Common Terrestrial & Freshwater Worms in the Los Angeles Region

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LOS ANGELES COUNTY

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Introduction

Southern California is host to intriguing and ecologically diverse groups of non-arthropod worms. While the thought of worms often conjures images of familiar earthworms or leeches, other types of worms are so out of the ordinary as to illicit curiosity or concern. Indeed, the very word 'worms' too often carries with it reputations that are not deserving of these fascinating creatures. In this brief overview, we'll take a look at five groups of terrestrial and freshwater worms you might encounter in the Los Angeles area: land planaria, horsehair worms, earthworms, aquatic leeches, and crayfish (branchiobdellid) worms.

I. Land Planaria

Among the terrestrial worms you are likely to find in Los Angeles urban habitats, one of the strangest is the land planarian, *Bipalium kewense* (Figure 1). Planaria are flatworms. Flatworms are members of the phylum Platyhelminthes (from the Greek *platy*, 'flat,' and *helminth*, 'worm'), which includes planaria (class Turbellaria), flukes (class Trematoda), and tapeworms (class Cestoda). While all species of planaria are free living, flukes and tapeworms are parasitic. Flatworms have a solid body construction, meaning that there is no internal body cavity other than the gut. This contrasts with other notable types of worms: round worms (phylum Nematoda), horsehair worms (phylum Nematomorpha), and segmented worms (phylum Annelida) – all of which receive internal support from the presence of body cavities called the pseudocoel or coelom.

Figure 1. Hammerhead worm, *Bipalium kewense*

Occurrence

While the natural habitat of *Bipalium kewense* extends from Vietnam to Malaysia, individuals have been dispersed around the world and thrive in `mild climates with adequate moisture. Indeed, the species was originally described from a greenhouse at Kew Botanical Gardens near London, England, in 1878. In the US, *B. kewense* have been found in Florida, Louisiana, Georgia, Texas, North and South Carolina, and Southern California, and reported in greenhouses in some more northern states. The wide dispersal of this species has likely been due to the transport of tropical plants and associated potting soil.

Reproduction

***Bipalium kewense* mainly reproduces asexually, by fragmentation of the body (Figure 2). New individuals readily regenerate from these fragments. This type of reproduction has facilitated the establishment of *B. kewense* in introduced regions.**

Figure 2. Asexual reproduction of a land planarian by fragmentation

Feeding

Land planaria are active predators, feeding on earthworms (Fig. 3), small arthropods, and even other planaria. Unfortunately, as introduced species, they usually have no enemies to control populations. For instance some introduced flatworm species in England and Ireland have had drastic consequences, where they have decimated native earthworm populations. The potential for similar problems have been reported for *B. kewense* in the US, where they are regarded as a nuisance in earthworm farms.

Figure 3. Planarian feeding on an earthworm

Learn More about Bipalium kewense

http://entnemdept.ufl.edu/creatures/misc/land_planarians.ht

http://aggie-horticulture.tamu.edu/galveston/beneficials/beneficial-57(partial)_land_planarian.htm

http://www.backyardnature.net/n/a/planaria.htm

http://www.redwormcomposting.com/reader-photos/predatory flatworm-bipalium-kewense/`

II. Horsehair Worms

Horsehair worms (Figure 4), also known as Gordian worms or nematomorphs (from the Greek *nematos*, 'thread,' and *morphe*, 'form'), comprise a group (phylum Nematomorpha) that are similar in appearance to round worms (phylum Nematoda). Both nematomorphs and nematodes differ from the flatworms (Platyhelminthes) and segmented worms (Annelida) in that they have a unique form of body cavity, sometimes referred to as a pseudocoel, and stiff, external cuticle. Flatworms have a solid body construction (except for the digestive system), and segmented worms have a body cavity called a coelom that surrounds the organs.

Figure 4. Adult horsehair worm

The common name, horsehair worm, originated when the concept of spontaneous generation was believed to be a viable explanation, up into the 19th century. It was thought that when a long hair of a horse fell into a watering trough that it would transform into a worm. The phrase, Gordian worm, comes from the ability of horsehair worms to tie themselves into a knot, thus somewhat reminiscent of the legend of Alexander the Great and the Gordian knot.

