Black Sea turbot- A comprehensive production manual

- Prepared by the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO)
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- Publication year: 2023 , 70 pp
- Primarily aimed at Black Sea countries, with broader relevance for turbot hatcheries and research institutions
- Applicable to turbot hatcheries and research institutions beyond the Black Sea.
- Supports knowledge transfer across the Mediterranean and Black Sea region

Objectives

- Support sustainable Black Sea turbot aquaculture development
- Provide practical guidance across the full production cycle
- Strengthen regional capacity and technology transfer.

Black Sea turbot (*Scophthalmus maeoticus)*
European turbot (Scophthalmus maximus)

Main features of the publication

Approach

- Practical and production-oriented manual
- Combines scientific knowledge and hatchery experience
- Developed from over 20 years of experience in Türkiye

Scope

- Covers the full hatchery production cycle from broodstock management to juvenile production
- Addresses key technical bottlenecks
- Includes both conventional and innovative technologies

Target users

- Hatchery operators and aquaculture technicians
- Researchers, students and trainers
- Aquaculture extension institutions

Content

Chapter 1. Turbot Production Overview

Status

- Black Sea turbot is a high-value marine flatfish with strong market demand
- Commercial aquaculture production developed in the Black Sea region during the 1990s
- Hatchery production technologies have been successfully established and refined

Production development

- Global turbot aquaculture expanded rapidly over the last decades
- Aquaculture production surpassed wild capture production around 2005

Production systems and challenges

- Predominantly land-based farming systems
- Hatchery-produced juveniles support both aquaculture and stock enhancement programmes
- Technically demanding production process requiring advanced hatchery skills
- Strong dependence on live-feed production, broodstock management and water-quality control
- Intensive health management and biosecurity measures required throughout production

Environmental requirements

- Temperature: 16-19 °C
- Salinity: 15-33.5 ppt
- Dissolved oxygen: 6-9 mg/L
- Light regime: 12 h light / 12 h dark
- Ammonia: below 2-3 mg/L

High-value species with proven farming technologies, but requiring strict environmental control and intensive technical management.

Chapter 2.1 Live Food Production: Microalgae

Role in turbot production

- Foundation of the hatchery food chain
- Essential feed for rotifers and *Artemia*
- Improves water quality through the "green water" technique

Main species

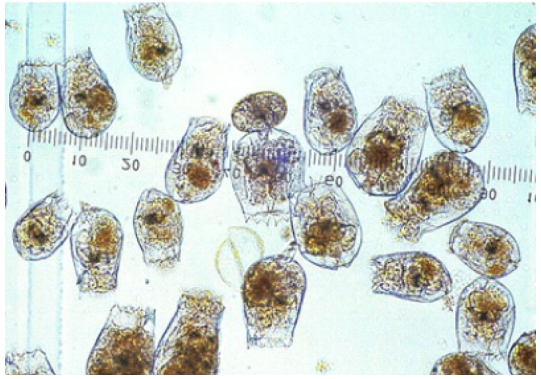
- *Nannochloropsis* sp.
- *Phaeodactylum* sp.

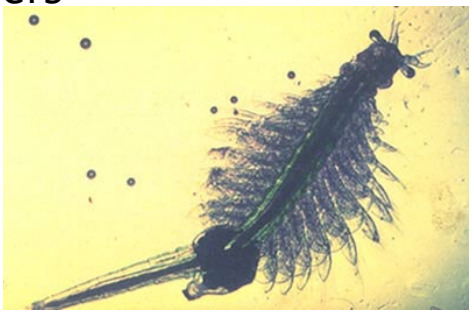
Production process

- Stock culture maintenance and purification
- Laboratory-scale propagation
- Scale-up to mass production tanks
- Algae concentration and storage

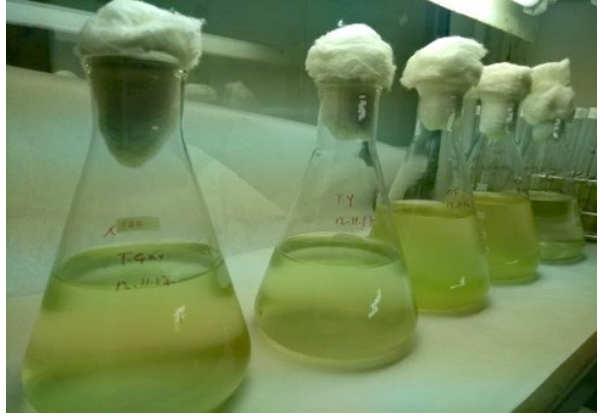
Key requirements

- Controlled temperature, light and nutrients
- Sterile culture conditions
- Continuous monitoring of cell density
- Prevention of contamination by bacteria, protozoa and rotifers





Chapter 2 Live Food Production: Rotifers and Artemia (Con`t)



