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Impact of temperature and growth hormone on growth physiology of juvenile Atlantic wolffish (*Anarhichas lupus*)



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ABSTRACT

The effects of temperature and growth hormone (GH) implantation on growth of juvenile Atlantic wolffish (*Anarhichas lupus*) were investigated. The year-long study had three sequential experimental phases (EP) termed EP1, EP2 and EP3, lasting for 6, 9 and 37 weeks, respectively. The experimental fish were divided into four groups and reared at different target temperatures (3, 7, 11 and 15 °C) during EP1 and EP2, but at a constant temperature of 7 °C during EP3. At the beginning of EP2, half of the fish from each group was implanted with formulation of recombinant bovine GH (Posilac®), while the other half was sham-implanted with vehicle. The optimal temperature for growth ($T_{opt,G}$) of early juveniles (geometric mean weight 7.5 g) was determined as 12.1 °C during EP1, while the upper critical temperature (T_c) was concluded to be very close to 15 °C, as fish at that temperature had stunted growth, increased mortality and showed external signs of skeletal deformities. Thus, the species was found to be relatively stenothermic during the early juvenile stages and therefore vul-

Catalogue



研究背景



材料与amp;方法



结果分析

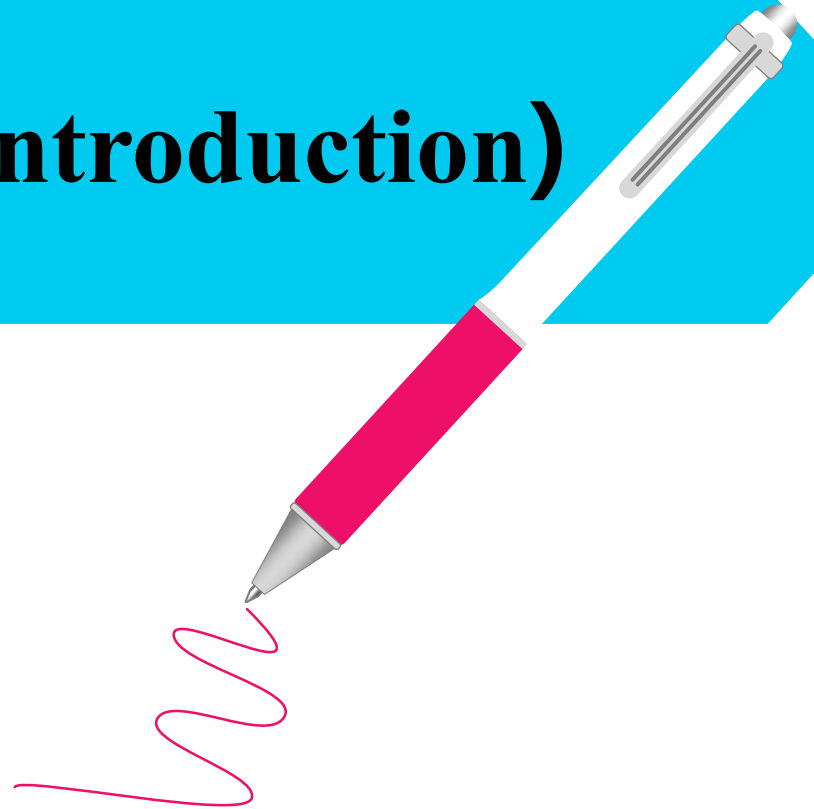


结论



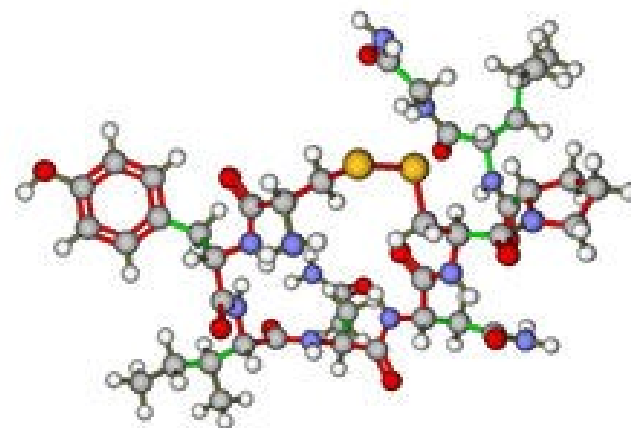
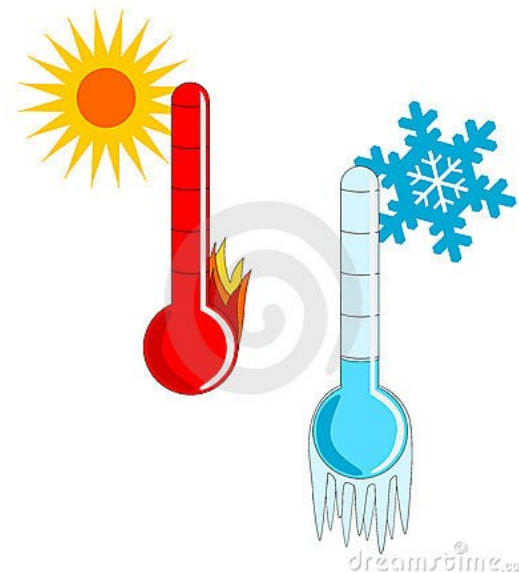
1

研究背景(Introduction)



研究背景

温度是影响生物生长的主要因素之一，因为它可直接影响体内的所有生物反应。研究表明，大多数鱼类的生长速率会随温度的升高而加快，且在最适温度时达到峰值，在较高温度时，生长速率会下降。此外，生长激素(GH)也是影响动物生长主要因素，它可直接或间接调控IGFs的表达来刺激肌肉和骨骼生长。





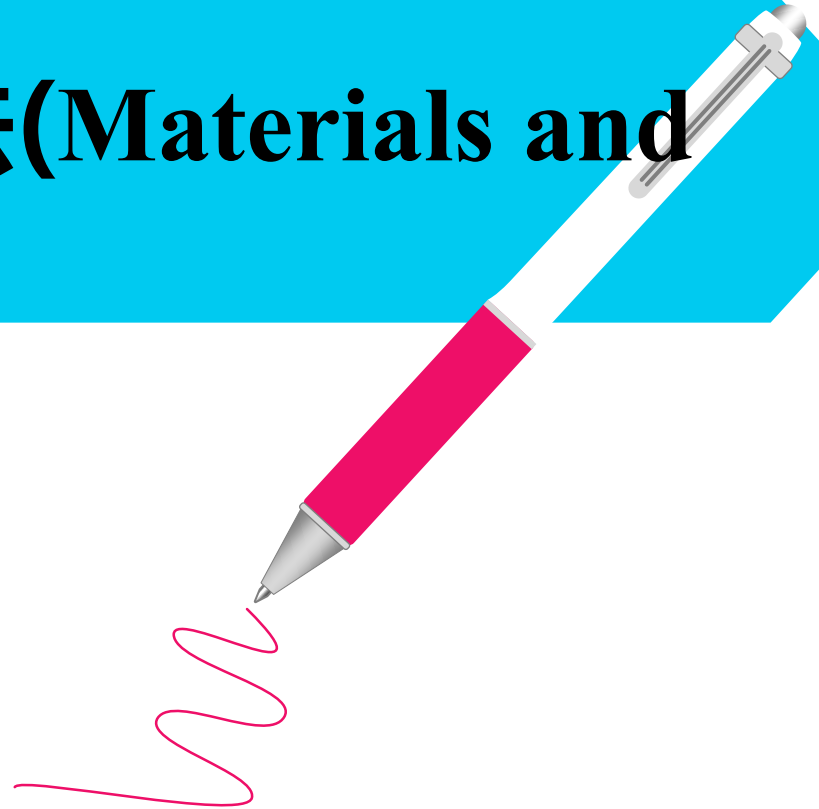
大西洋狼鱼，是一种冷水海洋鱼类，主要栖息在岩石底部。狼鱼具有许多重要的养殖优势，例如较强的生存力，较高的鱼片产量和经济价值等。而现今有关温度和激素对其影响的研究并不多。

本研究的目的是探究孵化后的大西洋狼鱼的生长与温度，GH之间的关系，为其驯化和育种提供一些参考。



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材料与方法(Materials and methods)