Horsehair worms are unusual because the adults are aquatic (most species are freshwater, a few marine), free living, and completely non-feeding. Larvae and juveniles, however, are parasitic in arthropods. Adult horsehair worms can range from several inches to almost six feet in length, but are no more than one-tenth of an inch wide. Hence the common name of the group. Adults are free living, but non-feeding, as the gut is degenerate. Their principle activity as adults is reproduction.

Occurrence

Over 350 species of freshwater horsehair worms are known worldwide, but only about 11 species are known from the US. Adults can be found in natural bodies of water (Figure 5), such as streams, rivers, and lakes, but have been reported in swimming pools. There is no indication that species in California have been introduced due to human activity.

Figure 5. Adult horsehair worm in stream

Reproduction

Horsehair worms have a remarkable life cycle (Figure 6). Upon mating, females produce millions of eggs that hatch into microscopic larvae. Larvae must then be swallowed by aquatic insect larvae, such as those of some flies. Once inside this host, the larval worm encysts itself. With the metamorphosis of insect larvae to the terrestrial adult form, the horsehair worm cysts are thus available to be eaten by the final host, which most often are crickets, but also include grasshoppers, roaches, beetles, and praying mantises. When the terrestrial insect host eats a cyst, the larval worm penetrates the host's gut and enters the body cavity, where it grows into an adult worm. Larval horsehair worms live in insect hosts for 4 to 20 weeks. The presence of the adult worms then causes the altering of the host's behavior, causing it to go into water. The worms then quickly break out of the body of the host and swim away to continue life as a free-living adult (Figure 7).

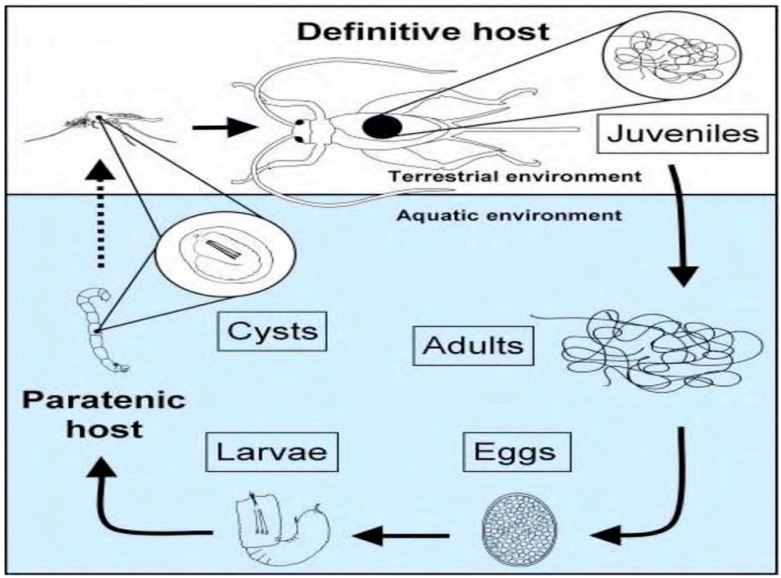

Figure 6. Life cycle of freshwater horsehair worms

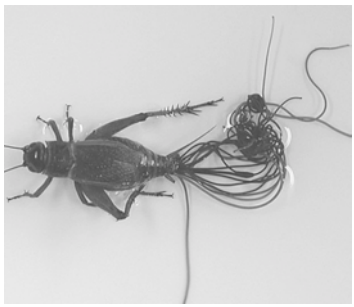

Figure 7. Horsehair worms breaking out of cricket host, ready to continue life in freshwater as free-living adults

Learn More about Horsehair Worms

Poinar, Jr., G.O. 2010. Chapter 19. Nematoda and Nematomorpha. In: Thorp, J.H. & Covich, A.P. (eds) *Ecology and Classification of North American Freshwater Invertebrates*, pp. 237–276. Academic Press, Boston.

http://www.nematomorpha.net/GeneralInformation.html

http://entnemdept.ufl.edu/creatures/misc/horsehair_worms.htm

http://faculty.uml.edu/rhochberg/hochberglab/Courses/Parasite/PDF%20Papers/Nematomorphs/Nematomorphs%20and%20praying%20natids.pdf

III. Segmented Worms

When most people think of 'worms,' the group best known is the segmented worms. The segmented worms comprise the phylum Annelida (Figure 8). The term Annelida comes from the Latin word, *annellus*, 'a little ring,' which refers to the segments that comprise most of the body. The segmented body plan differs from the non-segmented bodies seen among flatworms (phylum Platyhelminthes; see above), round worms (phylum Nematoda), and horsehair worms (see above).