Rotifer production

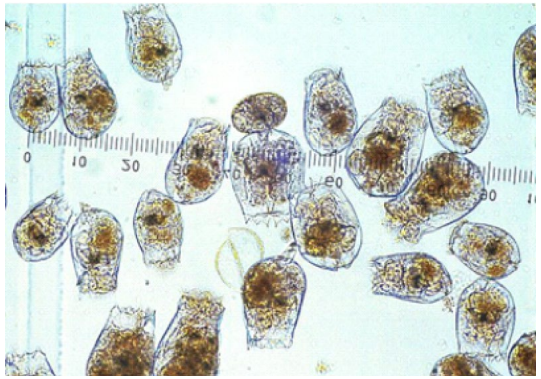
- First live feed for turbot larvae
- Gradual scale-up from laboratory cultures to mass production
- Regular enrichment to improve nutritional quality
- Continuous monitoring of density and culture health

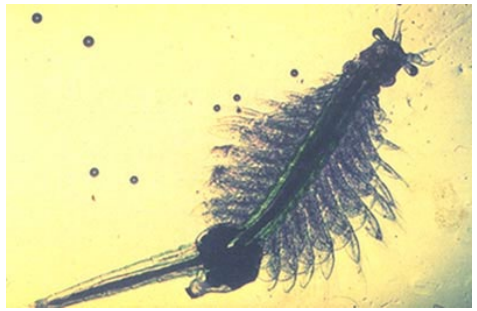
Artemia production

- Second live-feed source during larval development
- Produced through cyst incubation and nauplii hatching
- Enriched with essential fatty acids before use
- Supports larval growth and survival during later stages

Key challenges

- Maintaining a continuous live-feed supply
- Preventing contamination and culture collapse
- Ensuring adequate nutritional enrichment
- Meeting increasing feed demand as larvae grow





Chapter 3. Broodstock Management and Reproduction

Broodstock management

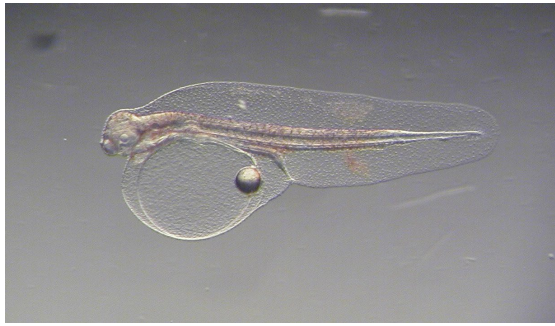
- Uses both wild-caught and hatchery-reared broodstock
- Relies on wild fish for broodstock renewal and genetic diversity
- Includes capture, transport, quarantine and health screening
- Selection based on fish condition and reproductive maturity
- Controlled feeding and maturation management

Reproduction and incubation

- Hormonal treatments used to induce spawning
- Artificial insemination applied to maximize fertilization success
- Egg quality, fertilization and hatching rates routinely monitored
- Controlled incubation conditions maintained until hatching
- Only high-quality egg batches retained for larval production

Key challenges

- Securing healthy broodstock and maintaining genetic diversity
- Dependence on wild fish for broodstock renewal
- Achieving high fertilization and hatching success
- Preventing disease transmission and maintaining biosecurity
- Producing consistent supplies of high-quality eggs and larvae



Chapter 4. Larval and Juvenile Rearing

Larval rearing

- Covers the period from hatching to juvenile metamorphosis
- Three developmental stages: pre-larval, post-larval and metamorphosis
- Gradual transition from live feeds to artificial diets
- Careful control of temperature, water exchange and illumination
- Regular monitoring of growth, survival and fish development

Juvenile rearing

- Begins at approximately 40 days post-hatching
- Emphasis on grading, stocking density and feeding management
- Progressive shift to formulated feeds
- Regular growth monitoring and health control
- Survival rates can exceed 80% under proper management

Health management

- Frequent monitoring for parasites and diseases
- Routine tank cleaning and water-quality management
- Rapid response to disease outbreaks through treatment protocols

Key challenges

- High sensitivity of larvae to environmental changes
- Managing the transition from live feed to artificial diets
- Preventing deformities, malpigmentation and disease outbreaks
- Maintaining high survival rates throughout metamorphosis
- Ensuring uniform growth and fish quality through grading procedures

Chapter 5. Biotechnological Applications

Cryopreservation

- Long-term storage of sperm for breeding programmes
- Greater flexibility in broodstock management and artificial fertilization
- Facilitates genetic resource conservation

Triploidy

- Production of sterile fish through chromosome manipulation
- Reduces reproductive investment and may improve production performance
- Useful for aquaculture and stock enhancement programmes

Female monosex production

- Based on the faster growth of females compared with males
- Aims to improve production efficiency and harvest size
- Uses controlled breeding and chromosome manipulation techniques

Key challenges

- Requires specialized expertise and equipment
- Additional technical and operational costs
- Need to maintain genetic quality and production performance

Key Messages and Lessons Learned

Black Sea turbot aquaculture

- High-value species with strong potential for aquaculture diversification
- Complete hatchery production technology is available
- Suitable for both commercial production and stock enhancement programmes

Critical success factors

- High-quality broodstock management
- Reliable live-feed production
- Strict environmental control
- Effective biosecurity and health management

Main production constraints

- Dependence on wild broodstock for renewal
- Technically demanding hatchery operations
- High sensitivity during larval and metamorphosis stages
- Significant requirements for technical expertise and infrastructure

Future opportunities

- Development of domesticated broodstock programmes
- Application of cryopreservation and selective breeding
- Expansion of hatchery production capacity
- Strengthened regional cooperation and knowledge sharing