材料与amp;方法

实验前阶段

1. 将从野外获取的狼鱼卵在4°C海水中孵化，孵化一周后的幼鱼在7°C海水中暂养，用自动饵料器进行饲喂，饲料粒径为0.4-0.8 mm。
2. 孵化后约四周，鱼开始稳定。在第30、34、42、50、62、70、86 和106 天(dph)测量鱼的体长及体重。

正式实验

EP1. 将幼鱼分别放在3、7、11、15°C海水中进行饲养，在第3周(127 dph)和第6周(149 dph)测量鱼缸中所有鱼的体长及体重。

EP2. 在每条鱼的腹中植入应答器标签和微型移液管，处理组装 rbGH，对照组装芝麻油，缓释剂量为1mg/g。分别在第170、190和212 dph 测量鱼缸中所有鱼的体长及体重。

EP3. 在212 dph后，将所有鱼放在7°C进行饲养，直到469 dph。在此期间，对鱼的体长及体重进行了八次测量。在429 dph后，11°C和15°C 组各取一条鱼，获得他们的X射线图像。



3

结果分析(Results and analysis)



3.1 SGR与温度之间的关系

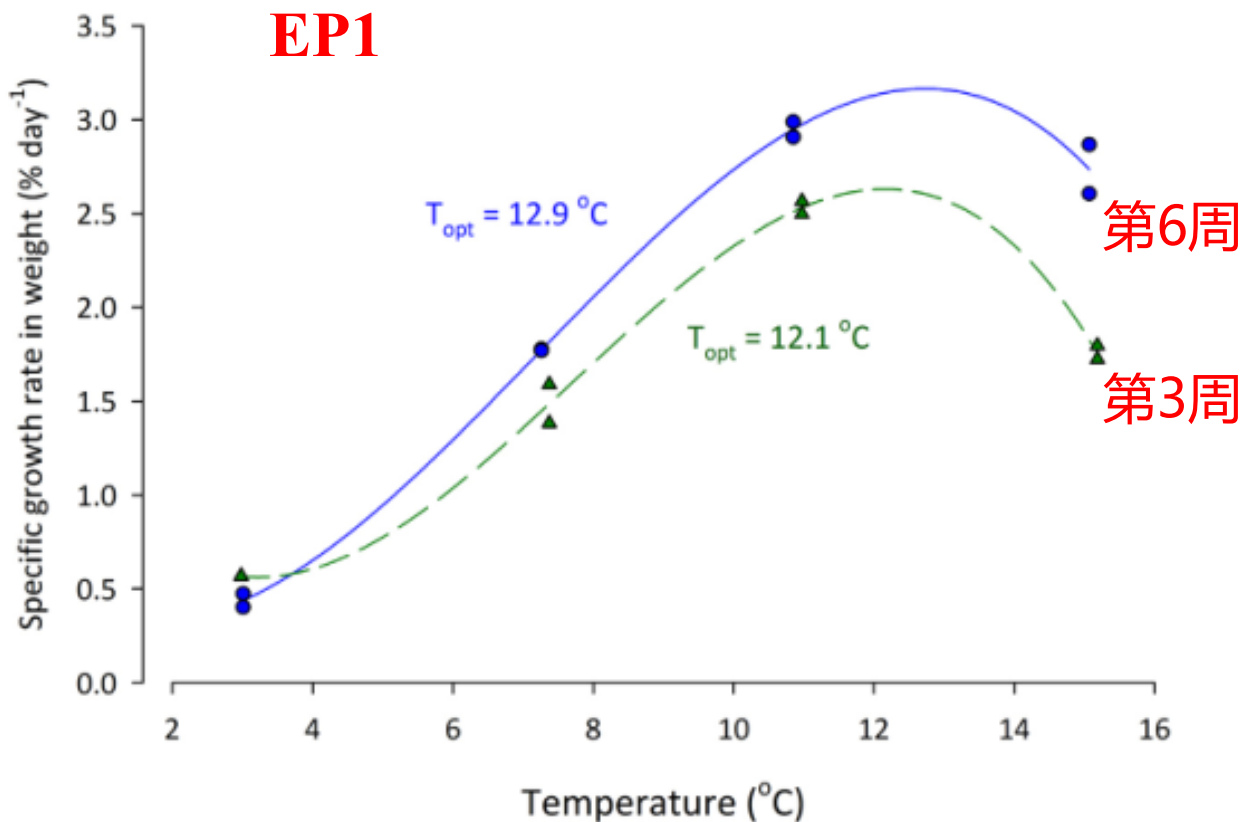


Fig. 1. Specific growth rates for weight (SGR W) of juvenile Atlantic wolffish held in duplicate tanks at four rearing temperatures (3, 7, 11 and 15°C). The specific growth rate is calculated over the **three-week** period from 106 to 127 dph (solid line and circle symbols in blue; $R^2 = 0.995$) as well as over the **six-week** period from 106 to 149 dph (dashed line and triangle symbols in green; $R^2 = 0.993$).