The Annelida includes two classes: Polychaeta, with over 10,000 species of predominantly marine segmented worms, and Clitellata, with about 8000 species. The word Polychaeta is derived from two Greek words, *polys*, 'many,' and *chaite*, 'long hair,' referring to the distinct bundles of bristles or chaetae emerging from the lateral margins of segments. The term Clitellata comes from the Latin *clitella*, 'a pack saddle,' referring to the clitellum (Figure 9), a discrete glandular swelling or region of the epidermis that secretes a cocoon into which the eggs are deposited. Chaetae are also present among earthworms and acanthobdellids, but absent in leeches and crayfish worms.

The Clitellata contains two groups of worms familiar to many: the earthworms (subclass Oligochaeta) and leeches (subclass Hirudinida), as well as two enigmatic groups related to leeches – the crayfish worms (subclass Branchiobdellida) and acanthobdellids (subclass Acanthobdellida). All clitellates are hermaphrodites, meaning each individual has both female and male reproductive organs. Like earthworms, leeches occur in terrestrial, freshwater, and marine habitats. While the diet of earthworms is the sediment in which they live, leeches range from being predatory to parasitic depending on the species. Branchiobdellids and acanthobdellids are freshwater; branchiobdellids being ectocommensals on crayfish, and acanthobdellids ectoparasites of salmonid fishes. In addition to considering earthworms in this section, we will look at leeches and branchiobdellids in subsequent sections, as these are worms you might also encounter in the Los Angeles area.

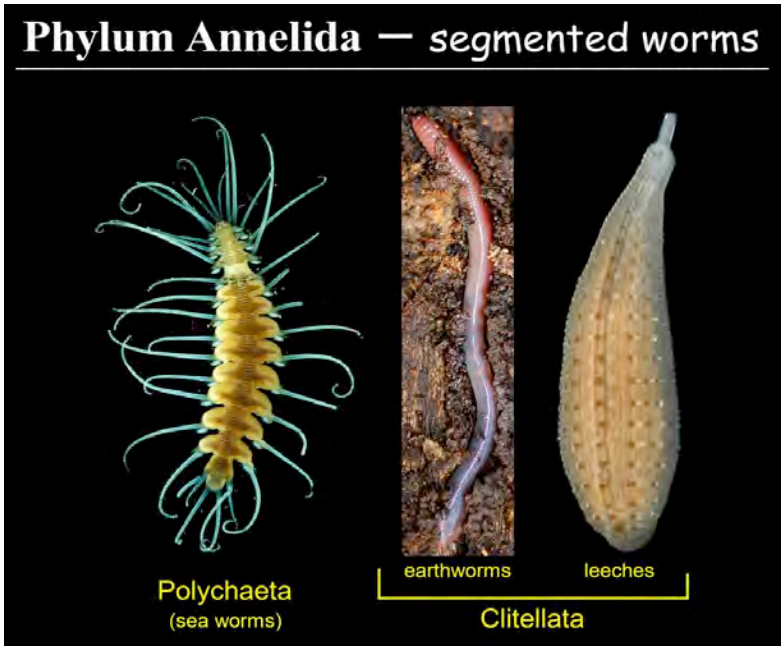

Figure 8. Evolutionary relationships among the major groups of Annelida. Two groups of clitellates, Acanthobdellidae and Branchiobdellidae, are not shown.

