

# The colonial tunicate *Botryllus schlosseri*: A key species for evolutionary developmental studies

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I discovered tunicates while attending classes of Comparative Anatomy of Vertebrates as a Biology student at the University of Padua, Italy. I was fascinated by the evolutionary developmental (evo-devo) approach while I was analyzing vertebrate adaptations looking at their sister group, the simple tunicates. I graduated in 1988 and subsequently entered my university's graduate program in Bioscience. In 1993, I obtained my PhD Degree in Evolutionary Biology. I owe a great debt of gratitude to my mentors, Prof. Paolo Burighel and Prof. Giovanna Zaniolo, who instilled in me a passion for tunicate research, a rigorous scientific working method, and above all a commitment to intellectual honesty in interpreting literature-based results, which I consider their most important lesson. In 1998, I became a junior faculty in my University, and in 2010 I was promoted to associate professor. Currently, I teach Comparative Anatomy of Vertebrates and Eco-Evo-Devo and I am a member of the faculty of the graduate school in Biosciences. Over the course of 25 years of my academic life, I have had the opportunity to work as visiting scientist at the Université Paris XI (France), at the Friday Harbor Laboratories of the University of Washington (USA), and at Stanford University (USA). I have been also collaborating with members of the global tunicate research community and enjoy meeting them at the biannual International Tunicate Meetings.

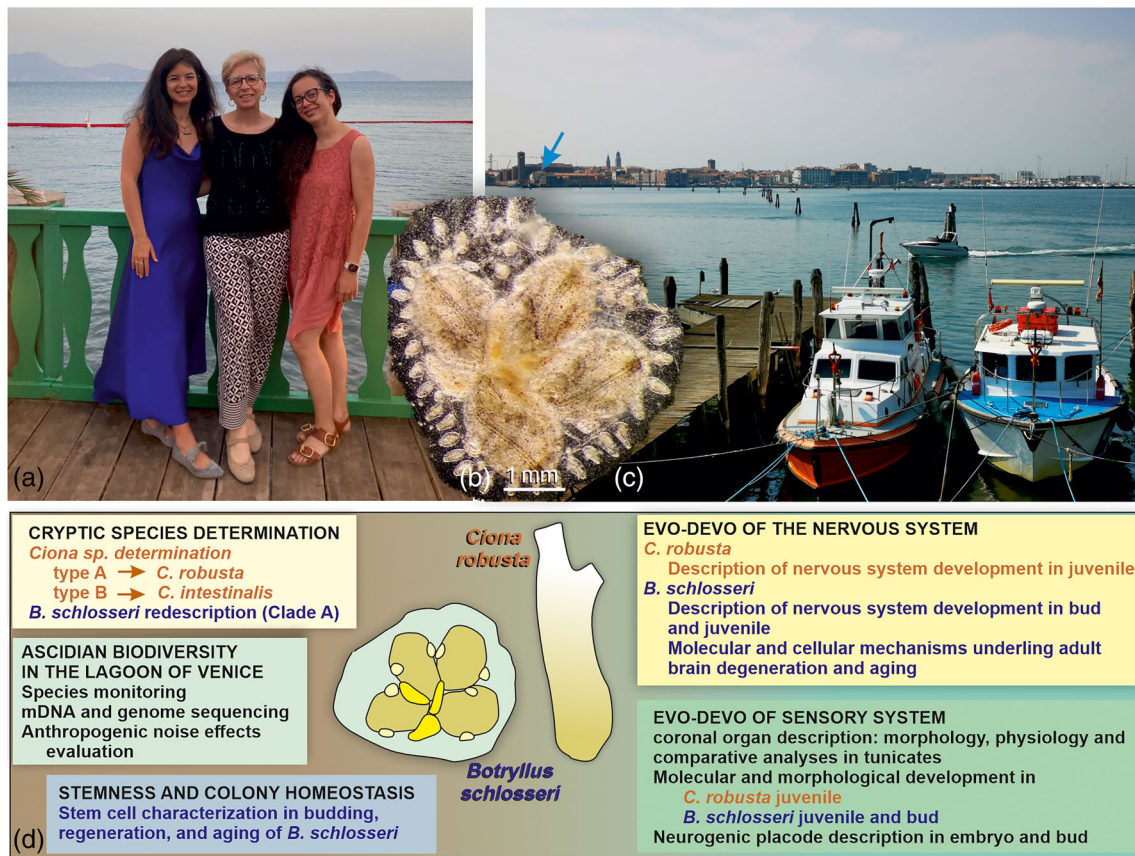
My research activities have primarily centered around the colonial ascidian *Botryllus schlosseri*, which I can easily collect in the Southern Lagoon of Venice, near the city of Chioggia, where the Hydrobiological Station of my University is located (Figure 1). I love this animal for its unique stem-cell based asexual cycle and its regenerative ability (Kowarsky et al., 2021; Manni et al., 2007, 2014, 2019; Vanni et al., 2022). The weekly resorption of adult zooids, synchronized with the maturation of their buds, offers a valuable opportunity to study

