

Basic knowledge on sex differentiation of perch and roach

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The concern that hormonally (estrogenically) acting substances in the environment affect sex differentiation of male fish and thus, influence the sex ratio of wild-living fish populations triggered the field study outlined in Table 1.

Tab. 1: Study design

Indicator species	Perch (<i>Perca fluviatilis</i>) Roach (<i>Rutilus rutilus</i>)
Study areas	5 and 3 sampling sites with low and high antropogenic impact resp. (Hessischer upper Rhine, 2 low mountain range lakes, Taubergießen)
Sampling period	Dec. 2000 - Dec. 2002
Sampling mode	2 /a (1 x summer, 1 x winter) 40 individuals of each species
Fishing method	Electrofishing
Sex determination	Perch: testis bilobed, ovary single lobed Roach: Testis, one attachment site at the peritoneum (Fig. 1a); ovary, two attachment sites, oocytes detectable in early stages of oogenesis (Fig. 1b)
Biomarkers investigated:	age (scale method), development (corpulence index), parasitization (skin, gills, intestines, abdominal cavity), sex ratio (gonad histology), sex development (gonad histology, GSI), intersexuality (gonad histology) Vitellogenin (electrophoresis of the blood)

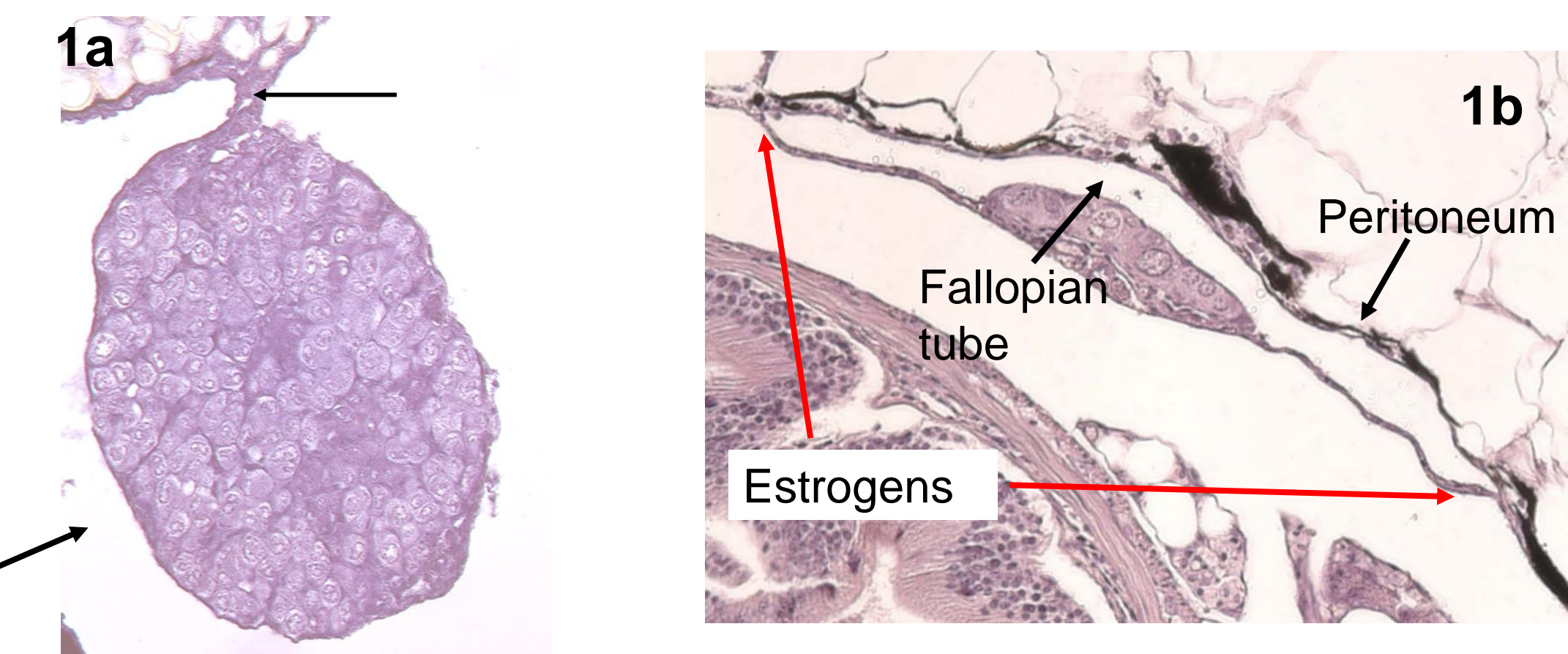


Fig. 1: The formation of the fallopian tube (= 2 attachment points on the peritoneum) is controlled by estrogens. In laboratory experiments, waste water constituents can induce the formation of a second attachment site in male organisms (Rodgers-Gray et al. 2001).