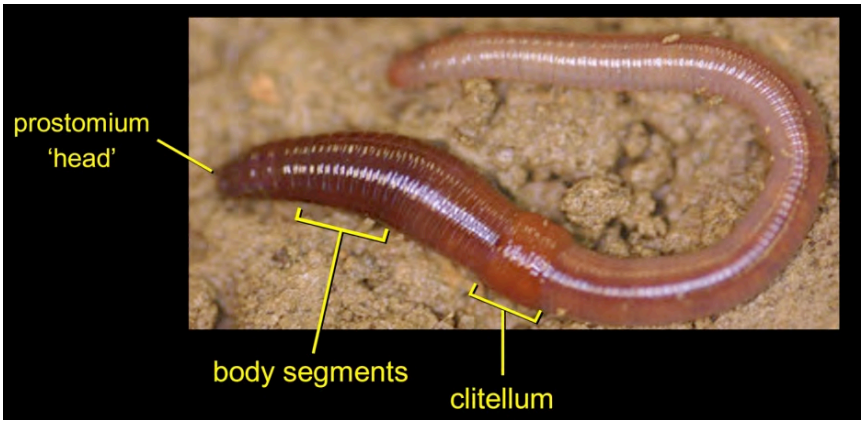

Figure 9. Basic earthworm anatomy

IIIa. Earthworms

If you have ever dug in dirt, worked in your garden, or visited a bait shop, you have encountered earthworms. But among the over 3500 earthworm species, not all are terrestrial; there are numerous freshwater and marine representatives.

Identifying earthworm species is not an easy task. There are few external features readily visible without magnification, and proper identification often requires examination of internal anatomical structures. But some basic characters can sometimes be useful, such as body length of mature worms (i.e. those with a clitellum), number of segments, body shape, color, and distance between the head and start of the clitellum.

Occurrence

Ecologically, terrestrial earthworms are important for altering the physical and chemical properties of soils, such as increasing soil fertility or porosity, nutrient transformation, plant nutrient uptake, and plant litter decomposition. This importance derives from the fact that, depending on the species, earthworms occupy burrows (Figure 10) that are (1) very shallow, just below the surface (e.g. leaf litter), (2) extending deeper into the topsoil, or (3) very deep, into the subsoil. Depending on the species, body lengths of mature individuals can range from less than one-quarter inch to over 10 feet. Because members of different species occupy different burrow depths and have very specific soil, temperature, and moisture requirements, they are very sensitive to environmental alterations.

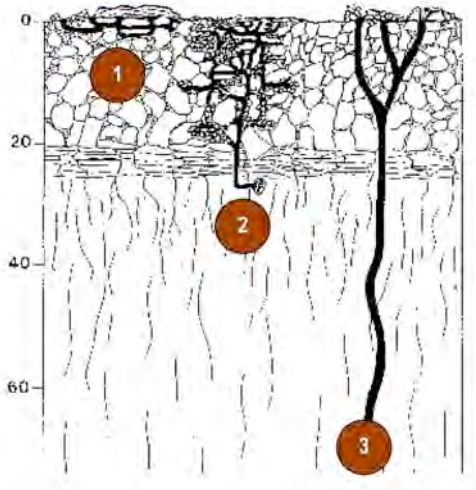

Figure 10. Basic habitat requirements of earthworms. Depending on the species, earthworms have distinct depth preferences: (1) soil surface dwelling or compost; (2) topsoil; (3) subsoil.

Distribution in North America

A popular view is that earthworms were introduced to North America by European settlers. On the contrary, there are about 100 native earthworm species in the US. About 70 species are found in the eastern half of the US and 28 species along the Pacific coast. Except for the extreme Pacific Northwest, no native earthworms occur in Canada, and the same holds for Alaska (Figure 11). This restricted northern distribution is a consequence of the last Ice Age, where massive ice sheets covered the northern half of the continent, effectively eliminating the earthworm fauna from those regions. Notice that the northernmost distribution of North American earthworms closely follows the glacial margin. The limited presence of earthworms north of this margin is indicative of the slow process of colonization that has occurred during the past 10,000 years. Only a small number of native earthworm species have been reported from southern California, principally from coastal areas in association with habitats along rivers.

Figure 11. Combined distributions of the approximately 100 native North American earthworm species (green) in relation to the southernmost margin of glaciers during the last Ice Age (red line).

Impacts from Introduced Earthworm Species

At least 45 earthworm species have been introduced to North America, from such regions as Europe (25 species), Africa (3 species), Asia (14 species), and South America (5 species). Such introductions over the past several centuries have largely been unintentional, by way of the transport of plants and soil as consequences of human migrations and commercial activities. But intentional importations of earthworms have become common due to the fish bait industry and use of earthworms for composting.

The most notable effects of introduced earthworms in North America have been on soil dynamics in regions where earthworms do not naturally occur, especially north of the last Ice Age margin (Figure 11). With alterations of soils can come changes in native plant composition. Even in southern California, significant effects on soils and plant communities have been documented from the actions of exotic earthworms in chaparral environments.

