Molecular insights into the role of perivitellins in the evolution of terrestrial oviposition in *Pomacea* Perry, 1811 (Gastropoda: Ampullariidae)

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Background

Among New World Ampullariidae, out-of-water egg laying is unique to the *Pomacea* genus[1]. This transition from aquatic to terrestrial oviposition involved major structural and biochemical changes in the egg[1,2]. Perivitellines, the main egg fluid proteins, provide nourishment and antipredation defense. Among these, the MACPF–tachylectin complex, known as perivitellin-2 (PV2) (**Fig. 1**) is a potent neurotoxin exclusive from *P. canaliculata* and *P. maculata*[3,4]. Here, we investigate the PV2 coding sequence (CDS) gene duplication in three endemic Pomacea species (*P. reevei, P. aulanieri, P. nobilis*).

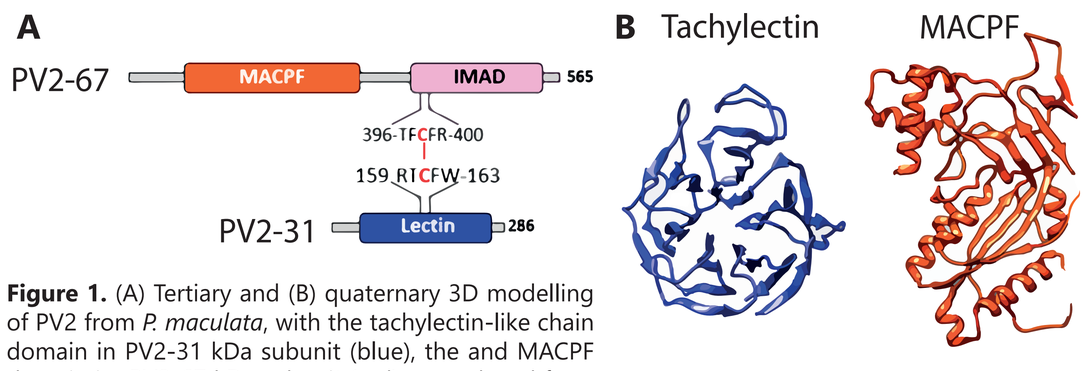
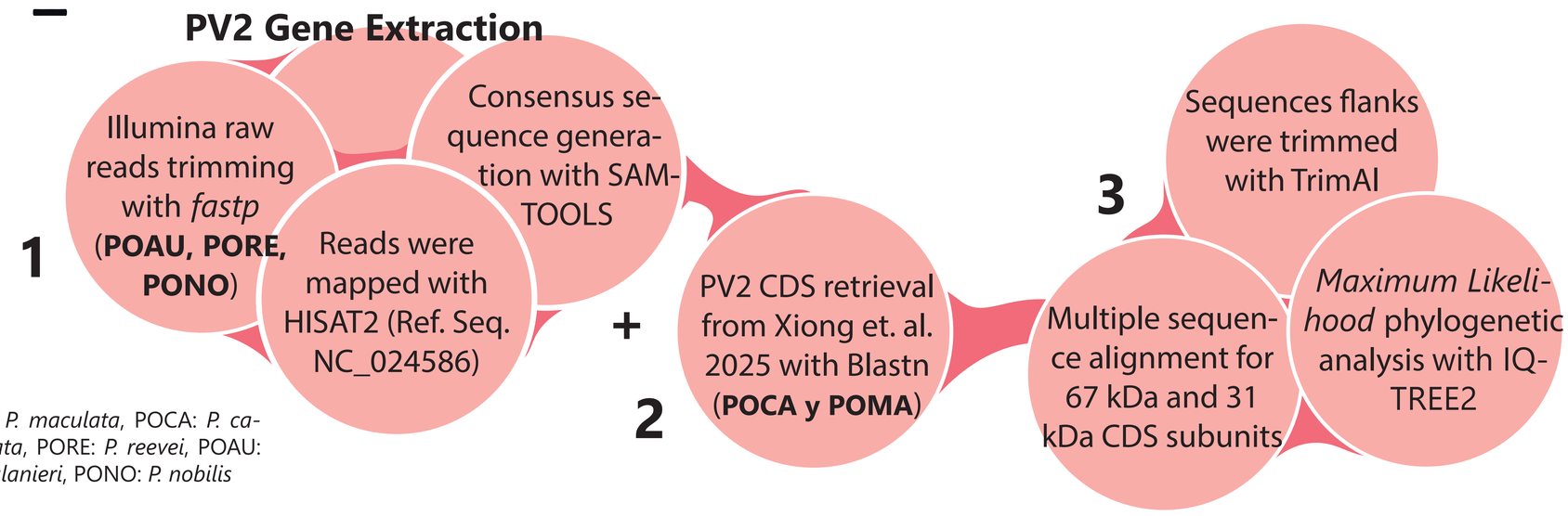


Figure 1. (A) Tertiary and (B) quaternary 3D modelling of PV2 from *P. maculata*, with the tachylectin-like chain domain in PV2-31 kDa subunit (blue), the and MACPF domain in PV2-67 kDa subunit (red), reproduced from Giglio et. al. (2020)[5].

Methodology



POMA: *P. maculata*, POCA: *P. canaliculata*, PORE: *P. reevei*, POAU: *P. aulanieri*, PONO: *P. nobilis*

Results

The PV2-67 kDa and PV2-31 kDa subunits exhibit approximately two and four gene duplications, respectively (**Fig. 2**). Both PV2 domains appear to be present not only in the *P. canaliculata* group but also across other congeners, suggesting that this genomic arrangement is conserved throughout the *Pomacea* genus.

