding them with natural or prepared diets (Pearse et al. 2004).

Japan was the first country to address the issue of overexploitation and initiated stock enhancement progress very early (Saito 1992; Hagen 1996). These techniques include habitat enhancement (artificial reef), artificial feeding, translocation and building of hatcheries that produce several million of seeds a year that are transplanted to the field. Hatcheries may be a solution to ensure recruitment where harvesting eliminates adults before they spawn, but good natural habitats are required, like large tide pools, to give enough protection to juveniles released in the field (Grosjean 2001).

The ultimate step in the aquaculture production of sea urchin is independence from natural resources, that is, to control the whole life cycle in culture, from spawning to gonad enhancement (Le Gall 1990; Hagen 1996). Somatic growth of juveniles until they reach marketable size is a process that requires major improvements in current technology and is key to the successful development of closed-cycle echinoculture (Grosjean 2001).

Hatchery Technology

Reduced natural recruitment in many sea urchin fishery countries had led to increased interest in hatchery systems that could provide stock for replenishing natural population and outplanting of juvenile to aquaculture lease sites for sea ranching of sea urchins in Japan (Harris et al. 2003). The Japanese have developed an effective and well-documented hatchery system to produce small animals (sea urchins) for outplanting, and the depletion of wild population was being compensated through the large-scale seed stock release programme to get a sustainable yield of sea urchins from the wild.

Larviculture

Larviculture in Japanese hatcheries commences with the mixing of gametes from several animals. Excess perm is rinsed off, and the fertilized eggs hatch after approximately 20 h (Fig. 1). Three to four days later, they have pluteus stage which requires planktonic microalgae as food. Diatom *Chaetoceros gracilis* is commonly used in commercial hatcheries as food for larvae at the rate of

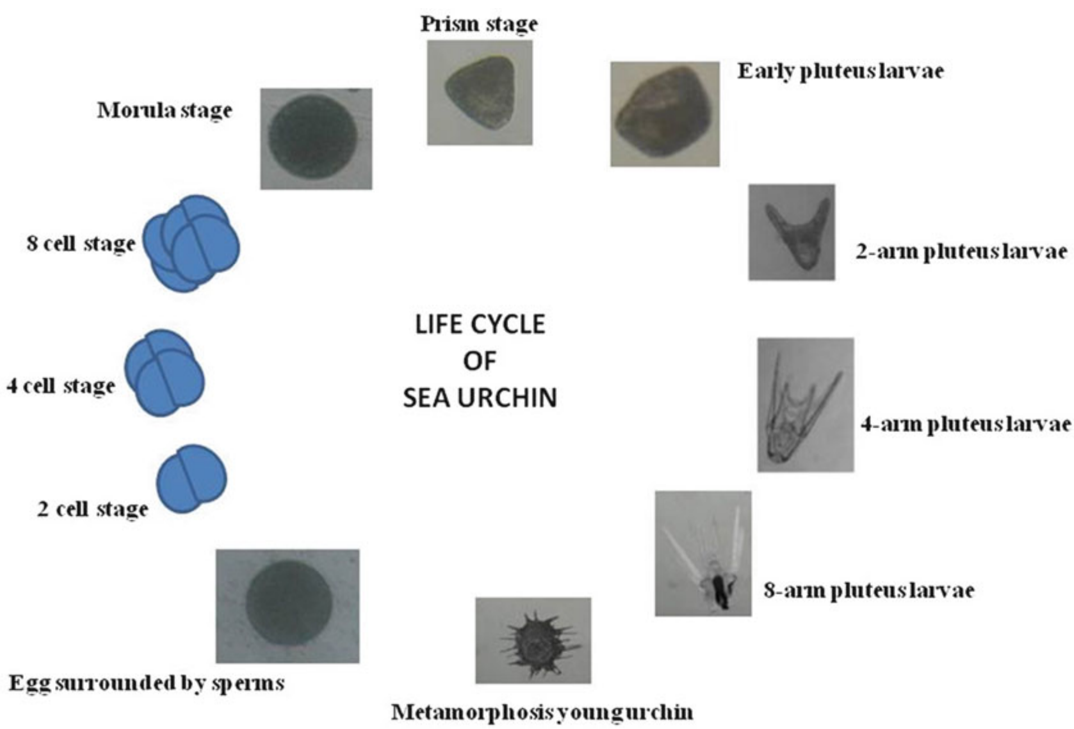

Fig. 1 Life cycle of sea urchin

5,000 cells/ml in which the amount gradually increased to 10 l/tank/day in the final stages of cultivation. The larvae are cultivated in 1,000 l tanks with continuous flow of 1 um filtered seawater. Circulation in the larvae tanks is provided by two large airstones with a gentle flow, one on the bottom and another near the surface. The density is initially 1.5 larvae/ml but is decreased to 0.8 larvae/ml at the time of settlement. The metamorphosed juveniles are approximately 0.3 mm in size.

Early Juvenile Rearing

Larval settlement in sea urchin is induced by introducing placing small rocks taken from the low intertidal area where the parents were collected or transparent polycarbonate plates can be used should be inoculated with the desired algae. Feeding with the soft seaweeds commences when the juveniles reaches 3–4 mm size.

Nursery Culture

The settled juveniles were transferred to nursery tanks with open mesh cages or hanging cages which suspended 1–2 m below the surface. The juveniles were fed with preferred seaweeds. Juveniles can be released to the environment 6 months after fertilization when they are 7–10 mm. The large juveniles are ready to be recaptured 2 years after release when they reach a diameter of more than 40 mm.