• In the present study, even with a 50-80% wastewater load (Schwarzbach), there were no disturbances in the development of the gonadal ducts.

Therefore, it cannot be assumed that the juveniles were exposed to estrogenic substances in effect-relevant concentrations.

Roach shows a strictly seasonal / circadian control of gonadal recrudescence taking place synchronous in all individuals of the same age. The successive germ cell stages can be clearly defined histologically (Fig. 2). Hydrogeological characteristics such as temperature or trophy level of the sites have only a minor influence on the structure/reconstruction of the gonad.

- Factors that inhibit gonadal recrudescence/ ripening: 1. Infection with tapeworms (*Ligula intestinalis*)
2. Waste water pollution (Schwarzbach)
- Intersexual gonads (*Testis ova*) were not found.
- The natural equal distribution of the sexes also exists at polluted sites (Fig. 3)

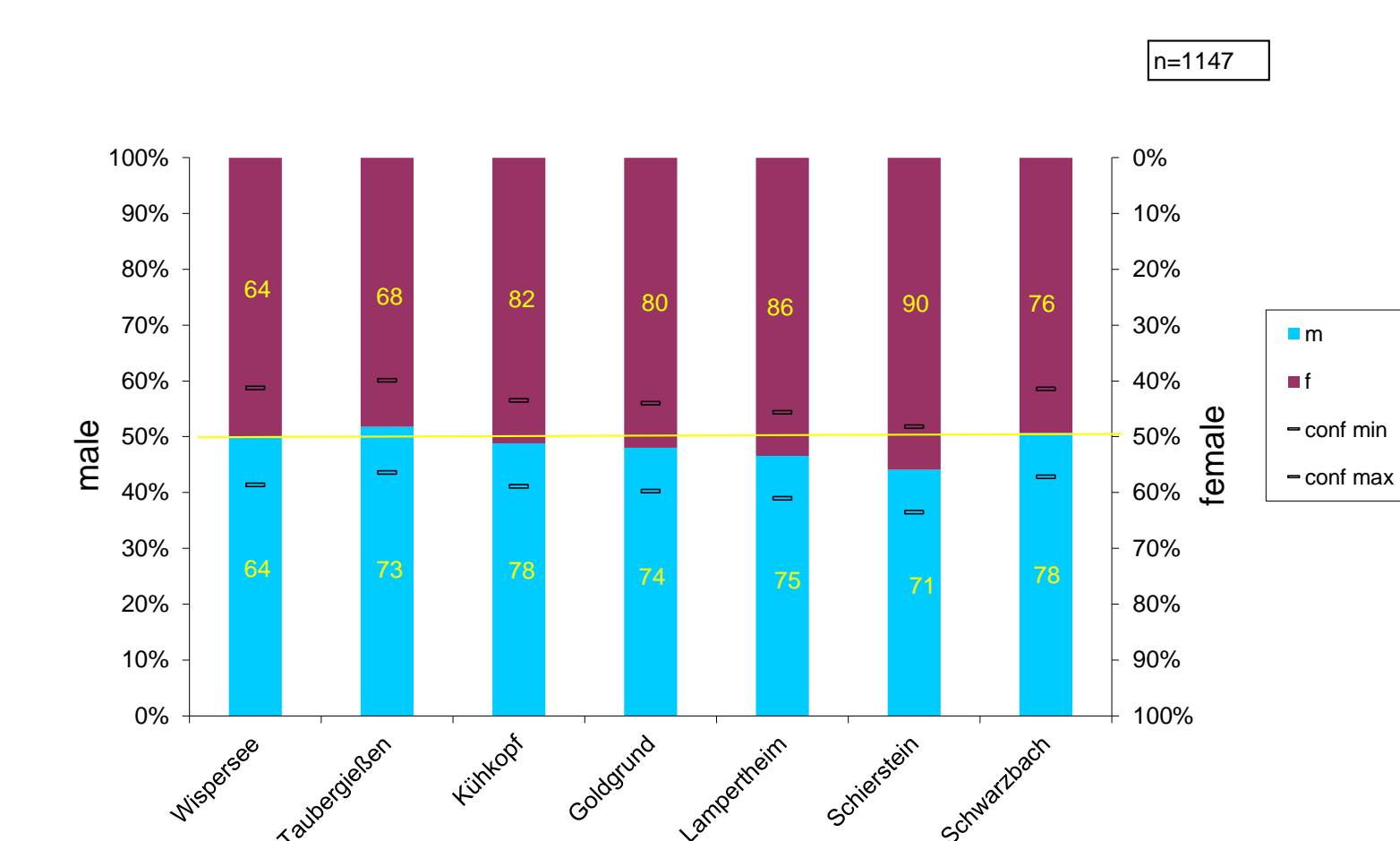


Fig. 3: Gender ratio of the roach

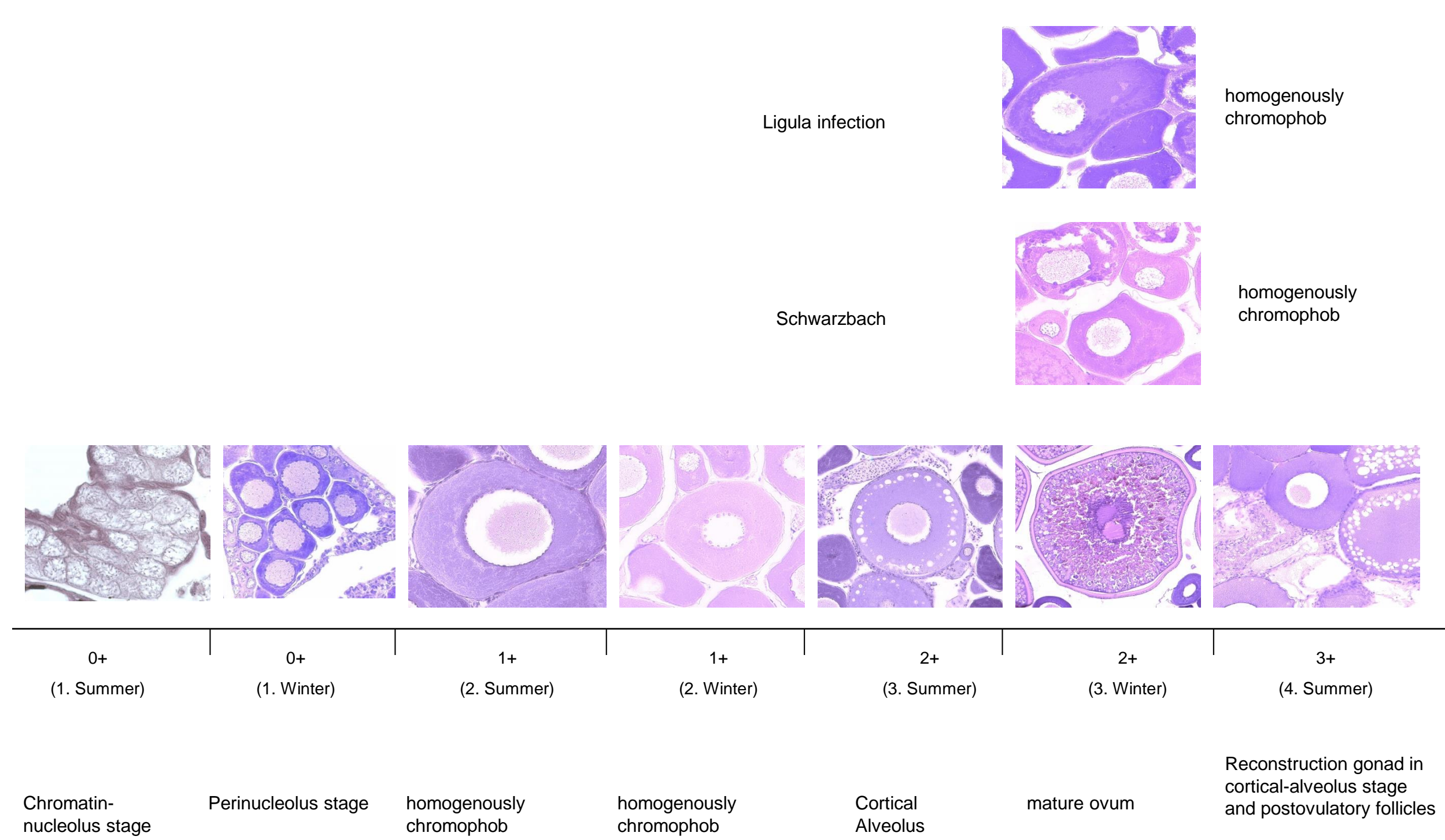


Fig. 2a: Sex development of roach females

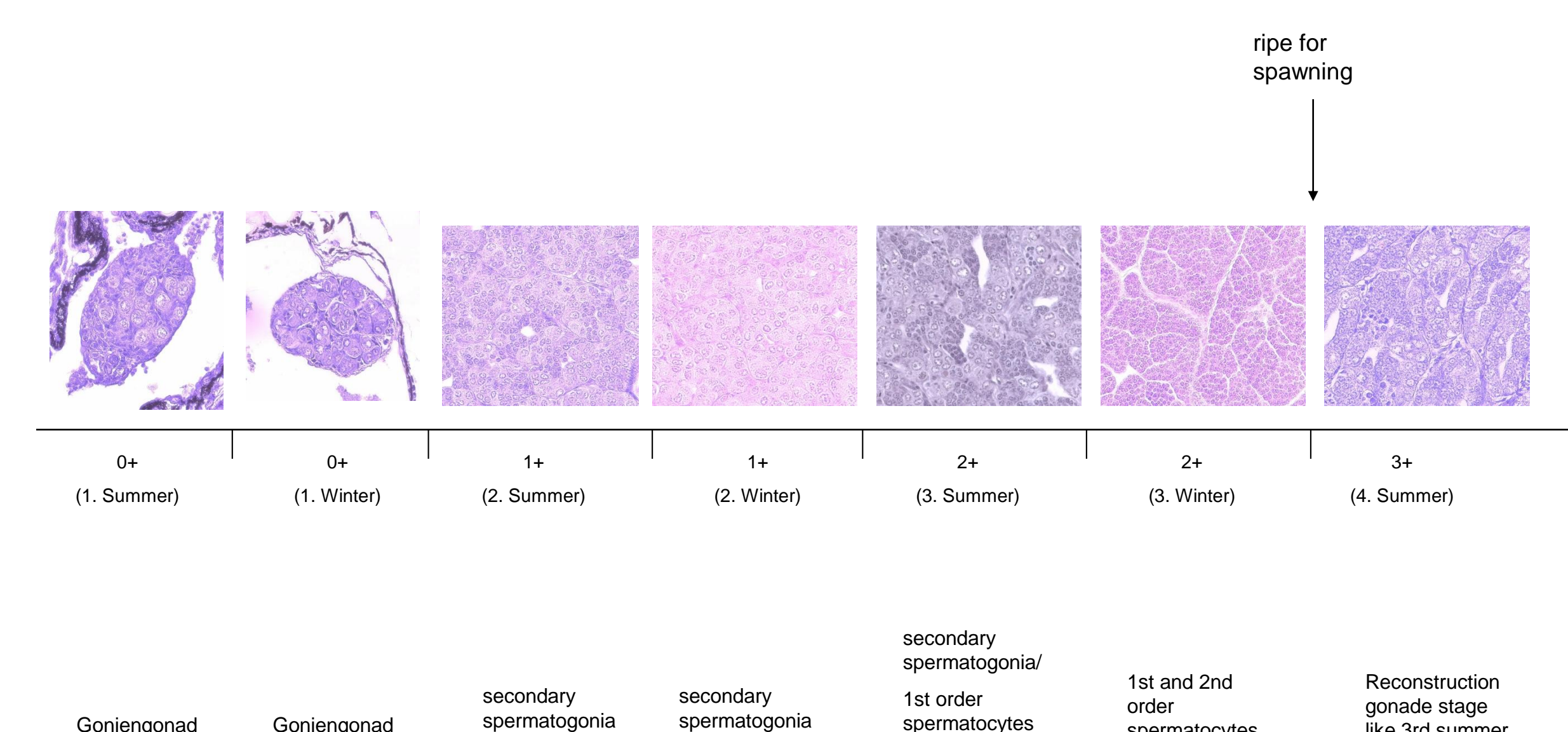


Fig. 2b: Sex development of roach males

Perch showed a higher plasticity of sex development than roach (Fig. 4):