the homeostatic relationships between zooid generations, their degeneration and aging, and the developmental and regenerative capabilities of new buds under different environmental conditions. Through my work with *B. schlosseri*, I contributed to the description of a novel tunicate sensory organ, the coronal organ, whose cells are homologous to vertebrate hair cells (Burighel et al., 2003; Rigon et al., 2017). This discovery has led to the reinterpretation of certain tunicate embryonic territories, now considered homologous to vertebrate placodes, and has prompted a revision of the vertebrate origin theory (Manni et al., 2004). Coronal cells are fascinating mechanoreceptors that are currently the focus of my investigations, as they represent a possible target of underwater noise pollution. I am coordinating an international European consortium financed by the European Joint Programming Initiative Oceans (JPI Oceans) whose main task is to study the effect of anthropogenic noise on marine organisms. While studying the sensory systems of different ascidians, I also studied the nervous system. In recent years, I have enjoyed studying the weekly brain degeneration in *Botryllus*' zooids, as this process shares many features with human neurodegenerative diseases (Anselmi et al., 2022).

Furthermore, I have studied other tunicate species, including the ascidian *Ciona robusta*. I had also the privilege of leading an international working group for the taxonomic revision of the model ascidian *Ciona intestinalis*. Through this effort, we revealed the existence of two cryptic species (*C. robusta* and *C. intestinalis*) previously hidden under the same name (Brunetti et al., 2015). The revision of this genus was significantly challenging for the tunicate community, raising awareness about the undetected risk of working with different species when collecting wild animals from different seas around the world.

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**FIGURE 1** (a) From left: Chiara Anselmi, Lucia Manni, and Virginia Vanni. Euro Evo Devo Meeting 2022, Naples (Italy), May 31–June 3, 2022. (b) Colony of *Botryllus schlosseri*, composed of four adult individuals. Ventral view. (c) Southern Lagoon of Venice; view of the city of Chioggia. Arrow: Hydrobiological Station “Umberto D’Ancona,” Department of Biology, University of Padua, Italy. (d) Illustration summarizing my main scientific accomplishments and showing my two preferred ascidian models: the colonial *Botryllus schlosseri* and the solitary *Ciona robusta*.

Throughout my career, I enjoyed collaborating with numerous students including bachelor, master, PhD, and post-doctoral students. Among them, I have developed a particularly strong bond with Dr. Chiara Anselmi (Stanford University, USA) and Dr. Virginia Vanni (Oxford Brookes University, UK) both of whom obtained their PhD degree under my supervision and mentorship and continue to contribute to tunicate biology research. I take great pride in having sowed the seeds of tunicate evo-devo research in them.

