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Embryonic, early larval development time, hatching mechanism and interbrood period of the sac-spawning euphausiid *Nyctiphanes simplex* Hansen

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Females of the sac-spawning euphausiid *Nyctiphanes simplex* Hansen were incubated under shipboard laboratory conditions to observe the embryonic and larval development time and hatching mechanism. Females ready to spawn have a pale pink ovary that extends from the back of the stomach to the first abdominal segment, filling most of the haemocoel. This species usually behaves as a total spawner (produces one batch of oöcytes per cycle of the ovary) leaving an 'empty' space in the cephalothorax where the spent ovary is located. After spawning, the young oöcytes mature and turn pale pink. The eggs do not have a measurable perivitelline space (PVS) in any of the embryonic stages (6.6 x magnification). The embryos hatch as nauplius (80–91 h after spawning, 16°C ± 1°C). They further develop into pseudometanauplii (PMN, 90–105 h after spawning) and metanauplii (MN, 92–140 h after spawning) inside the ovigerous sac. The nauplius breaks the thin and fragile chorion by increasing the volume of the body and by using the first and second antennae. We call this an 'expansion' hatching mechanism, the fifth distinct hatching mechanism observed so far among euphausiids. *N. simplex* larvae escape from the ovigerous sac late in the MN stage (5 days after spawning), just a few hours before molting into calyptopis 1 (C1) (0.5–4 h). This delayed molt likely increases the risk of predation independently increasing the time of not return if the calyptopis does not find favorable feeding conditions. Females are not ready to spawn again until at least two days after the previous batch of embryos leaves the ovigerous sac. The interbrood period (IBP) observed ranged between 7 and 15 days at 16–18°C. This IBP is about one-fourth to half than was previously assumed for this species suggesting a significant underestimation of the fecundity of this species. *N. simplex* hatching success usually was 100%, except for a few females with all of their embryos dying during embryonic development. Other females either molted before releasing the embryos, or the oöcytes were spawned unfertilized (0% hatching success), particularly during winter conditions. Efficient hatching and late free-swimming strategy may partially explain why this species is the most abundant neritic euphausiid in the southern part of the California Current System (CCS) and in the Gulf of California.