- the time of the first sexual maturity is variable ("precociousness")
- the annual recrudescence of ovaries is not obligatory (**optional two-year spawning cycle**)
- the sex ratio (Lampertheim, Fig. 5) and gonadal maturation (Schwarzbach, Fig. 4a) may be influenced by exogenous factors

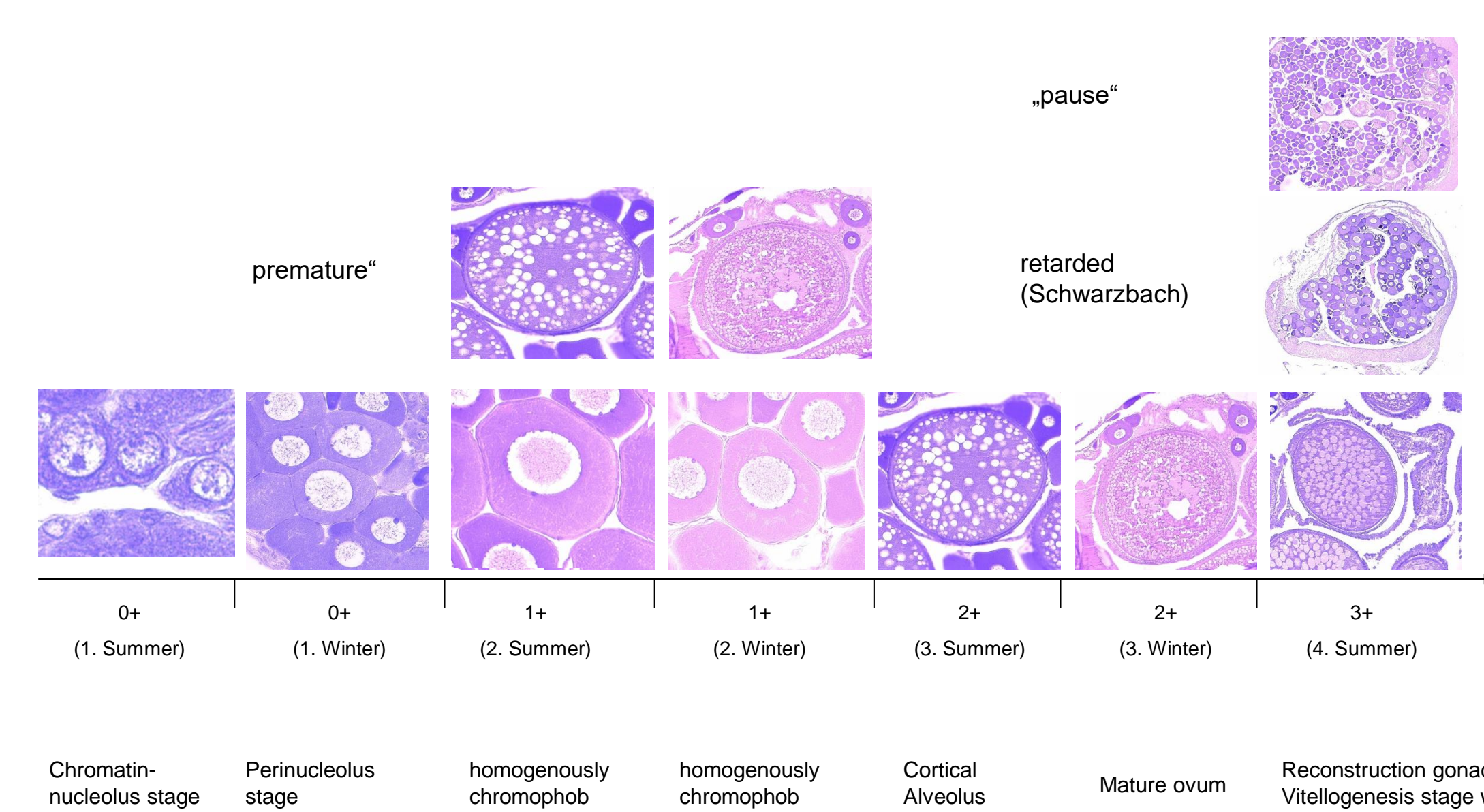


Fig. 4a: Sex differentiation of perch females

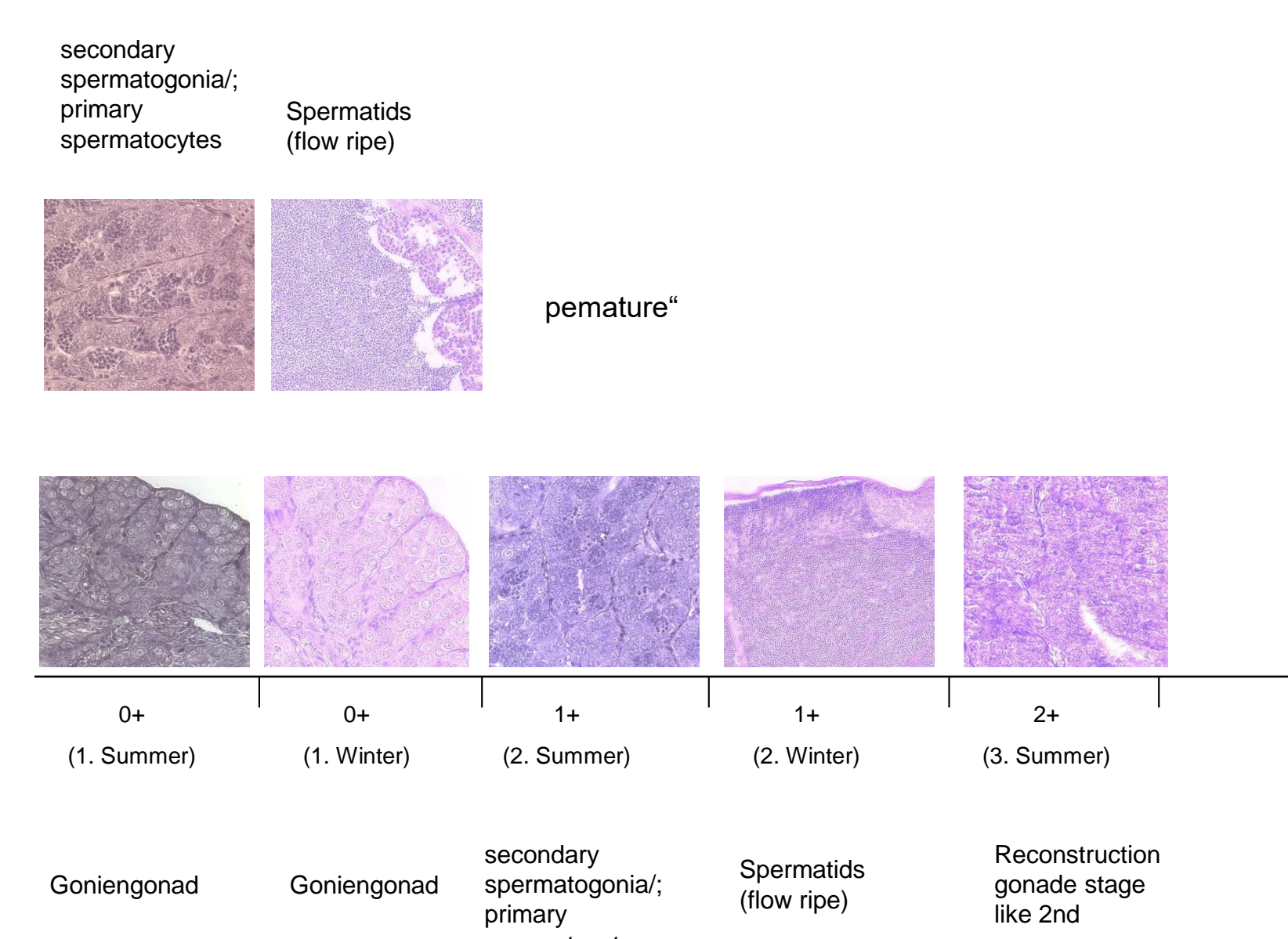


Fig. 4b: Sex differentiation of perch males