Grow-Out System

Closed-Cycle Cultivation

Closed-cycle cultivation requires grow-out facilities. These can be constructed by expanding existing nursery techniques, by adapting technology developed for the intensive cultivation of abalone. The French adopted the last alternative and developed a prototype of multilayered grow-out tanks which consist of four stacked, sloping shelves. Water is pumped up to the top shelf from a reservoir tank under the shelves and then runs down through the stack of shelves in a zigzag pattern. The accumulation of sea urchin faeces in the reservoir tank is siphoned off at regular intervals. The recirculated water is gradually replenished by marine groundwater. The commercial scale grow-out facility would require a stable food supply. Closed-cycle cultivation is capital intensive and has high operational costs but requires only a modest investment in R&D. Full-scale hatchery and nursery technology is well established in Japan (Hagen 1996).

Values of Sea Urchins

Ornamental

Sea urchins were harvested mainly for their gonads and their tests for ornaments all over the world. They are used as decorations for bordering mirrors instead of molluskan shells and used as ash trays and lamp shades, and the spines are used as writing tool for small kids in slates (Fig. 2).

Fig. 2 Ornaments made from sea urchin shell

Nutritional and Food Value

Sea urchin roe is rich in nutrients such as protein, carbohydrate, saturated and polyunsaturated fatty acids and vitamins (Table 1). The nutrient content of sea urchin roe is equivalent to a tuna fish and five eggs.

Uni is known as a delicacy in Japan and sushi bars worldwide. Sea urchin uni is primarily sold fresh rather than frozen. Uni has a very sweet flavour as it melts in your mouth. Whole sea urchins and sea urchin roe are available in the market. Individual roe pieces are available as packed on wooden or plastic trays (Fig. 3).

Table 1 Nutritional composition of sea urchin gonad

Protein	36.14 %
Carbohydrate	4.86 %
Lipid	26.35 %
Saturated FA	46.72 %
MUFA	13.85 %
PUFA	39.41 %
Sodium	35.00 mg/100 g
Zinc	1.042 g/100 g
Vit. B1	24.86 mg/100 g
Vit. B12	6.24 mg/100 g
Vit B6	5.96 mg/100 g
Folic acid	96.9 mg/100 g

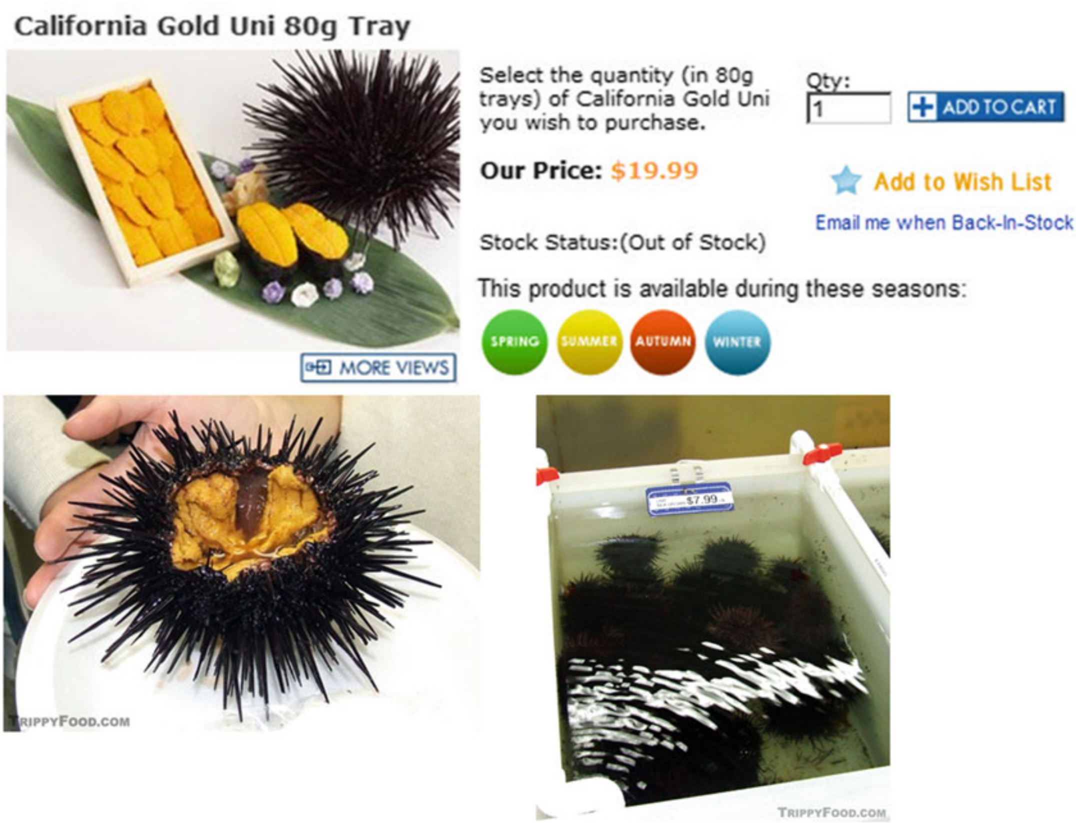

Fig. 3 Live sea urchin and packed uni in plastic tray

Ecological Value

Sea urchin plays a major role in the seaweed ecosystem and coral reef ecosystem. It checks the over growth of seaweeds in both the ecosystems. Especially in coral reef ecosystem, it controls the growth of seaweed which competes for the sunlight. Also, it creates new spaces for the coral recruitment. Sea urchin serves as one of the major food item for the lobster, which is key stone species in the seaweed ecosystem. It checks the sea urchin population overgrowth in the ecosystem in order to maintain a balance between seaweed growth and its grazer. So sea urchin is one of the major components in determining the health of the ecosystem in which it lives.

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