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Reproduction and health of whitefishes in aquaculture

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“GosNIORKH” named after L.S. Berg**



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Kolarctic CBC 
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Reproduction as the most important characteristic of brood stock

Successful reproduction of brood stock depends on each stage of the growing cycle: keeping of brood stock and preparing for maturation; obtaining eggs; incubation conditions, obtaining and growing larvae. So reproduction as the most important characteristic of brood stock is determined by the technological norms



The present work summarizes the data on the reproductive biology of whitefishes in aquaculture (*Coregonus muksun*, *C. nasus*, *C. peled*, *C. lavaretus*, *Stenodus leucichthys nelma*)

Nutrition and its importance for brood stock reproduction

- Cultured fish has no natural feed; its metabolism is completely depends on artificial feed.
- Provision of fish with physiologically complete feed is fully controlled by humans in industrial cultivation.
- Quality of feed and the nutritional status of brood stock is important for the maternal loading of protein, lipid, vitamins, minerals, carotenoids and hormones into growing and maturing eggs.
- The feeding regime is selected taking into account specific characteristics of nutrition, while the seasonal cyclicality of food activity is simulated, including those associated with reproductive biology.

Berg Institute:

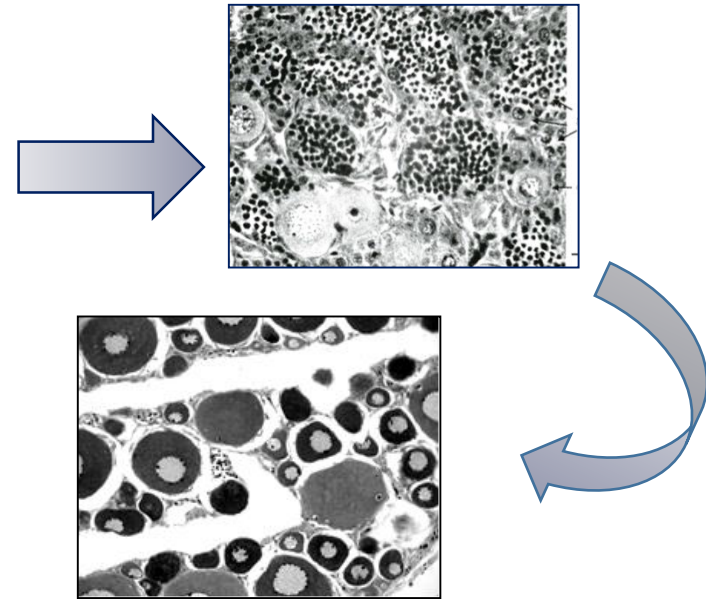
- has a long history of study and development of feed receipts for whitefishes, including feed on the basis of gaprin.
- was very successful in feed recipes development that allowed in 1980s to cultivate millions of whitefish juveniles for lake aquaculture of Russia.
- continues to develop and test feed recipes for whitefish juveniles.
- since 2019 has been developing recipes for nelma spawners in the Kolarctic project. Developing recipes takes into account the needs of nelma in special nutrients for maturation and recovery after spawning.

Water temperature and its influence on whitefish reproduction in cage cultivation

Water temperature is not an adjustable factor in cage cultivation. In abnormally hot summers, the temperature of the water in cages, exceeding the optimum for whitefish, can adversely affect maturation processes and, ultimately, fecundity and egg quality.

We found juvenile hermaphroditism in *Coregonus lavaretus baery* (Ladoga lake) caused by increased water temperature during sex differentiation (Bogdanova, 2004).

Hermaphroditism in juveniles does not subsequently affect the course of oogenesis, but delays the maturation for 1 year.