大西洋狼鱼的SGR随温度的升高而增加，且在第三周和第六周的最适生长温度分别为12.1°C和12.9°C，这表明幼鱼的生长对温度存在热依赖性。

3.2 温度和GH对体重的影响

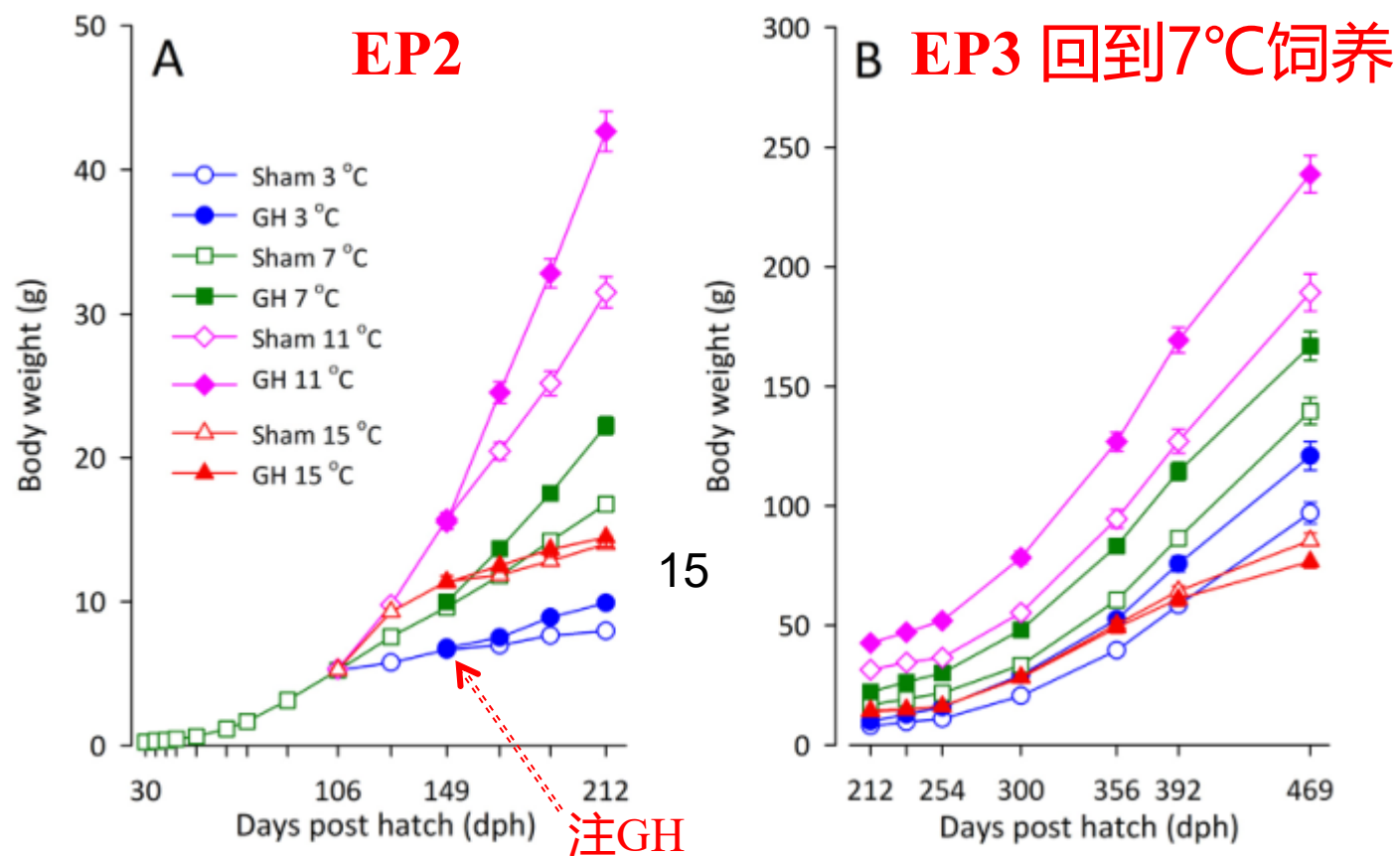


Fig. 2. The effects of rearing temperatures and growth hormone (GH) implants on body weight (W) of Atlantic wolffish from 30 to 469 dph

未注射GH前(106-149dph), 体重会随温度升高而增加。注射GH后, 3、7和11°C均使幼鱼增重, 而15°C对生长无影响。在放回7°C饲养后, GH对体重的增加量均约为30%。这表明GH促进生长的作用机制与温度无关。

3.3 注入GH 后温度对SGR的影响

