than slightly matured egg[5]. To determine the effective dose of pituitary gland for successful stripping, different concentration of pituitary glad were injected for representative pond (7mg/kg; 6mg/kg; 5mg/kg) and cage reared (5mg/kg; 3mg/kg; 3mg/kg) brood fish. They were applied on the basis of their body size and state of egg maturation.

From this experiment, it has been shown that pond reared broodstock with slightly mature eggs (560 to 600 µ) required higher pituitary gland dose (7mg/kg; 6mg/kg; 5mg/kg) and highly mature cage reared broodstock (600 to 612µ) required lower pituitary gland dose (4mg/kg, 3mg/kg, 3mg/kg) to attain the ripe stage, which enhanced successful ovulation. It has well been shown that stripping percentage was higher in cage reared broodstock (4.13%; 5.58; 5.18%) than pond reared broodstock (2%; 3.3%, 4.45%). Stripping was related with the hormone dose and egg maturation. Highly mature eggs (600 to 612 µ) required lower PG because they were in near about the ripe stage. This amount of pituitary gland was sufficient to attain the ripe stage and stripping percentage was recorded higher at this lower pituitary gland dose.

Conclusion

This type of experiment was the first time in Cox's Bazar where the utilization of coastal waters have been used both in cages and pond for the gonadal maturation of Mugil cephalus. With this scientific intervention, a remarkable maturity of grey mullet was found in cage reared broodstock compared to ponds. It has well been shown that cages located near the flow of tidal water can be better utilized for broodstock management, thus the gonadal maturation was facilitated in cages due to the availability of tidal water and increase in salinity which was not possible in the enclosed water in the inland pond systems of SMAFRC. This new concept in the arena of aquaculture will create a new hope for the fish farmers. If this technology is further developed and disseminated among the coastal people and fish farmers, they will be able to improve the hatchery technique of grey mullet. Thus, the economic development of the country will surely be improved.

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Eggs are put in a hatching jar for easy management.

The research team visiting the experimental pond.

Cultivation of gilthead sea bream (*Sparus auratus* L.) in low saline inland water of the southern part of Israel desert

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Fish development, growth and survival are influenced by various physiological factors among which water salinity is one important parameter. Many studies have indicated that the various developmental stages during fish embryogenesis depend on water salinity. Salinity also plays a key role in growth control, influencing growth rate, metabolic rate, feed intake and feed conversion. Keeping this in mind a short term trial was conducted to adapt and/or acclimatize the gilthead sea bream, *Sparus auratus* L., into low saline inland waters. Gilthead sea bream is a euryhaline teleost capable of living in environments of different salinities ranges from 2‰ to 60 ‰[1]. Adaptation of euryhaline fish to different environmental salinities induces changes/activation of ion transport mechanisms.

This adaptation is usually accompanied by changes in oxygen consumption, suggesting variations in the energy demands for osmoregulation[2]. *S. auratus* is available in the natural habitat ranges from the Mediterranean and Black Sea to the eastern Atlantic Ocean from Senegal to the United Kingdom[3]. It is commonly found in shallow lagoons along the coast, but migrated into deeper water to spawn after late autumn.

