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An Overview on Development and life cycles of Crustaceans

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Abstract

In various stages of their life cycles, Crustacea (or Pancrustacea) have almost explored every conceivable environment, including freshwater, marine, terrestrial ecosystems, and even the air (pterygote insects). Numerous taxa of crustaceans have complicated life cycles that often change their habitat, way of life, or both. By emphasising variations in the life cycles and how various stages in a life cycle are suited to their environments, this chapter will study the enormous variety of crab life cycles. Changes in the life cycles of crustaceans may be rather abrupt, as is the case with many decapods and barnacles, which transition from a pelagic larval stage to an adult benthic stage. The feeding and swimming tactics of taxa that stay in the same habitat throughout development, such as holoplanktonic Copepoda, Euphausiacea, and Dendrobranchiata, alter significantly. Many species transition from an early larval naupliar (anterior limbs) feeding/swimming system that primarily relies on cephalic appendages to a juvenile/adult one that nearly entirely depends on more posterior appendages. The chapter is organised around a variety of developmental themes, including anamorphosis, metamorphosis, and epimorphosis, and it mostly focuses on nondecapods. Few crustacean taxa, according to the argument, can be classified as totally anamorphic and none as entirely metamorphic. Many species exhibit both traits, and some even undergo two separate metamorphoses (as in the case of barnacles) or are fundamentally anamorphic yet undergo numerous discrete morphological changes as they mature (e.g., Euphausiacea and Dendrobranchiata). The Crustacea are almost unmatched in the Metazoa for the variety of lifestyles they exhibit, with many species exhibiting notable shifts in habitat (pelagic vs benthic, marine versus terrestrial) or manner of eating. Probably one of the main reasons for the evolutionary success of Crustacea is that they have such complicated life cycles.

Keywords: Euphausiacea and Dendrobranchiata, Crustacea, anamorphosis

1. Introduction

Rarely do crustaceans have the same lifestyle their whole lives and remain in the same general environment (e.g., benthic, planktonic, parasitic). In the life cycle of the majority of crab species, there occurs a transition (or many shifts) in habitat and/or lifestyle. Complex life cycles refer to how an animal's life unfolds as distinct developmental periods with opposing morphological,

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physiological, behavioural, or ecological characteristics. This chapter examines the life cycles of crustaceans with an emphasis on lifestyle changes, such as changes in movement and eating throughout development, and their relationship to environmental changes (e.g., from pelagic to benthic or from free-living to parasitic).

Classical examples of abrupt life cycle changes include the development of a variety of decapods (such as crabs and lobsters), where the transition from a pelagic larval phase to a benthic phase with bottom-associated, typically crawling adults occurs or the irreversible adult settlement of barnacles. The life cycle of river-dwelling amphidromous caridean shrimps, which frequently have upstream hatching, river drift of larvae to the sea, and again upstream larval/juvenile migration (crawling/swimming along banks at night) to the adult habitat, provides additional examples of spectacular changes in environment during development (Bauer 2011, 2013; see Chapter 8 in this volume). Even land crabs and terrestrial hermit crabs must transition from their larval stage in the ocean to their adult stage on land as part of their life cycle The parasitic barnacles (Rhizocephala) and tantulocarids, whose development includes complex changes in lifestyle, such as larval stages that are specialised for settling and adults that are modified to absorb nutrients from primarily crustacean hosts, undoubtedly exhibit the most spectacular changes in morphology and lifestyle over the course of the life span.

Less drastic but nevertheless significant alterations may also occur throughout the life cycles of crustaceans. Taxa that spend almost their whole life cycle in the same habitat might modify their feeding/swimming behaviour often. Many species go from a juvenile/adult system that almost solely relies on more posterior appendages to an early larval naupliar feeding/swimming system employing just cephalic appendages. Examples include giant branchiopods like fairy shrimps (Anostraca) and tadpole shrimps (Notostraca), whose young larvae primarily employ naupliar appendages for both eating and movement before both tasks are completely transferred to more posterior appendages as the larvae mature. Other taxa, like the harpacticoid copepods, mystacocarids, and interstitial/benthic cephalocarids, begin with a naupliar feeding and locomotory system that is primarily maintained throughout development, also in adults, but

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supplemented by a posterior system, resulting in the two systems operating concurrently from late larvae into the adult.