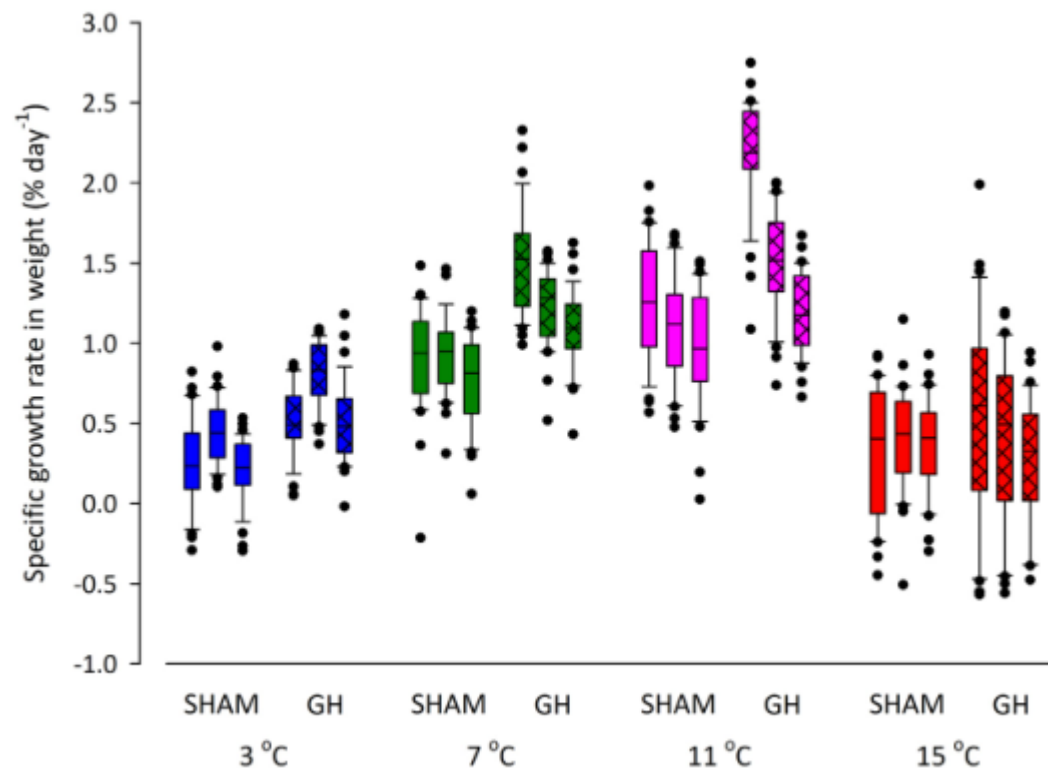


Fig. 3. The distribution of specific growth rates in weight (SGR W) of sham-implanted (clear boxes) and growth hormone (GH)-implanted (cross-hatched boxes) Atlantic wolfish reared at four different temperature regimes over three successive 3-week periods; from the time of GH/sham-implantation at 149 to 170 dph, from 170 to 190 dph, and from 190 to 212 dph.

