Twenty years of invasion

Round goby
Neogobius melanostomus

- *Neogobius melanostomus* (Pallas 1814)
- Family Gobiidae
- one of the most wide-ranging invasive fish on earth

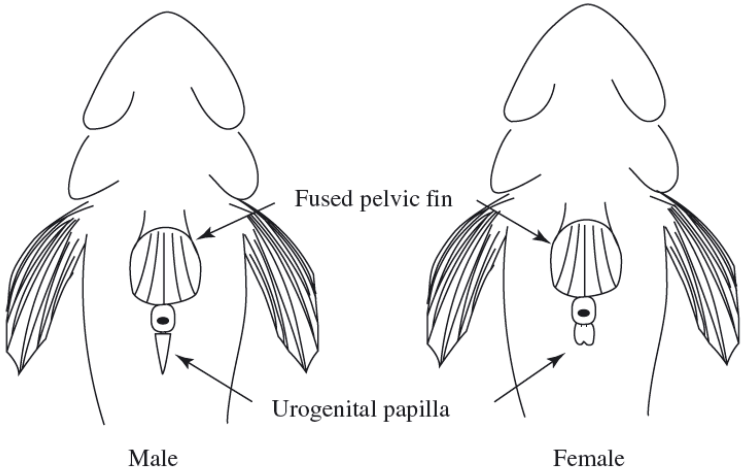
Neogobius melanostomus melanostomus (Black Sea)

Neogobius melanostomus affinis (Caspian Sea)

Neogobius melanostomus

MORPHOLOGY

- elongate body
- terminal mouth, thick lips
- Sexual dimorphism
  - males have a larger size at age, enlarged cheeks and darker colouration
  - Both sexes have an erectile urogenital papilla between the anus and the base of the anal fin.
  - The female papilla is broad and blunt (0·3–0·5 mm wide, 0·2–0·4 mm long), whereas the male papilla is longer (0·3–0·6 mm)



Biology

- Prefer shallow, brackish waters but also occur in fresh waters
- in lagoons and lakes, large rivers, harbors, on sand or rock bottom; mostly found on well vegetated or rock bottom
- Can tolerate a temperature range of 0 to 30 C, but mainly thrive in warm temperate waters
- able to tolerate low oxygen content waters for several days
- Oviparous, with demersal eggs
- Longevity up to 4 years

- river regulation, the connection of contiguous basins by canals,
- ballast water transport by ships
- Vistula River, the Dnieper, Dniester and Don Rivers, the Moscow River and the Danube River through Croatia, Serbia, Hungary and Austria

- first discovered in the Baltic Sea (*via* ballast water)
- Genetic analysis of 6 newly established populations in the southern Baltic Sea
- Despite close proximity to one another (30 km of each other), 10 of 15 genetic comparisons between these sites were significantly different
- indicating rapid, site-specific genetic differentiation after only 10 generations
- *N. melanostomus* rapidly adapt to new habitats

REPRODUCTION

- multiple spawners, typically spawning every 3–4 weeks from April through to September
- Males guard nests and may not feed during spawning, suggesting most males die after one spawning season

- females may repeat spawning during a season, every 18-20 days
- body of males entirely black during this season
- Adhesive eggs deposited on stones, shells and aquatic plants
- males guard eggs until hatching and usually die after spawning season.
- Egg clutches are supposed to be occasionally transported attached to the hull of ships, facilitating introduction to other areas.

- Up to 10 000 eggs from four to six females may be present in a nest
- Fertilization and hatching rates are as high as 95%
- Eggs and larvae are relatively large (3·2 mm diameter) compared to other gobiid species

AGE AND GROWTH

- *Neogobius melanostomus* growth rates are highly variable and site specific
- males are larger than females
- *N. melanostomus* in the southern Baltic Sea have a longer life span (up to age 6 years) and larger size at age

THERMAL, OXYGEN AND SALINITY TOLERANCES

- *N. melanostomus* tolerate a wide range of habitat conditions
- exhibit a wide salinity tolerance, inhabiting fresh, brackish and marine waters
- salinity tolerance of 40,5 (Caspian Sea)
  - salts in these habitats are from two distinct molecules (CaSO4 in the Caspian and Aral Seas and NaCl in the ocean)
- there are no known populations in a full ocean habitat
- a recent laboratory experiment found that all *N. melanostomus* died within 48 h under 30 salinity
- if ballast tanks are filled with ocean water for *c*. 5 days, may prevent future *N. melanostomus* introduction events

- *N. melanostomus* also has a wide thermal tolerance, ranging from −1 to 30 C
- prefer warmer water
- energetic optimum temperature is estimated to be 26 C
- It is most widespread and at its greatest densities in the warmest lake (Erie) and has the smallest range and lowest densities in the coldest (Superior)
- *N. melanostomus* are tolerant of very low dissolved oxygen levels
- may attempt to escape hypoxic conditions
- Critical lethal threshold values range from 0·4 to 1·3 mg l−1

HABITAT PREFERENCES

- spawn, feed and hide in hard substrata
- most abundant in rocky habitats
- mud and sand habitat
- abundance correlate with depth and density of aquatic vegetation

SAMPLING METHODS

- Active methods:
  - electrofishing, angling and visual assays (scuba or remotely operated video)
- Backpack and towboat electrofishing (clear, wadeable water)
- *N. melanostomus* lacks a swimbladder and does not float when electrofished
- Passive methods:
  - minnow traps, fyke nets, gillnets and trotlines
  - extremely inefficient when compared to active methods
- Multiple colours and tagging locations could produce a substantial number of unique combinations to individually identify fish

ECOLOGICAL EFFECTS

- *N. melanostomus* - important component of the food webs
- high abundance and widespread distribution
- positive and negative effects on various species
- competition, predation

Species	Evidence
Stonecat *Noturus flavus*	Suspected from habitat and diet overlap
Percina sp.	Suspected from habitat and diet overlap
Logperch *Percina caprodes*	Decreased abundance, habitat and diet overlap, laboratory studies (diet, territoriality)
Juvenile yellow perch *Perca flavescens*	Habitat and diet overlap
European flounder *Platichthys flesus*	Diet overlap, decreased abundance
Eelpout *Zoarces viviparous*	Suspected from diet overlap
European eel *Anguilla anguilla*	Suspected from diet overlap
Perch *Perca fluviatilis*	Suspected from diet overlap
Roach *Rutilus rutilus*	Suspected from diet overlap
Vimba bream *Vimba vimba*	Suspected from diet overlap

MANAGEMENT

- *N. melanostomus* is too abundant and widespread in large systems such (Great Lakes and the Baltic Sea) for eradication efforts to succeed
- reduce densities locally
- prevention campaigns towards aquatic invaders
- early detection and eradication efforts in smaller systems
- In the Chicago Sanitary and Ship canal, an electric barrier was constructed to prevent the spread of *N. melanostomus* into the Mississippi River catchment

- Ballast water regulations
- Eradication or control of *N. melanostomus* populations may be possible in smaller systems if action is taken soon after detection of the species
- chemicals such as rotenone may be the only appropriate management tool and unwanted side effects (killing native fishes)