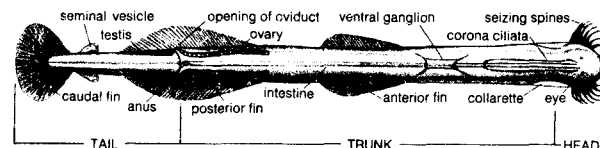


open out to the exterior, to the seminal receptacle (tube along the female gonads) of another individual. The eggs are fertilized by the sperm either shortly before or as they are laid, in a part of the duct common to the oviduct and to the seminal receptacle. In several genera (e.g., *Eukrohnia*, and probably also in the genera *Bathyspadella*, *Krohnitta*, and *Heterokrohnia*), mature eggs and larvae are enclosed in a sac formed at the opening of oviducts. In *Pterysagitta*, eggs are laid in a capsule; in *Sagitta*, eggs are discharged into the surrounding water one at a time in several cycles; and in *Spadella*, eggs have an adhesive coat and a stalk and attach to any surface.

Ecology. Chaetognaths are voracious feeders; they consume copepods, euphausiids, fish larvae, medusae, other chaetognaths, cladocerans, amphipods, appendicularias, and eggs and larvae of various animals. Chaetognaths inhabit oceans, seas, and coastal lagoons. Although some species are cosmopolitan, others are restricted to a geographical region or an ocean. Southeast Asia seas have the largest number of species. Epipelagic species—i.e., those within 200 metres of the water surface—increase in numbers from the poles to the Equator. Mature chaetognaths inhabit deeper oceanic layers than do the young.

Few chaetognaths have parasites; those that do are more often parasitized in neritic (close to shore) waters than in the open ocean.

Form and function. The body of a Chaetognatha is covered by a cuticle of cells (called collarete when thickened). The head has hooks (curved, grasping spines) covered by a hood or thin fold of skin, which retracts when the arrowworm is catching prey. Head muscles control the movement of hooks, teeth, and mouth; body muscles are longitudinal with some transverse bands. Chaetognaths swim with dartlike movements by contracting the longitudinal muscles and flapping the tail.



Body plan of arrowworm (*Sagitta bipunctata*).

The nervous system consists of a large cerebral ganglion with sensory nerves (e.g., optic, coronal). The cerebral ganglion is connected with the ventral ganglion by a pair of nerve cords. Additional ganglia and nerves spread along the body. Touch receptors, small, round, ciliated (hairlike) prominences, are scattered over the body.

There is evidence that regeneration of the head and the anterior part of the body occurs; during regeneration, the eyes appear first, then the mouth and hooks. The eyes contain a pigmented central cell, which encloses five clusters of photoreceptor cell processes (or ocelli). A conical body found in the photoreceptor cell either may guide the animal as it swims or act as a resonator. The pigmented central cell may have various shapes (e.g., starlike) in different species. No pigment is present in most deep-sea dwelling species.

The corona ciliata is an olfactory (smell) receptor or chemoreceptor peculiar to the Chaetognatha and is formed by a series of rows of ciliated cells forming a ring or elongated oval at the neck or extending toward the head and the trunk. The digestive tract, which is lined by glandular and absorptive cells, extends from the mouth to the anus and is supported by a mesentery. The central mesentery divides the trunk and tail into two cavities. Trunk and tail regions are filled with a colourless fluid that circulates forward along the body walls and backward in the medial region of the body. Two ovaries, filled with rows of unfertilized eggs, extend along the trunk and are attached to the sides of the body by a mesentery. The seminal receptacle in the oviducts stores sperm after copulation. The testes are located in the tail cavities; a spermduct, or vas deferens, connects the testes with the

The
corona
ciliata

Chaetognatha

Size and
distribution

The phylum Chaetognatha comprises a group of small wormlike marine animals with transparent to translucent or opaque arrowshaped bodies, hence their common name arrowworms. The phylum consists of about seven extant genera and one fossil genus. There are more than 50 species, most of which are in the genus *Sagitta*. The size of the Chaetognatha ranges from about three millimetres to more than 100 millimetres; species inhabiting colder waters generally are larger than those from tropical seas. Chaetognatha are hermaphroditic (having both male and female sex organs, or gonads). The body is divided into head, trunk, and tail by two transverse walls or membranes and has lateral fins and a tail fin. Respiratory, circulatory, and excretory systems are not properly developed.

Natural history. *Life cycle.* Chaetognaths are protandric (i.e., male gonads mature earlier than female gonads). Most chaetognaths die after spawning, although some undergo cycles of maturity and often also growth. Cross-fertilization has been observed, the sperm passing from the storage organs called seminal vesicles, which

seminal vesicles, which open out from the body. The ovaries in the trunk, therefore, are isolated from the testes in the tail, with no internal communication between male and female gonads. The seminal vesicles burst when filled with sperm, ejecting the spermatozoa into the surrounding waters or into the seminal receptacle of another individual.

Relationships and classification. The Chaetognatha is an isolated phylum in the animal kingdom; i.e., comparative anatomy and embryology fail to link these animals with any other group. Chaetognaths have been considered as worms, and attempts have been made to relate them to many animal groups (e.g., Heteropoda, Annelida, Nematoda, Arthropoda). They also have been placed taxonomically between Annelida and Nematoda. Structure of the chaetognath eye, however, indicates a probable evolutionary relationship to echinoderms and chordates.

The highest taxonomic rank in the phylum Chaetognatha is the genus. Genera are distinguished by the number, position, and extension of lateral fins and by the teeth. The presence of two pairs of lateral fins separates *Sagitta* from the other genera. Species within each genus are identified by minor differences (e.g., shape and position of anatomical structures). There are at least six other genera of chaetognaths: *Spadella*, *Eukrohnia*, *Krohnitta*, *Heterokrohnia*, *Bathyspadella*, and *Pterosagitta*. A mid-Cambrian fossil species *Amiskwia sagittiformis* is also known.

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