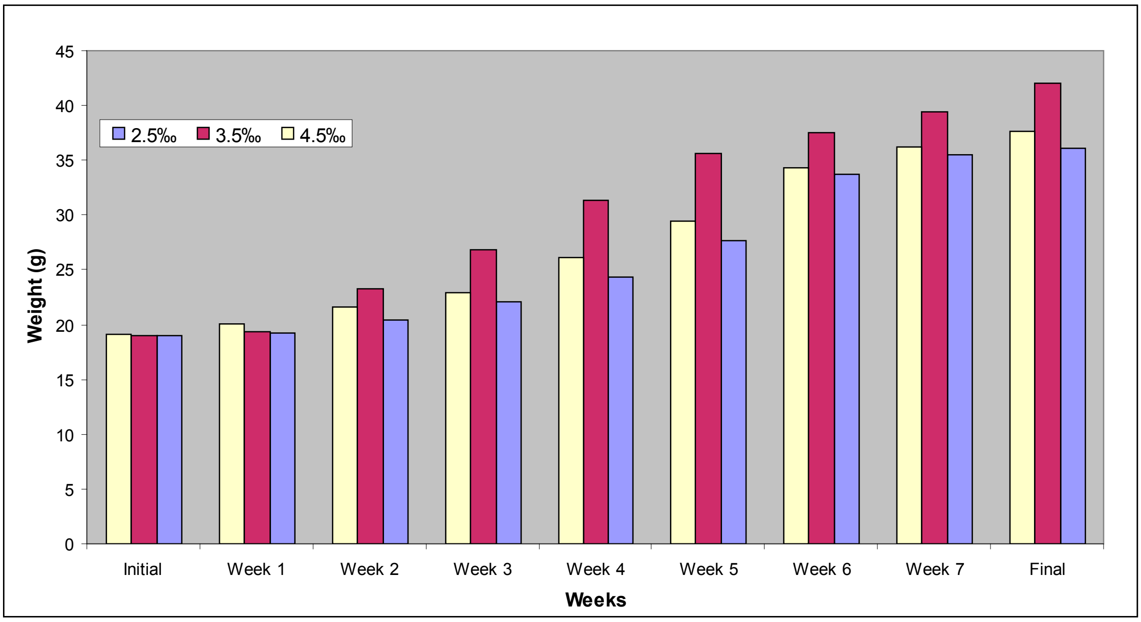
Main producers and production statistics

S. auratus is an economically important marine species. Extensive culture was popular in coastal lagoons and saltwater ponds, until intensive rearing systems were developed during the 1980s. The Italian 'vallicoltura' or the Egyptian 'hosha' are extensive fish rearing systems that act like natural fish traps, taking advantage of the natural migration of juveniles from the sea into coastal lagoons. Artificial breeding was successfully achieved in Italy in 1981-82 and large-scale production of gilthead sea bream juveniles was definitively achieved in 1988-1989 in Spain, Italy and Greece. The hatchery production and farming of this fish is one of the success stories of the aquaculture business. This species very quickly demonstrated a high adaptability to intensive rearing conditions, both in ponds and cages, and its annual production increased regularly until 2000, when it reached a peak of over 87,000 t (Plate 4). Most production occurs in the Mediterranean, with Greece (49 %) being by far the largest producer in 2002. Turkey (15%), Spain (14%) and Italy (6%) are major Mediterranean producers. There is also gilthead sea bream production in the Red Sea, the Persian Gulf, and the Arabian Sea. The main producer is Israel (3% of total production in 2002); Kuwait and Oman are minor producers.

Multiple use of low saline inland water

Two thirds of Israel is covered by desert, which is inhabited by only 2-3% of the population. Beneath this desert are large aquifers containing huge quantities of fossil, geothermal saline water. For the last 30 years this brackish water has been successfully used for irrigation of agricultural crops (e.g., tomatoes, melons, wheat, cotton, olives, etc.). In the past ten years, investigations have shown the significant potential of the geothermal, brackish water for the successful culture of aquatic organisms such as fish, crustaceans and algae. In order to improve the economic viability of both sectors - aquaculture and agriculture - it is obvious that a chain of users of the desert water is needed. Ramat Negev Highlands is a district in the Israeli desert with a community of 4,000 inhabitants and a current use of 4.5 million m^3 brackish water per annum. Seven drillings, to a depth of between 550-1000m, supply the brackish water at a salinity of between 2,680 – 4,360 TDS, at temperatures of between 39 - 41°C for aquaculture/agriculture. A practicable, efficient chain of users is illustrated below: Several wells, possibly linked, continuously supply brackish water to both first users - greenhouses (for heating) and thermal baths (medicinal or recreational). Water from the first two users runs to an environmentally controlled fish polyculture system. Water, rich with suspended organic material, leaves the fish culture system and enters a reservoir which stores the water to meet the demand of the next user - irrigation of agricultural crops, which supply, among other items, fodder for livestock including dairy cows, sheep and ostriches. Furthermore, a proportion of the original saline water can be cost-effectively desalinated and used as freshwater for human consumption. Efforts are being directed towards optimization of such models, for maximizing economic viability through 'denis' (sea bream locally known as) culture.