注入GH后, 在3°C, 7°C和11°C, GH 在三个时期均显著提高了SGR, 但在15°C时, GH对SGR 没有影响。

3.4 GH对增重的影响

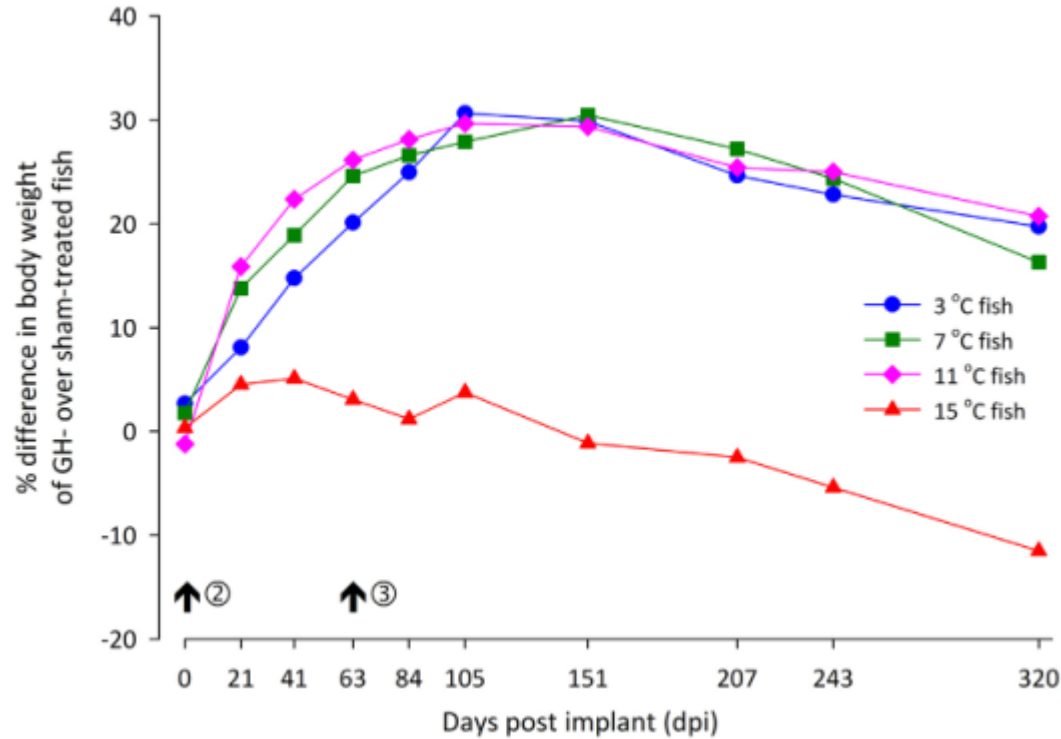


Fig. 4. Body weight (W) of growth hormone-implanted Atlantic wolffish relative to sham-implanted conspecifics. The fish were implanted on 149 dph (↑②), when the fish were at four different rearing temperatures; 3 °C (●), 7 °C (■), 11 °C (◆) and 15 °C (▲). Nine weeks later (63 dpi, ↑③), all fish were returned to their initial rearing temperature of 7 °C.

注入GH(0-320dpi), 在3°C, 7°C和11°C, 幼鱼增重量升高后降低, 最高增重量为30%, 而在15°C, 幼鱼增重量无显著变化。这表明在3至11°C的饲养温度下, GH对大西洋狼鱼具有很强的长期生长促进作用。