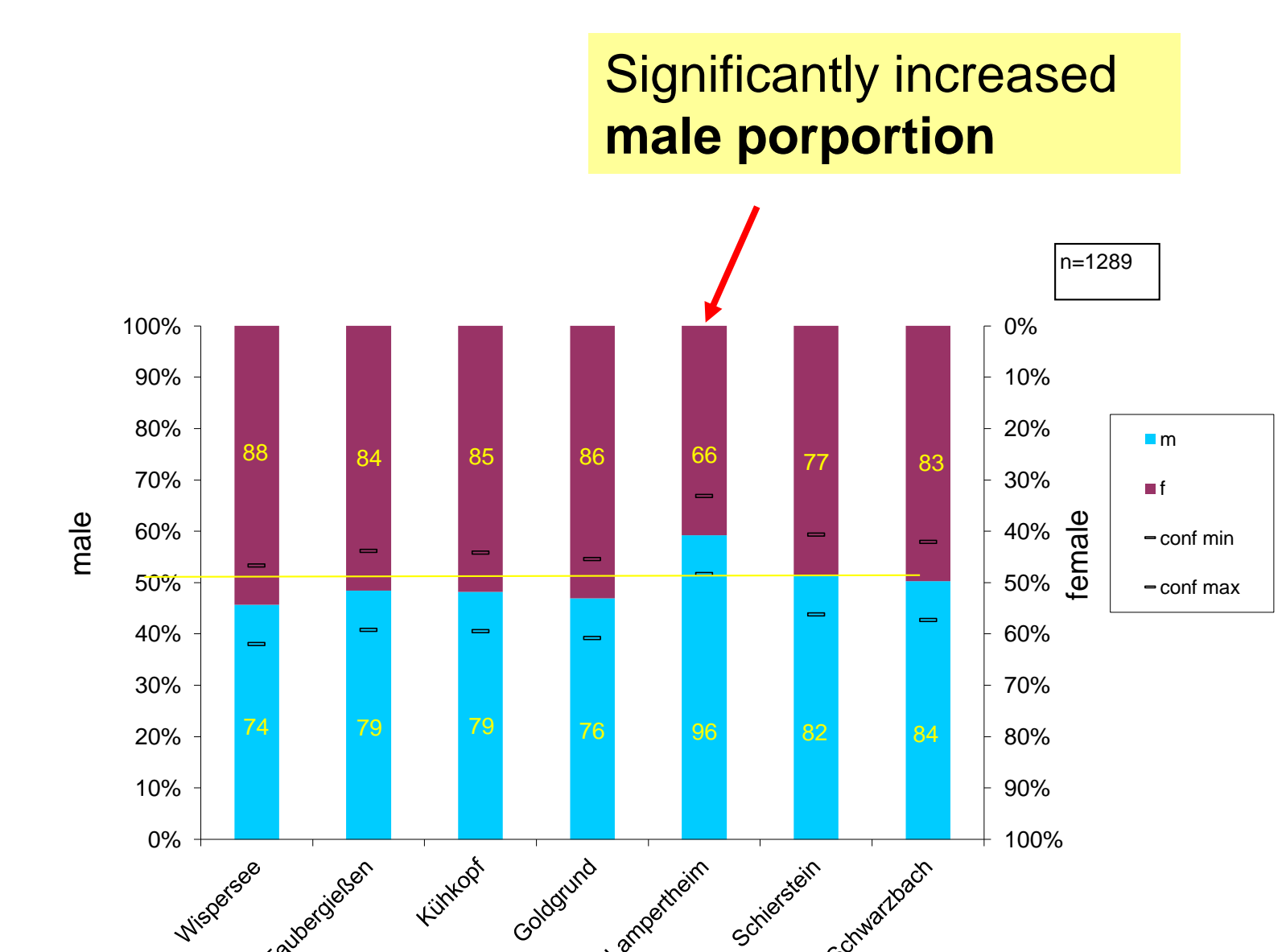


Fig. 5: Sex ratio of the perch; a significant male surplus was observed at the Lampertheimer Altrhein, which was contaminated with tin organylene.

Conclusion: The homogeneity of natural sex differentiation in Roach enables the recognition of deviations from the normal gonadal recrudescence. Thus, roach is suited as an indicator species to monitor the ecological status of a water body. The plasticity of sex differentiation of the perch seems to be associated with a higher sensitivity to exogenous influences. Therefore, the perch is suited to detect specific pollutant burden.

Literature: Rodgers-Gray, T., Jobling, S., Kelly, C., Morris, S., Brighty, G., Waldock, M., Sumpter, J., Tyler, C. (2001): Exposure of Juvenile Roach (*Rutilus rutilus*) to Treated Sewage Effluent Induces Dose-Dependent and Persistent Disruption in Gonadal Duct Development., Environ. Sci. Technol., 35: 462-470.