Fig 1: Weight gain (g) of sea bream reared at three different salinities (2.5‰, 3.5‰ and 4.5‰) for 8 weeks.



Adaptation of sea bream into low saline water

Sea bream rearing in low salinity water is becoming an important component of aquaculture growth and can be found in many regions[4]. Cultivation practices in the Mediterranean region vary considerably mainly due to the regional environmental conditions and available quality and quantity of water resources. In low salinity adapted fish, the passive outward flux of ions such as Na^+ and Cl^- from the fish to the external medium, via the gills, faeces, and renal system, must be overcome by active uptake of ions (e.g., Na^+, Cl^-, K^+, and Ca^{2+}) from the water and/or from the diet[5]. The gill is a major osmoregulatory organ in fish, undergoes large morphological changes, even at low salinities[1]. Adaptation to salinity regimes markedly lower than sea water is an important physiological ability in the many species of marine fish that constitute non-estuarine dependent nekton in estuarine ecosystems[7].

Research findings

Sea bream with an average body weight of 19 g were reared under three different salinity levels. Water of three different salinities was collected for the trials; one batch from the inland of the Negev District of Israel (low saline inland water I; 2.5‰), a second from the southern part of the desert (low saline inland water II; salinity 3.5‰) and the third from the Dead Sea area (low saline inland water III; salinity 4.5‰). Each tank was connected with water flow through system separately, along with a filtration unit. Continuous aeration was given to both systems. Every day morning, before first feeding (09.00 h) water salinity (‰), temperature (°C) and water flow (L/min) were measured and recorded. Water flow was maintained between 2-3 L/min uniformly in all the three systems. Any fluctuation in the salinity due to evaporation was mitigated by the addition of de-chlorinated fresh water to maintain salinity consistent salinity levels throughout the trials. Each system was also provided with water heater (EHEIM Aquatics, Germany) to maintain the temperature at not less than 27°C. The experiment was conducted in nine (3 treatment x 3 triplicates) different plastic containers (each capacity 60 L) for 8 weeks.

A group of 135 individuals of *S. auratus* juveniles acclimatized at 6 ppt were collected from the hatchery of the Bengis Centre for Desert Aquaculture, Ben-Gurion University of the Negev, Israel. They were acclimatized in plasson systems (2.5 x 1 x 1 m) for one month. 15 randomly selected individuals were selected for each tank after recording initial weight. Fish weight was measured weekly to observe growth rate and fed ad libitum with the prepared commercial experimental feed (25% crude protein; crumbles; Zemach Feed Mills of Israel; Feed No. 4834) three times daily. Growth, survival, feeding behavior and feeding rate were calculated. Mean differences in growth rate and survival were assessed at $P<0.05$ using the students 't' test.

The growth and survival of water I, II and III reared individuals were presented in Table 2 and Fig 1. Overall, individuals reared in water II had superior growth to the other treatments ($P<0.05$), and also the best survival and FCR. Water I reared individuals also had relatively good survival. Water III reared individuals had the lowest survival and worst FCR, although the latter was not significantly different from water I. Water III reared individuals grew well up to one week (20.05 ± 6.91 g after 1 week, 21.56 ± 6.77 g after 2 weeks & 22.86 ± 7.64 g after 3 weeks), but after one week yellow water reared individuals (water II) grow faster than brackish water individuals (water III) (19.31 ± 5.32 g after 1 week, 23.28 ± 6.16 g after 2 weeks & 26.76 ± 7.05 g after 3 weeks).

This study shows that gilthead sea bream can adapt to a wide range of salinities with adjustment in body fluids, which are more evident at the extreme range of salinities (2‰ - 60‰). The results indicate that the most favorable conditions for maximum growth of sea bream fry are the low salinities rather than brackish water or the open sea. This is in accordance with the general knowledge on this species biology, which indicates that fry remain in the coastal lagoon areas for the first year of their life[8]. However, it should be noted that salinity effects are very difficult to distinguish from those of other factors, because food quality and quantity may affect salinity tolerance[9].