3.5 温度和GH对肥满度的影响

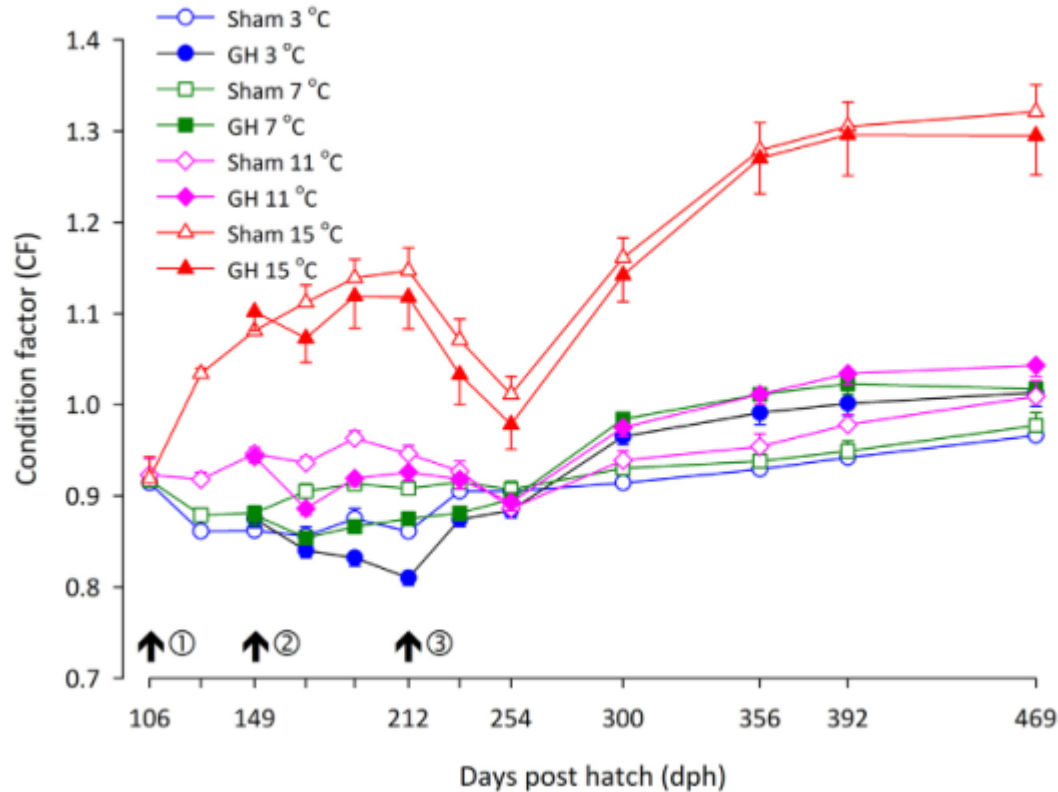


Fig. 5. Condition factor (CF) of Atlantic wolffish reared at four different temperatures, 3 °C (●), 7 °C (■), 11 °C (◆) and 15 °C (▲) from 106 dph (↑①). At 149 dph (●), the fish were sham-implanted (open symbols) or growth hormone-implanted (closed symbols). At 212 dph (↑③), all groups were placed back on a 7 °C temperature regime.

在EP1(106-149dph), CF在3°C和7°C显著降低, 15°C显著增加, 11°C无显著变化。在EP2(149-212dph), 经GH处理的鱼的CF在所有温度组中均显著降低。在EP3(212-469dph), 温度从11和15°C降低到7°C的鱼的CF值均先降低后增加且具有显著性, 而从3°C迁移到7°C的鱼显著升高, 而保持在7°C的鱼CF无变化。从整体看, 15°C对鱼肥满度影响较大。

