Summary Article: Kinorhyncha
From Encyclopedia of Life Sciences

Abstract
The kinorhynchs (mud dragons) are a small phylum of microscopic, free-living, segmented acoelomate or pseudocoelomate invertebrates belonging exclusively to the marine meiofauna. Some 150 species have been described from polar to tropical environments. The kinorhynchs have their phylum, but they are related to the phyla Loricifera and Priapulida. Cambrian microfossils may belong to the stemgroup of both Kinorhyncha and Priapulida.

keywords
Aschelminthes
Cambrian microfossils
ecdysozoa
meiofauna
muddy sediments
18S rRNA genes

Introduction
Kinorhyncha constitutes a small phylum of microscopic, free-living, segmented acoelomate or pseudocoelomate invertebrates. About 150 species have been described worldwide from polar regions to tropical waters. All kinorhynchs belong to the marine meiofauna. Generally the length is much less than 1 mm and the animals can only be collected by a sieve-system with mesh size smaller than 0.1 mm, but a few Arctic species reach the size of 1 mm and are found in the 0.5 mm fraction of sieved macrofauna. In finer sediments such as silt or mud, the kinorhynchs belong to the micro-infauna (endobenthic), where they are concentrated in the upper few centimetres of the sediment. In coarse sediments such as sand or shell gravel, the species are interstitial (mesobenthic) and they may be found as deep as 1 m in high-energy beaches. Kinorhynchs are found from the intertidal zone to abyssal depths, but until now they are not recorded from the hadal zone in the deep sea. Several species are found in association with other invertebrates such as bivalve molluscs, bryozoans and sponges, or in association with coralline red algae or the holdfasts of kelps.

Basic Design
All adult kinorhynchs consist of 13 segments also called zonites (Figure 1(a) and (b)). The segments may be indistinct in juveniles or some of the 'neotenic' species, or strongly sclerotized as in Pycnophyes, but the body wall always has a true cuticle with chitin in the procuticle. Kinorhynchs lack free cilia in the epidermis, but all sensory structures contain modified cilia. The first segment forms an eversible head (introvert) with up to seven rows of recurved spines (scalids), and a terminal mouth cone with nine anteriorly directed oral styles. The second segment (neck) forms a closing apparatus that usually consists of a series of plates that close over the introvert when it is withdrawn into the trunk. The
trunk itself is divided into 11 segments and these are divided longitudinally into plates. Locomotion takes place by eversion of the introvert using the trunk muscles. The musculature consists of longitudinal, diagonal and dorsoventral bundles of true cross-striated fibres attaching to the cuticle via an epidermal cell. Circular muscles are present in the mouth cone, the introvert and the neck. The muscular pharynx consists of both mesodermal muscle fibres and epidermal cells covered with cuticle. The 10-lobed brain is separated into a ganglionated forebrain and hindbrain, and a glial midbrain, and it surrounds the pharyngeal bulb. The trunk nervous system is orthogonal and has two midventral nerve cords that are very large and are associated with segmental double ganglia. The reproductive system is nonsegmented and consists of dorsolateral gonads (Figure 1a, ov). The gonopores open between segments 12 and 13. The digestive system is a straight tube that is regionally differentiated into a cuticular foregut, a midgut with dense microvilli and a hindgut in the form of a cuticle-lined rectum opening at segment 13. The excretory system consists of a single pair of protonephridia with terminal cells located in segment 10. Each terminal cell always bears two cilia. Kinorhynchs lack circulatory or respiratory structures, and therefore the nature of the body cavity is difficult to assess. In the smaller species of Cyclorhagida the body cavity is lacking or totally reduced, and these species could be called secondarily acoelomate. See also: Chitin

Morphology of the Arctic kinorhynch Echinoderes aquilonius. (a) Ventral view of a female. Note that the head and the mouth cone are fully extruded. (b) Dorsal view of a female. Note that the head is retracted and the neck (pl) forms a closing apparatus. Abbreviations: ag, adhesive gland; as, lateral terminal accessory spine; br, brain; D-10, dorsal spine; dg, dorsal gland; gp, pore of mucous gland; go, gonopore; gu, midgut; L-11, lateral spine; Lt, lateral terminal spine; mg, mucous gland; Nc, nephridiopore; os, oral style; ov, ovariun; ph, pharyngeal bulb; pl, placid of the neck; pr, protonephridium; re, rectum; si, sieve plate; sr, seminal receptacle; S-3 to S-13, trunk segments; ss, spinoscalid; ts, trichoscalids. (Modified from Kristensen and Hay-Schmidt, 1989; drawn by Beth Beyerholm.)

Diversity and Life Styles
The phylum is divided into two orders, Cyclorhagida and Homalorhagida, based on the shape of trunk plates, the neck, and the number and location of adhesive tubes and trunk spines. There are three
suborders (six families and ten genera) of cyclorhagids, and a single order (two families and four genera) of homalorhagids (Figure 2).

A few kinorhynchs have been reported as feeding on diatoms, because these algae have been found in the midgut. However, usually the kinorhynchs obtain organic material from the muddy sediments through which they burrow, as deposit feeders. Most evidence indicates that kinorhynchs are exclusive bacteria feeders, and they may be gardening the mud for bacteria with mucus from large glands located posteriorly on the body (Figure 1a, mg). In feeding, the introvert and the mouth cone are extruded fully and the nine oral styles spread and thrust into the food material. The food material is then ingested by a sucking action of the pharyngeal bulb. Zooxanthellae have been recorded in the epidermis, but these findings have not been confirmed by electron microscopy.