In terms of survival the best performance may be achieved at water salinity of 3.5‰. This indicates that the intermediate environment of 3.5‰ salinity is best, not only form the point

Table 1: Water quality measurements during the experimental period (mean values ± standard deviation).

Water quality parameters	Low saline inland water I (2.5 ‰)	Low saline inland water II (3.5 ‰)	Low saline inland water III (4.5 ‰)
Salinity (‰)	2.5 ± 0.3	3.5 ± 0.2	4.5 ± 0.4
Temperature (°C)	29.6 ± 2.0	28.2 ± 2.4	27.2 ± 1.9
Water flow (L/min)	2.1 ± 0.24	2.1 ± 0.24	2.1 ± 0.24

Table 2: Weight, weight gain (g) average weight gain (%), specific growth rate (SGR; %d-1), food conversion ratio (FCR) and survival (%) of sea bream (*S. auratus*) reared at 2.5‰, 3.5‰ and 4.3‰ water salinities.

Parameters	I Low saline inland water (2.5 ppt)	II Yellow water (3.5 ppt)	III Brackish water (4.5 ppt)
Initial weight	19.05 ± 3.95	19.01 ± 4.34	19.07 ± 5.21
Final weight	36.11 ± 9.65	42.01 ± 12.47	37.59 ± 10.6
Weight gain	17.06	23.0	18.58
Average weight gain	89.55	120.98	97.73
SGR	0.4960	0.615	0.5287
FCR	2.34	2.1	2.45
Survival (%)	70.5	73.3	60.0

of view of good growth, but also fish adaptation and survival. These parameters are very important for commercial scale aquaculture. This is in accordance with other studies on euryhaline species and supports the observation that lower salinities than those naturally occurring in open waters are the most favorable for rearing of this species[4]. The ability to adapt to lower salinities is based on the rapid reversion of the osmoregulatory mechanism on the cell membrane level[11]. Differences in survival ability are attributed to the ability of fish to conclude this reversion as quickly as possible and successfully. The iso-osmotic point for marine species between body fluids and the sea water was found to be around 10 ± 2‰[12], below which the reversion of the osmoregulatory mechanism occurs.

Conclusion

Sea bream is able to withstand a wide range of environmental salinities with minor changes in plasma osmoregulatory variables and the effective regulation of the gill Na^+, K^+ and ATPase. Further research is necessary to investigate the effect of adding salts that are deficient in low saline water sources into the diets of sea bream to make this culture practice as more feasible.

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Mariculture development opportunities in SE Sulawesi, Indonesia

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The island of Sulawesi, Indonesia, is recognized by the government of Indonesia as a major area for development of mariculture. Within Sulawesi, one of the least developed areas is SE Sulawesi Province, which consists of twelve districts, comprising ten regencies and two towns, including Kendari which is the major population and commercial centre.

SE Sulawesi is a relatively impoverished region of Indonesia. The fishery related activities are of importance to this region and currently estimated to account for about 12 percent of the annual GDP, to which mariculture contributes approximately 3-4 percent. In 2007 aquaculture production in the Province reached 153,160 t, valued at approximately 1000 billion Indonesian Rupia, with seaweed production showing the highest growth. A total of 115,483 households and 160,140 persons were involved in aquaculture in the Province.

SE Sulawesi and the associated islands have many accessible and well sheltered bays and inlets with abundant natural resources for mariculture, including good water quality. Resident coastal communities are eager to increase their quality of life through adoption and development of commercial production systems for various local products including grouper, seaweed, lobster, abalone, pearl oyster and sea cucumber.

Mariculture and fisheries development is often seen as an important strategy to contribute to poverty alleviation of rural coastal communities. The Government of Indonesia, having recognized this fact, is in the process of initiating development activities in partnership with the Australian Government