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#### REFERENCES

- Anselmi, C., Kowarsky, M. A., Gasparini, F., Caicci, F., Ishizuka, K. J., Palmeri, K. J., Ravel, T., Sinhar, R., Neff, N., Quake, S. R., Weissman, I. L., Voskoboynik, A., & Manni, L. (2022). Two distinct evolutionary conserved neural degeneration pathways characterized in a colonial chordate. *Proceedings of the National Academy of Sciences*, 119, e2203032119. <https://doi.org/10.1073/pnas.2203032119>
- Brunetti, R., Gissi, C., Pennati, R., Caicci, F., Gasparini, F., & Manni, L. (2015). Morphological evidence that the molecularly determined *Ciona intestinalis* type A and type B are different species: *Ciona robusta* and *Ciona intestinalis*. *Journal of Zoological Systematics and Evolutionary Research*, 53, 186–193. <https://doi.org/10.1111/jzs.12101>
- Burighel, P., Lane, N. J., Gasparini, F., Tiozzo, S., Zaniolo, G., Candia Carnevali, M. D., & Manni, L. (2003). A novel, secondary sensory cell organ in ascidians: In search of the ancestor of the vertebrate lateral line. *The Journal of Comparative Neurology*, 461, 236–249. <https://doi.org/10.1002/cne.10666>
- Kowarsky, M., Anselmi, C., Hotta, K., Burighel, P., Zaniolo, G., Caicci, F., Rosental, B., Neff, N. F., Ishizuka, K. J., Palmeri, K. J., Okamoto, J., Gordon, T., Weissman, I. L., Quake, S. R., Manni, L., & Voskoboynik, A. (2021). Sexual and asexual development: Two distinct programs producing the same tunicate. *Cell Reports*, 34, 108681. <https://doi.org/10.1016/j.celrep.2020.108681>
- Manni, L., Anselmi, A., Cima, F., Gasparini, F., Voskoboynik, A., Martini, M., Peronato, A., Burighel, P., Zaniolo, G., & Ballarin, L. (2019). Sixty years of experimental studies on the blastogenesis of the colonial tunicate

- Botryllus schlosseri*. *Developmental Biology*, 448, 293–308. <https://doi.org/10.1016/j.ydbio.2018.09.009>
- Manni, L., Gasparini, F., Hotta, K., Ishizuka, K. J., Ricci, L., Tiozzo, S., Voskoboynik, A., & Dauga, D. (2014). Ontology for the asexual development and anatomy of the colonial chordate *Botryllus schlosseri*. *PLoS One*, 9(5), e96434. <https://doi.org/10.1371/journal.pone.0096434>
- Manni, L., Lane, N. J., Joly, J. S., Gasparini, F., Tiozzo, S., Caicci, F., Zaniolo, G., & Burighel, P. (2004). Neurogenic and non neurogenic placodes in ascidians. *Journal of Experimental Zoology (Molecular and Developmental Evolution)*, 392B, 483–504. <https://doi.org/10.1002/jez.b.21013>
- Manni, L., Zaniolo, G., Cima, F., Burighel, P., & Ballarin, L. (2007). *Botryllus schlosseri*: A model ascidian for the study of asexual reproduction. *Developmental Dynamics*, 236, 335–352. <https://doi.org/10.1002/dvdy.21037>
- Rigon, F., Gasparini, F., Shimeld, S., Candiani, S., & Manni, L. (2017). Developmental signature, synaptic connectivity and neurotransmission are conserved between vertebrate hair cells and tunicate coronal cells. *The Journal of Comparative Neurology*, 526, 957–971. <https://doi.org/10.1002/cne.24382>
- Vanni, V., Salonna, M., Gasparini, F., Martini, M., Anselmi, C., Gissi, C., & Manni, L. (2022). Yamanaka factors in the budding tunicate *Botryllus schlosseri* show a shared spatio-temporal expression pattern in chordates. *Frontiers in Cells and Developmental Biology*, 10, 782722. <https://doi.org/10.3389/fcell.2022.782722>

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