Trilobites in early Cambrian tidal flats and the landward expansion of the Cambrian explosion

John R. Paterson
Earth Sciences, School of Environmental & Rural Science, University of New England, Armidale, NSW 2351, Australia

Mángano et al. (2014) provide important new evidence regarding the role of trilobites in the colonization of intertidal ecosystems during the early Cambrian. However, this uncommon occurrence of trilobite incursions in tidal environments has broader paleoecological and evolutionary implications for this iconic group of fossil arthropods than otherwise realized in that study.

Mángano et al. propose several hypotheses, including reproduction and feeding strategies, to explain the migration of olenellid trilobites into the intertidal zone. They discuss the trilobite ‘nursery hypothesis' with reference to Rusophycus clusters from tidal flat deposits at other Laurentian sites being indicative of egg laying behavior similar to horseshoe crabs, but note that such clusters occur only in subtidal deposits in the Rome Formation, Tennessee, USA. Mángano et al. do not provide morphologic or taphonomic body fossil evidence for reproduction or spawning of trilobites from either the intertidal or subtidal deposits of the Rome Formation, but they should not necessarily dismiss the nursery hypothesis. A study that they may have overlooked on the emuellid trilobite Balcoracania dailyi from the early Cambrian (Stage 4) of South Australia (Paterson et al., 2007) provides compelling evidence, including size frequency data showing a high percentage of juveniles, from the Warragee Member of the Billy Creek Formation to support the interpretation that B. dailyi migrated into the tidal zone to copulate and spawn.

Mángano et al. favor the ‘microbial garden hypothesis’ where the trilobites visited the tidal flats to feed on enriched nutrients resulting from intensive infaunal activity. While plausible, this strategy to periodically exploit a rich food resource would seem particularly risky in that tidal flats represent stressful environments with fluctuating water levels and temperatures, in addition to hypersalinity; this would also seem at odds with the view that olenelloids typically occupy deep subtidal environments (Webster et al., 2008). Modern marine arthropods, such as limulids, that visit such settings to reproduce do so in an attempt to avoid predators in deeper waters, but counteract this risk with a high spathfall at nursery sites (Botton and Loveland, 1989), as has been suggested for the trilobite B. dailyi (Paterson et al., 2007). Limulid forays into the intertidal zone are also seasonal, in contrast to the frequency that would be expected for feeding. This type of hostile environment also explains why B. dailyi occurs in monospecific assemblages, but Mángano et al. do not provide such faunal information from the Rome Formation for comparison.

The ‘nursery hypothesis' is further supported by the presence of Rusophycus in the intertidal facies of the Rome Formation. Although these particular traces do not occur in clusters (as mentioned above), nesting behavior cannot be ruled out, especially with regard to the intergradation of Rusophycus resting traces and continuous Cruziana trails (Mángano et al., their figure 3D). Similar trace assemblages occur in the lower Cambrian (Stage 4) Rouge Mudstone Member of the Marsden Sandstone in South Australia (Fig. 1). Interestingly, this unit also contains monospecific assemblages of Balcoracania dailyi (Gehling et al., 2011, their figure 6F), with partially articulated exoskeletons that are of comparable width to the Cruziana and Rusophycus traces. Although these types of traces could represent foraging (Cruziana) and resting/feeding (Rusophycus) (Seilacher, 2007), they may be a record of nest site searching and excavation. Again, by comparison with modern limulids (Penn and Brockmann, 1994), nest site selection would have been crucial to the survival and development of trilobite eggs.

Irrespective of strategy, the occurrence of phylogenetically and paleoecographically disparate early Cambrian groups, such as the olenelloids and emuellids, within intertidal deposits demonstrates that the Trilobita had adapted to this ecological niche in the earliest phase of their evolutionary history. This not only provides insight into the tempo of the Cambrian ‘explosion' and rapid ecosystem expansion, but highlights the continuing conundrum regarding the cryptic origin of the trilobites.

REFERENCES CITED