All species are dioecious and the two sexes may be distinguishable externally by secondary sexual dimorphism in spines (females of *Echinoderes*) or in adhesive tubes (males of *Pycnophyes* and *Kinorhynchus*). In the latter two genera, spermatophores are deposited at the terminal gonopores of the female. Fertilization is assumed to be internal as seminal receptacles have been found in all adult kinorhynch females. Nothing is known about the embryology of kinorhynchs, as only one instance of oviposition has been recorded. A juvenile with 11 of the 13 segments seen in adults hatches soon after oviposition. The juvenile grows by molting; the entire cuticle is shed including the lining of the pharyngeal apparatus and the rectum. Six different morphological juvenile stages exist, culminating in the adult, which does not molt again.

**Phylogeny and Fossil History**

Early investigators suggested the gastrotrichs as the closest relatives to the kinorhynchs and placed these taxa within the Aschelminthes. Today many scientists consider Aschelminthes as a polyphyletic taxon. Kinorhynchs may have affinities with other introvert groups such as nematomorphs, loricifera
and priapulids, but the outer segmentation of the trunk (always 13 segments) of the kinorhynchs is also seen in the serial repetition of ventral double ganglia. Segmentation, epidermal glands and cross-striated muscles are otherwise only seen in ‘Panarthropoda’ (Tardigrada, Onychophora and Arthropoda). No such segmentation is found in the trunk of Priapulida, Loricifera, or other Aschelminthes. The traditional hypothesis is that a close relationship exists between Arthropoda and Annelida. On the basis of the analysis of 18S rRNA genes, some molecular biologists have challenged this interpretation and instead propose a close relationship between all moulting animals (Nematoda, Nematomorpha, Priapulida, Kinorhyncha, Loricifera, Tardigrada, Onychophora and Arthropoda), giving a monophyletic taxon ‘Ecdysozoa’. See also: Arthropoda (Arthropods); Annelida (Segmented Worms) Nematoda (Roundworms); Nematomorpha (Horsehair Worms); Priapulida; Kinorhyncha; Loricifera; Tardigrada; Onychophora (Velvet Worms); Molecular Phylogeny Reconstruction

Until now there has been no fossil evidence of Kinorhyncha or other meiobenthic taxa of the so-called aschelminths in the Burgess Shale deposits from the Cambrian, where elsewhere the macrobenthic aschelminths were one of the most abundant animal groups. However three-dimensional preservation of microfossils is well known from anthraconitic limestone. This ‘Orsten’ fauna was first described from the Upper Cambrian Alum Shale of Sweden. New 'Orsten'-type phosphatized microfossils have recently been found worldwide. Few of these excellent preserved Cambrian microfossils are the loricated larvae of priapulids or the extinct palaeoscolecid worms, but some of the microfossils belong to the stemgroup of both Kinorhyncha and Priapulida. See also: Burgess Shale; Fossil Record; Fossils in Phylogeny Reconstruction

Further Reading

- Nebelsick, M (1993) Introvert, mouth cone, and nervous system of Echinoderes capitatus

https://search.credoreference.com/content/topic/kinorhyncha
(Kinorhyncha, Cyclorhagida) and implications for the phylogenetic relationships of the Kinorhyncha.
Zoomorphology 113: 211-232.

- Neuhaus, B (1994) Ultrastructure of alimentary canal and body cavity, ground pattern, and
phylogenetic relationships of the Kinorhyncha. Microfauna Marina 9: 61-156.
- Walossek, D and Müller, KJ (1997) Cambrian "Orsten"-type arthropods and the phylogeny of
Association Special Volume Series, vol. 55.

Glossary

Aschelminthes
A polyphyletic group of animal phyla with acoelomate or pseudocoelomate body cavity, e.g.
nematodes, gastrotrichs, rotiferans, acanthocephalans, kinorhynchs and other minor groups.

Hadal zone
The deepest zone in the deep sea (below 6000 m water depth) (Gr. hades, invisible or the world of
the spirits).

Introvert
The head of loriciferans, kinohynchs and priapulids (Lat. intro, within and verto, to turn), meaning the
head is turning inward.

Meiofauna
Multicellular animals smaller than 500 mm living permanently in bottom sediments.

Protonephridia
Excretory organs in lower invertebrates.

Scalids
Locomotory or sensory appendages on the head of Loricifera, Kinorhyncha and Priapulida.

Zonites
Special term of segments of kinorhynchs, indicating that the thirteen segments in kinorhynchs is not
homologous with segments in athropods.

Reinhardt MØbjerg Kristensen
University of Copenhagen
Copenhagen, Denmark

APA
from https://search.credoreference.com/content/topic/kinorhyncha

Chicago
from https://search.credoreference.com/content/topic/kinorhyncha

Harvard
from https://search.credoreference.com/content/topic/kinorhyncha

MLA
from https://search.credoreference.com/content/topic/kinorhyncha

https://search.credoreference.com/content/topic/kinorhyncha