What does this mean?

The presence of multiple PV2 gene copies in *P. reevei, P. aulanieri*, and *P. nobilis* suggest that duplication events within the PV2 complex occurred prior to the divergence of the genus *Pomacea* (**Fig. 3**). These duplications, followed by functional diversification, may have contributed to the ecological success and radiation of *Pomacea* compared to other Ampullariids[1], and could have facilitated resilience and a competitive advantage in invasive contexts[2]. PV2 gene complex duplications may have been subject to selective pressure optimizing defensive, nourishment and developmental functions within this group.

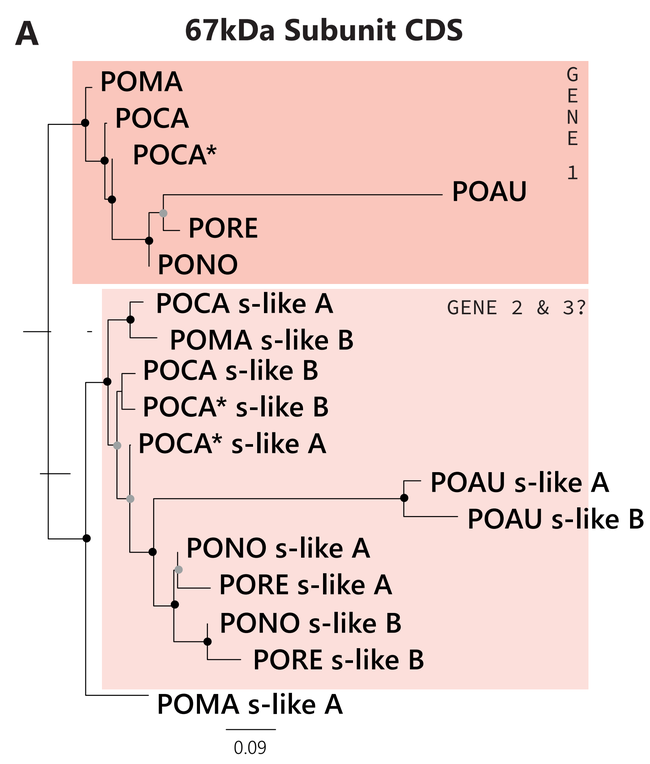


Figure 2. Maximum-likelihood phylogenetic analysis of PV2-67kDa and PV2-31kDa coding sequence (CDS) with the endemic *Pomacea* species included in this study. *Annotated sequences in the POCA reference genome.

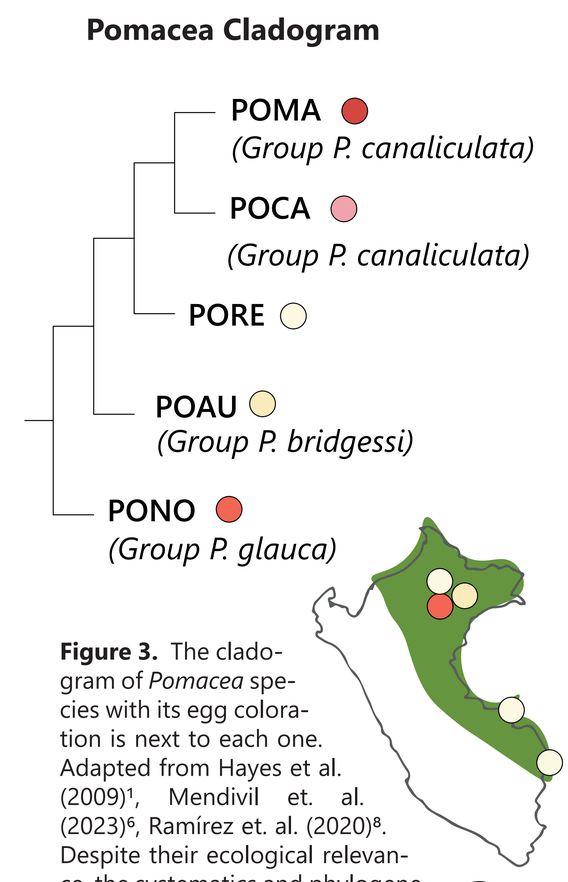
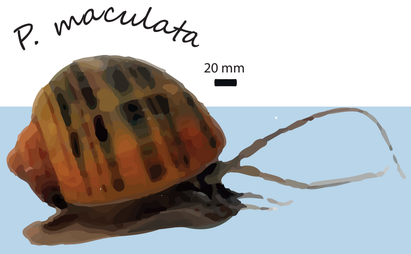


Figure 3. The cladogram of *Pomacea* species with its egg coloration is next to each one. Adapted from Hayes et al. (2009)[1], Mendivil et. al. (2023)[6], Ramírez et. al. (2020)[8]. Despite their ecological relevance, the systematics and phylogenetic relationships within this group is still in debate[1,7]. Collection sites for POAU[7], PORE[9] y PONO[8] are annotated in the map.

What is next?

Detecting positive selection in PV2 gene lineages may reveal adaptive evolution linked to aerial egg-laying via neofunctionalisation or subfunctionalisation.

Studying other proteins related to egg defense mechanisms, such as the calcium-binding protein, would allow us to complement our understanding of the aerial oviposition adaptation.



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