

松材线虫生殖系统发育研究

李泉¹, 刘文义¹, 陈静¹, 苏森¹, 邵蝴蝶¹, 胡加付^{1*}

(1. 浙江农林大学, 浙江杭州, 311300)

摘 要:【目的】松材线虫病在我国呈现明显的北扩西进态势, 严重威胁我国森林和生态安全, 从细胞水平研究松材线虫的生殖系统发育的过程, 为系统掌握松材线虫的发育和迅速繁殖的生物学过程, 进一步为有效遏制松材线虫病的蔓延扩散具有重要意义。【方法】利用光学显微镜对松材线虫不同龄期的性腺和性器官进行解剖和观察, 详细记录和拍摄松材线虫生殖系统的形态学特征, 并统计其重要的定量数据。【结果】J2 幼虫的性腺形态为“桶形”, 由位于身体 56.37% 处的腹侧 4 个细胞组成, 这 4 个细胞从前向后分别命名为 Z1、Z2、Z3 和 Z4。这些细胞在 25℃ 的条件下, 72h 即可增殖分化为整个成虫性腺器官, 这 4 个细胞又称“性腺原基”; 值得注意的是, 线虫个体发育至 J3 中后期, 雌雄性腺开始出现差异, 雌虫性腺呈“梭形”向前后两端发育, 雄虫性腺前部会出现向后反折现象, 即向前生长一段距离后开始向身体后部生长; 在 J4 前期, 雌雄差异更加显著, 此时, 雌虫身体 70% 处的 4 个表皮细胞开始发生分裂, 这几个细胞最终会通过分裂并向内挤压发育为雌成虫的阴户; 在 J4 后期, 雌虫阴户上方性腺中的锚细胞 (anchor cell, ac) 发生细胞程序性死亡后使性腺通过阴户连接到体外环境, 雄虫性腺近端的连接细胞 (linker cell, lc) 发生细胞程序性死亡后将性腺通过泄殖腔连接到体外; 在成虫阶段, 雌虫生殖系统包括卵巢、受精囊、子宫、阴户和外阴后囊, 雄虫生殖系统包括精巢、储精囊、射精管以及交合刺。【结论】松材线虫的卵及 J1 阶段, 无法确定线虫性腺形态特征; J2 至 J3 中期阶段, 线虫雌雄个体无差异; J3 中后期至 J4 阶段, 可根据性腺形态特征对线虫性别进行区分; 成虫阶段, 雌雄生殖系统已发育完全个体差异更加显著。

关键词: 松材线虫; 生殖系统; 性腺发育; 配子发生

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Development of the Reproductive System of *Bursaphelenchus xylophilus*

Quan Li¹, Wenyi Liu¹, Jing Chen¹, Miao Su¹, Hudie Shao¹, Jiafu Hu^{1*}

(1. Zhejiang A & F University, Hangzhou, 311300)

Abstract: 【Objective】There is a significant northward and westward expansion of pine wilt disease, posing a serious threat to the country's forest and ecological security in China. Studying the development of the reproductive system of *B. xylophilus* at the cellular level is crucial for a systematic understanding of the nematode's development and rapid reproduction processes. This will be fundamental to effectively curbing the spread of pine wilt disease. 【Method】The gonads and sex organs of *B. xylophilus* at different stages of development were dissected and observed by light microscopy. Morphological features of the reproductive system from *B. xylophilus* were carefully recorded and photographed. Additionally, The important quantitative data are counted. 【Results】The gonads of J2 larvae were 'barrel-shaped', consisting of four cells located at 56.37% of the body length ventrally. These four cells, named Z1, Z2, Z3, and Z4 from anterior to posterior, can proliferate and differentiate into the entire adult gonadal organ under the condition of 25℃ for 72 hours, referred to as the 'gonadal primordium'. Notably, during the middle to late stages of J3, the female gonads looked like 'shuttle-shaped'. These four cells are also known as the 'genital primordium'. As the nematode develops into the middle to late J3 stage, differences between male and female gonads begin to appear: the female gonad becomes 'pike-shaped' and

extends both anteriorly and posteriorly, whereas the anterior part of the male gonad bends backward. At the early stages of J4, the distinction between males and females becomes more clearly. At this stage, four epidermal cells located at 70% of the female body length begin to divide, eventually forming the adult vulva by inward division and compression. At the end of the J4 stage, the anchor cell (ac) in the gonad above the female vulva undergoes programmed cell death, connecting the gonad to the external environment through the vulva. Similarly, the linker cell (lc) near the male gonad undergoes programmed cell death, establishing a connection between the gonad and the external environment via the cloaca. In the adult stage, the female reproductive system comprises the ovary, spermatheca, uterus, vulva, and post-vulval sacs, whereas the male reproductive system includes the testis, seminal vesicle, ejaculatory duct, and spicule 【Conclusion】 In the egg and J1 stages of *B. xylophilus*, the morphological characteristics of the nematode gonads are indiscernible. From the J2 to the middle J3 stages, there are no observable differences between males and females. However, from the middle J3 to the J4 stage, the sexes can be differentiated based on gonadal morphology. In the adult stage, the differences between males and females become more pronounced, with fully developed male and female reproductive systems.

Key words: *Bursaphelenchus xylophilus*; reproductive system; gonadal development; gametogenesis