Reproductive parameters of whitefish brood stocks: growth rate and maturation age

Siberian whitefishes

Wild (the Ob' River)	Aquaculture (North-West Russia)
Age of female maturation	
<i>Coregonus muksun</i>	
5+-6+ at weight 0.8-1.3 kg	4+ at weight 1.3-2.0 kg
<i>Coregonus nasus</i>	
5+-6+ at weight 1.5 kg	3+- 4+ at weight 1.5-2.5 kg
<i>Coregonus peled</i>	
3+-4+ at weight 0.3-0.5 kg	1+-2+ at weight 0.3-0.6 kg
Males mature 1-2 years earlier	
Resume: cultivated Siberian whitefishes in the North-West mature earlier and, as a rule, at larger sizes	

European whitefishes

Wild	Aquaculture
Age of female maturation	
<i>Stenodus leucichthys nelma</i> (Kubenskoe Lake)	
5+-6+ at weight 2-4 kg	4+ -5+ at weight 1.7-2.0 kg
<i>Coregonus lavaretus</i> (Ladoga Lake)	
4+ at weight 0.5-0.8 kg	3+ at weight 0.6-0.8 kg
<i>Coregonus lavaretus maraenoides</i> (Chudskoe Lake)	
4+ at weight 0.5-0.8 kg	3+ at weight 0.5-0.7 kg
Males mature 1-2 years earlier	
Resume: cultivated European whitefish mature at a similar age in nature, usually at larger sizes, nelma - at smaller sizes	

Reproductive parameter of whitefish brood stock: fecundity

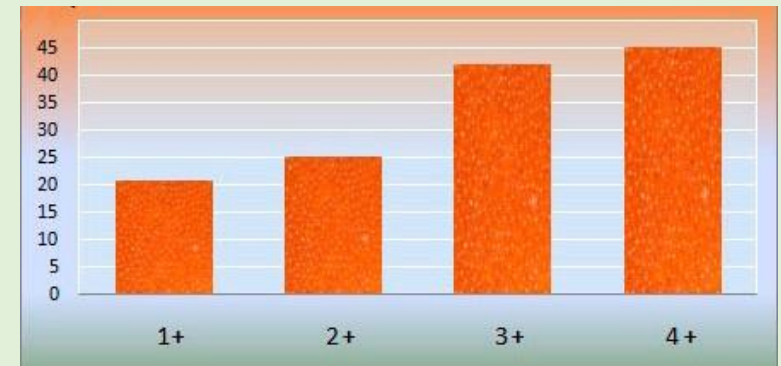


Fecundity of cultured whitefishes

	Fecundity, eggs (thous.)	
	First maturation	Recruits
<i>Coregonus muksun</i>	25-45	45-100
<i>Stenodus leucichthys nelma</i>	30-40	70-110
<i>Coregonus nasus</i>	20-35	60-80
<i>Coregonus peled</i>	15-20	40-70
European whitefish forms:		
Baltic	17-25	up to 70
Ladoga lake	12-25	up to 45
Chudskoe lake	20-35	60-90

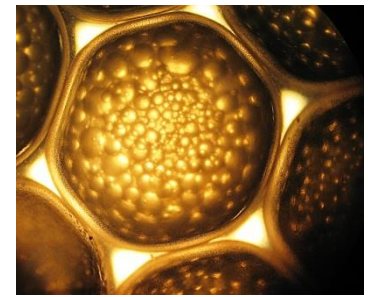
Increase of fecundity with age (on example of peled)

Eggs (thous.)



Age

Reproductive parameter of whitefish brood stock: fecundity and eggs size

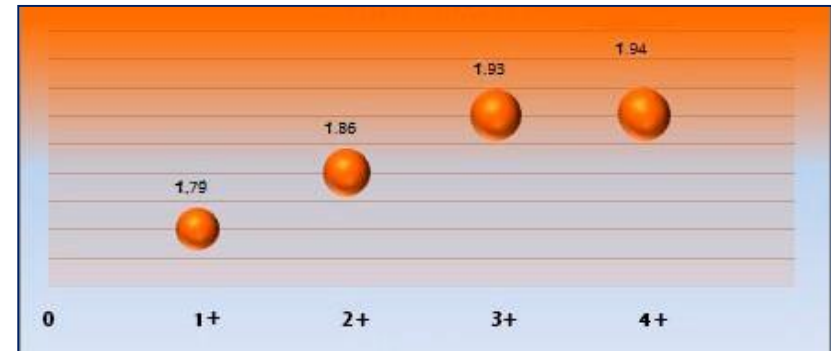


- Fecundity and eggs sizes depend on feeding condition
- Size of mature eggs is species specific
- Eggs sizes of whitefishes in aquaculture are larger compared to natural populations