While there is little evidence to suggest that introduced earthworms have detrimental effects on native earthworm populations in undisturbed habitats, exotic species tend to become well established in disturbed areas, as is typically the case with urbanization. Urbanization often results in the dramatic alteration of soil profiles, moisture and organic content, and flora, which will eliminate or severely reduce native earthworm populations. It is just such disturbed habitats that then become colonized by exotic earthworm species. The Los Angeles region is a clear example of such an urban environment, where native earthworm species have likely been eliminated and replaced with introduced species.

Mating and Reproduction

As noted earlier, all clitellates, including earthworms, are hermaphrodites. Regardless, members of most species do not self fertilize, but instead *mating* and *reproduction* are separate processes. As shown in Figure 12, a *mating* pair overlap their front ends with their lower surfaces in contact. It is in this position that sperm is exchanged between each individual and stored in respective sperm storage organs. Subsequent to this exchange, the worms detach and go their separate ways.

From hours to days after a pair of earthworms exchange sperm during *mating*, the process of *reproduction* occurs. The clitellum (Figure 9) secretes a tough, leathery ring around the worm. The worm then moves backwards, sliding the secreted ring toward the head. As the ring moves along the body, it receives the eggs and then the stored sperm obtained during *mating*. Fertilization then occurs within this ring. As the ring slips off the worm, the open ends seal closed, forming a cocoon or egg case (Figure 13) that is deposited in the soil, and development of young worms, usually one to 20 per cocoon depending on species, begins. Egg cases can withstand desiccation, which facilitates their dispersal by humans. Worms emerge as small, almost fully formed individuals after several weeks to months.

Figure 12. Earthworms mating

Figure 13. Earthworm egg case

Learn More about Earthworms

Hendrix, P.F. & Bohlen, P.J. 2002. Exotic earthworm invasions in North America: ecological and policy implications. *BioScience* 52: 801–811.

http://dpw.lacounty.gov/epd/sg/tech_sheets/wc_info.pdf

http://citeseerx.ist.psu.edu/viewdoc/download?rep=rep1&type=pdf&doi=10.1.1.224.3115

http://www.berkeleydailyplanet.com/issue/2006-03-14/article/23651?headline=Researchers-Worry-About-Worms-Worldwide-By-Joe-Eaton

http://en.wikipedia.org/wiki/Invasive_earthworms_of_North_America

http://www.dnr.state.mn.us/invasives/terrestrialanimals/earthworms/index.html

IIIb. Aquatic Leeches

If there are worms with an undeserved reputation, it would be leeches. While there are a small number of species that are temporary sanguivorous (blood-feeding) ectoparasites of fishes, amphibians, reptiles, birds, and mammals, including humans, most are predatory. Among the almost 700 species worldwide, only 100 are marine and 90 terrestrial (three in North America); all remaining species are freshwater. A total of 76 leech species are known from North America. In the Los Angeles region, the only leeches one is likely to encounter will be from freshwater.

As noted earlier, leeches are members of the phylum Annelida, the segmented worms (Figure 8). And since leeches are part of the class Clitellata, they have a clitellum, although usually not as conspicuous as in earthworms (Figure 9), and are hermaphroditic. What distinguishes leeches from earthworms is the presence of an anterior or oral sucker around the mouth (and commonly a posterior or anal sucker), and only 32 body segments, although segmentation is usually not externally visible because of the presence of body annulations (Figures 8, 14, 15). Unlike earthworms, which are cylindrical, leeches are usually dorso-ventrally flattened, although they can exhibit substantial abilities to expand and contract.