3.6 温度对骨骼的影响

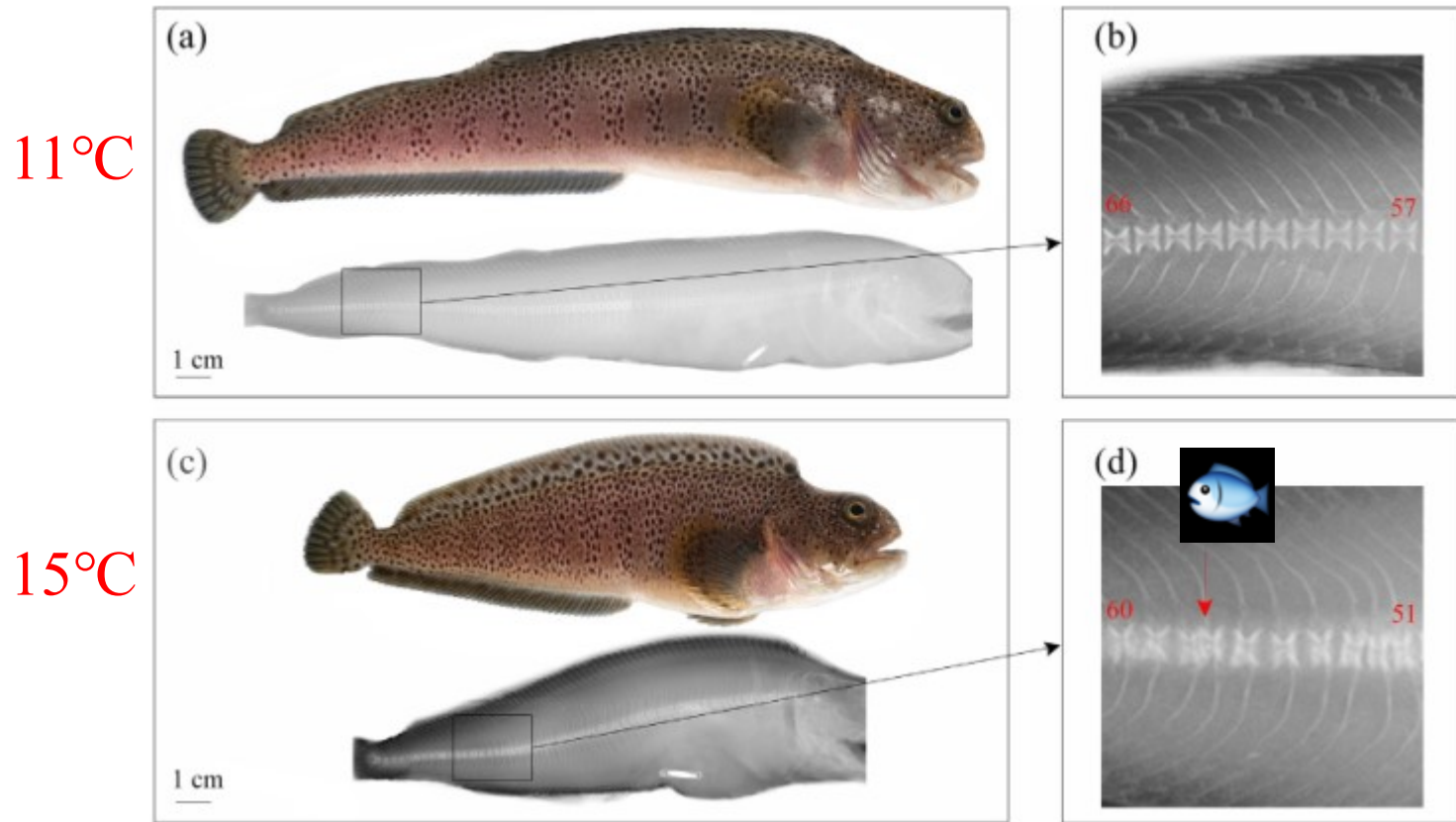


Fig. 6. Photograph and corresponding radiograph of a representative (a) normally growing Atlantic wolffish exposed to 11 °C and a representative (c) deformed Atlantic wolffish exposed to 15 °C. The insert (b) shows normal spinal patterning between vertebrae 57 and 66, whereas insert (d) shows non-symmetric and compressed structure of vertebrae 51–60, with ankylosis between vertebrae 57 and 58 (arrow). Photo: S. Egilsdóttir, MFRI.

与11°C相比，15°C下狼鱼的椎骨已发生严重的畸形，表明15°C是狼鱼的临界生长温度。



4

结论(Conclusion)



结论1

大西洋狼鱼在幼鱼期的最适生长温度为12.1-12.9°C，临界温度接近15°C。在临界温度下饲养，会造成鱼骨骼严重畸形。

结论2

在15°C时，生长激素注入对生长速率没有影响。在较低的饲养温度下，生长激素注入对生长速率有着长期的影响，且在3、7和11°C诱导了极为相似的相对生长刺激效果，这表明生长激素促进生长的机制与温度无关。

请各位老师批评指正

Thank you for listening