Reproduction and Life cycles of Crustaceans

In crustaceans, the sexes are typically, but not always, separated. Simultaneous hermaphroditism is a trait shared by the majority of individual barnacles, and in certain groups, the males are substantially smaller than the hermaphrodites when they do appear. These "dwarf" guys cling to the bigger individuals' mantle cavities and fertilise their eggs there. Some members of the Notostraca order (tadpole shrimps) are hermaphrodites as well; amid the developing eggs in their ovaries are sperm-producing lobes. Some shrimp species often experience a change in sex during their lives. For instance, some individuals in Pandalus montagui, a member of the Decapoda order, start off as males but eventually develop into functional females after around 13 months. Rhyscotoides isopods exhibit a similar transition from male to female as they age.

There are many and sometimes drastic structural or behavioural variations between the sexes in the Crustacea; the males of certain groups may be so minuscule that they are hard to locate on the much bigger female. Particularly in certain of the parasitic copepods, this is true. In the female genital canal of Gonophysema gullmarensis, the male is located in a tiny pouch. However, the males are often bigger than the females and can have considerably larger pincers in many of the more sophisticated decapods, including crabs and lobsters. The male having clasping organs, which are used to grasp the female during mating, is another example of sexual dimorphism. You may find almost any appendage adapted for this use. Male appendages may be changed to help transport sperm to the female directly. The sperm are often contained in a container, or spermatophore. Male decapods' first and second abdominal appendages as well as the highly modified fifth legs of male copepods of the order Calanoida are both employed to transmit spermatophores. These copepods can precisely position spermatophores close to the female duct openings. The sperm that will shortly fertilise the eggs are forced out of the spermatophores by a swelling of specific sperm. Some crustaceans are parthenogenetic, which means that they generate eggs that develop without being fertilized by a sperm. This differs from normal sexual

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reproduction, which includes the union of a sperm with an egg. Many branchiopods, certain ostracods, and some isopods are capable of doing this.

On "Metamorphosis" Within Crustacea

Only small subsets of crustaceans, like anostracans, undergo strictly anamorphic, or progressive, growth. Instead, development may be described as mostly anamorphic in many species, such as thecostracans, branchiurans, and malacostracans, but interrupted by moults between two instars that include considerable morphological or behavioural alterations. The word "metamorphosis" is often used to describe these sudden alterations. The transition from a naupliar phase to the cyprid (a settling stage) in most cirripedes and the distinctive shift from a zoeal phase to the decapodid (e.g., megalopa in Brachyura), a transitional stage between the planktonic and benthic phase of the life cycle, are two well-known examples of crustaceans that undergo metamorphic changes during their development.

We will examine the balance between anamorphic and metamorphic growth in a variety of crustacean specimens. In certain species, the potential adaptive relevance of metamorphosis will also be assessed. But first, it's important to analyse what the term "metamorphosis" truly means. A "profound change in morphology (usually accompanied by behavioural and functional changes over the life cycle of an organism)," as defined generally by Martin et al. (2014b). This definition correctly avoids addressing the crucial issue of how significant a morphological change has to be in order to be classified as a metamorphosis. Additionally, it ignores an issue related to the moulting behaviour of arthropods that is unique to them. Particularly, the development of the internal anatomical structure may be more slow than that of the cuticle on the outside (e.g., when internal changes begin well ahead of an eventual metamorphic moult and continue afterward).

Here, it is advised that the term "metamorphosis" be used largely based on alterations in the exterior cuticle for practical reasons. Cuticular information may be found in the literature for a wide variety of crustaceans and is easier to find than information on internal anatomy. Furthermore, it is proposed that a "metamorphosis" requires a "profound change in morphology" that involves a sudden change from one stage to another (or within a few stages) about which

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appendages are especially used for eating or movement. Other smaller changes, such as those that only involve the addition of new somites, appendages, or other body parts between two moults or the acceleration or delaying of the development of some morphological traits but not others (heterochrony), but do not involve significant changes in feeding or locomotion, can be referred to as "developmental jumps" if they occur frequently over a short period of time."

Conclusion

This chapter has examined the variety of crustacean (mostly nondecapod) life cycles with an emphasis on modifications to the life cycles and how various stages in a life cycle are adapted to their environments. The Crustacea exhibit among the Metazoa an almost unparalleled variety of lifestyles throughout their life cycle. For instance, several crab species significantly alter their method of movement and feeding strategy throughout growth, which is often accompanied by substantial environmental changes (e.g., from pelagic to benthic or from free-living to parasitic). However, even taxa that remain mostly in the same habitat and evolve gradually (anamorphic), such as those that live freely in the sea or between sand grains, often undergo considerable changes in their feeding method and mode of mobility.

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