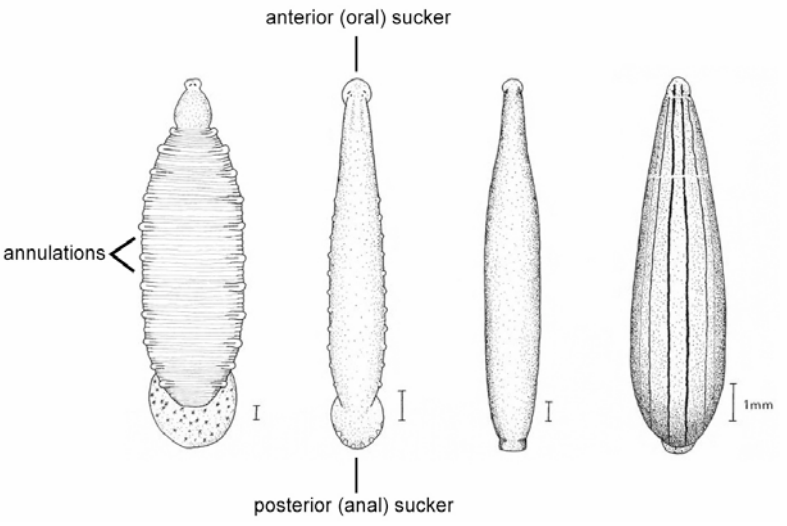

Figure 14. Representative freshwater leeches

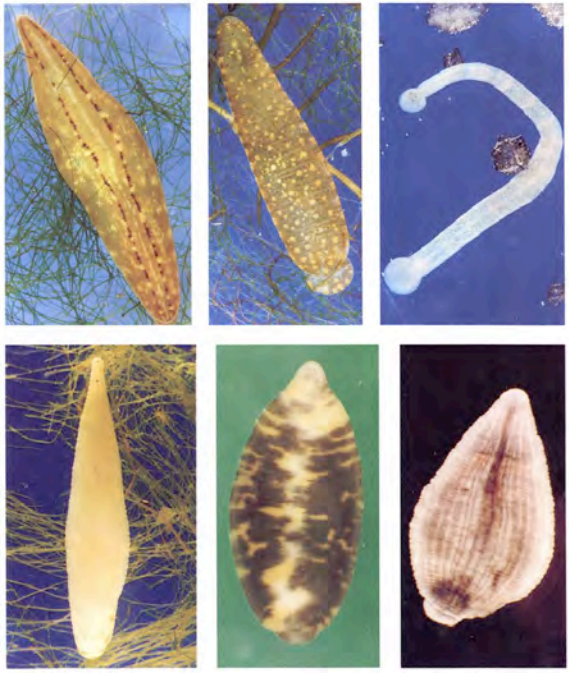

Figure 15. Representative freshwater leeches

Feeding

Leeches in North America are divided among two orders, Rhynchobdellida and Arhynchobdellida. The Rhynchobdellida are sometimes known as the proboscis leeches, referring to the proboscis that can be extended out of the mouth for feeding. Depending on the diet, the proboscis is used to ingest whole prey or to penetrate prey to take a blood meal. Members of two rhynchobdellid families are found in California: Glossiphoniidae – predators of aquatic earthworms, snails, and aquatic insect larvae, or temporary ectoparasites of fish, amphibians, turtles, or water birds; and Piscicolidae – parasites of fishes and some crustaceans. Members of the Arhynchobdellida do not have a proboscis, and depending on the species may have jaws with teeth. Two families are represented in California waters: Haemopidae and Erpobdellidae – predators of aquatic earthworms, snails, aquatic insect larvae, and crustaceans, or bloodsucking ectoparasites of aquatic and terrestrial amphibians and mammals.

Occurrence

Fewer than 20 freshwater leech species have been reported for California. Most are predatory, although there are some species that are parasites of fish, amphibians, and water birds. Since most are less than one inch long, they go largely unnoticed by all but the most observant.

Learn More about Aquatic Leeches

Govedich, F.R., Bain, B.A., Moser, W.E., Gelder, S.R., Davies, R.W., & Brinkhurst, R.O. 2010. Chapter 12. Annelida (Clitellata): Oligochaeta, Branchiobdellida, Hirudinida, and Acanthobdellida. In: Thorp, J.H. & Covich, A.P. (eds) *Ecology and Classification of North American Freshwater Invertebrates*, pp. 385–436. Academic Press, Boston.

http://sunsite.ualberta.ca/Projects/Aquatic_Invertebrates/?Page=18

http://australianmuseum.net.au/leeches

IIIc. Crayfish Worms

Among the aquatic segmented worms you might encounter, one of the most enigmatic are the branchiobdellids, or crayfish worms. Like earthworms and leeches, branchiobdellids are members of the Clitellata, and from an evolutionary perspective are regarded as most closely related to leeches. With only 15 body segments, crayfish worms have a cylindrical body that is just over one-third of an inch long. Segments can have ridges or short outgrowths. The mouth is surrounded by oral papillae and the posterior end is developed into a sucker (Figure 16). Of the 140 known species, 107 have been reported from North America. The phrase 'crayfish worms' comes from the association of branchiobdellids with freshwater crayfish. The association is ectosymbiotic not parasitic, wherein the worms live on the external surfaces of hosts, but dependence on the host appears to be one of providing a substrate for attachment as well as depositing egg cocoons. Depending on the species, branchiobdellids range from being herbivores to carnivores, but most are opportunistic omnivores. A single crayfish can be infested with over 1800 individuals of different species. Other hosts include freshwater crabs and shrimps.