1. Size of ovulated eggs increases with age and weight and variability decreases

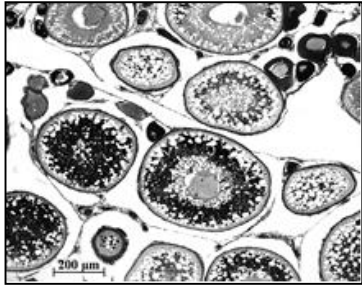
Fish of first and second spawning have smaller eggs. Recruit's age and weight do not affect eggs sizes (on the peled example)

Species	Egg diameter, mm	Survival during incubation, % (2019/2020)
<i>Coregonus muksun</i>	2.3	60-70
<i>Stenodus leucichthys nelma</i> (lake form)	2.7	60-70
<i>Coregonus nasus</i>	2.16	30-45
<i>Coregonus peled</i>	1.86	50-72
<i>Coregonus lavaretus</i>	2.4-2.6	70-80

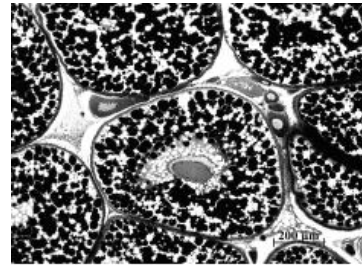


2. After hydration eggs size increases on 30-35 % in most species and on 40 % in broad whitefish

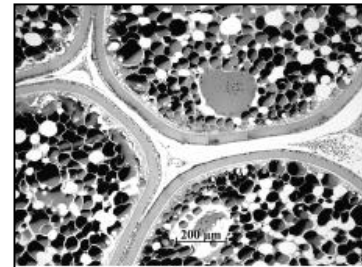
Maturing



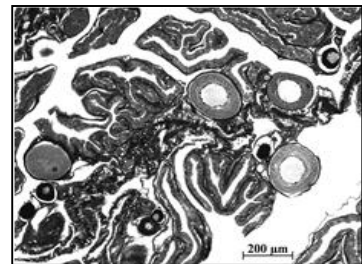
Vitellogenesis takes place in February – beginning of October. Intensive vitellogenesis occurring in mid-July



Vitellogenesis is completed, oocytes of spawning fond. Eggs are included in follicular cells. The stage lasts 15-25 day in middle October – early November



The stage of mature eggs. End of October – beginning of November. Nuclear of oocyte migrates to abnormal pole, the first meiosis is completed. Eggs are transferred to the body cavity



Ovary after spawning: empty follicles, oocytes in the early stages of development, unspent eggs. A new wave of vitellogenesis starts in February

Maturing cycling

- Muksun, broad whitefish, nelma: Young females mature after spawning following year. Among recruits, from 10 to 30% may miss next spawning due to high fecundity and long recovery
 - Whitefishes have mainly annual spawning
 - Peled - annually

Effective reproductive period in whitefish brood stock:

- Muksun – 5 years
- Broad whitefish – 3-4 years
- Nelma – 4 years
- Peled – 3-4 years
- Ladoga whitefish – 4 years

Conclusion

- **Berg Institute biotechnology of whitefishes cultivation promotes realization of high growth and sufficient reproduction**
- **Cultured whitefishes maturation occurs at the same or earlier age and at higher weight compared to the wild**
- **Increase in fecundity and size of eggs is noted mainly in first and second-maturing females. With following spawns the change of eggs size is insignificant**
- **Recruits of whitefish and peled have an annual ovary cycle. Other whitefishes have partial annual spawning**
- **In whitefish brood stocks effective reproductive period lasts 3-5 years**
- **Reproductive qualities of whitefish brood stocks depend on cultivating conditions**