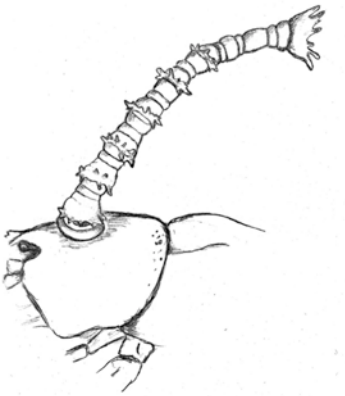

Figure 16. A branchiobdellid worm attached to a crayfish host using its posterior sucker

Several branchiobdellid species have been reported from California. At least in some cases their presence is due to the commercial transport of crayfish species. In an aquarium setting, branchiobdellids are readily visible on the surfaces of crayfish (Figure 17), actively crawling with an inch-worm movement.

Learn More about Crayfish Worms

Govedich, F.R., Bain, B.A., Moser, W.E., Gelder, S.R., Davies, R.W., & Brinkhurst, R.O. 2010. Chapter 12. Annelida (Clitellata): Oligochaeta, Branchiobdellida, Hirudinida, and Acanthobdellida. In: Thorp, J.H. & Covich, A.P. (eds) *Ecology and Classification of North American Freshwater Invertebrates*, pp. 385–436. Academic Press, Boston.

http://winvertebrates.uwsp.edu/schulzejosh_361_2012.html

Figure 17. Branchiobdellid worms (yellow arrows) attached to a crayfish in an aquarium

Figure credits

Title page: horsehair worm – Irene Kightley, https://www.flickr.com/photos/25918339@N00/2315268298; earthworm – http://archive.constantcontact.com/fs057/1101915097096/archive/1102821409563.html; land planarian – J. Kirk Fitzhugh
Figure 1: Hogue, C.L. 1993. *Insects of the Los Angeles Basin*. Natural History Museum of Los Angeles County; figure 480
Figure 2: http://cincyectotherms.livejournal.com/6585.html
Figure 3: http://cincyectotherms.livejournal.com/6585.html
Figure 4: http://baynature.org/articles/sticks-and-stones-can-make-a-home/
Figure 5: Photo by Dean Pentcheff
Figures 6, 7: http://www.nematomorpha.net/Nematomorphs.html
Figure 8: Leslie Harris (polychaete); William Vann (earthworm); Geoff Read (leech)
Figure 9: http://archive.constantcontact.com/fs057/1101915097096/archive/1102821409563.html
Figure 10: http://dpw.lacounty.gov/epd/sg/tech_sheets/wc_info.pdf, figure 6
Figure 11: Hendrix, P.F. & Bohlen, P.J. 2002. Exotic earthworm invasions in North America: ecological and policy implications. *BioScience* 52(9): 801-811. Redrawn from figure 1
Figure 12: http://www.treknature.com/gallery/photo237936.htm
Figure 13: http://urbanwormwonders.com/red-wiggler-worms.html
Figure 14: Sawyer, R.T. 1972. *North American Freshwater Leeches, Exclusive of the Piscicolidae, with a Key to All Species*. Illinois Biological Monographs 46, University of Illinois Press; figure 18
Figure 15: Clifford, H.F. 1991. *Aquatic Invertebrates of Alberta*. University of Alberta Press, Edmonton; plate 13.1
Figure 16: http://aquasnail.blogspot.com/2013/04/esquemas-anatomicos-anelidos-hirudineos.html
Figure 17: Photo by J. Kirk Fitzhugh

About the author:

J. Kirk Fitzhugh, Ph.D., is Curator of Polychaetous Annelids (marine segmented worms) at the Natural History Museum of Los Angeles County. His research focuses on the study of the evolutionary history of polychaetes, as well as philosophical issues regarding evolutionary biology.