NRAC Publication No. 223-2017

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How to Grow White Worms

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What are white worms?

White worms (*Enchytraeus albidus*) are small (2-4 cm TL adult size) oligochaete worms that grow in terrestrial systems but can survive in both fresh and full-strength seawater, wriggle and attract predators, and do not impair water quality when added to aquaculture systems, making them ideal live feeds for cultured aquatic species. They are easy and inexpensive to rear on a small scale and they show great promise as a live feed for a diverse set of cultured organisms during some period of their development, including freshwater and marine fishes (including ornamentals), as well as some crustaceans, amphibians, reptiles, and birds.

From L to R: White worms in soil; juvenile winter flounder (2 cm TL) stalking a white worm in the lab; white worms exiting soil.

White worm use in aquaculture

White worm cultivation was developed in the former Soviet Union in the 1940s in conjunction with expanding fish culture programs; worms were cultured in wall-to-wall stacks of boxes yielding 100-300 kg white worms/ week (with a peak biomass 35,000 g worms/m^3) for feeding 2.5-3 million juvenile sturgeon. Despite the apparent success of such operations, as far as is known, large-scale white worm production no longer exists - cessation appears to correspond with the breakup of the Soviet Union. Current use of white worms is low; research organism suppliers grow the worms for biological and toxicological studies as worm tissue is sensitive to chemical composition, and aquarium hobbyists cultivate them as a live feed for ornamental fishes. Because of the expansion in culturing new species, especially ornamental fishes, and the limited variety of small live feeds, white worm culture is of interest again. Here we provide our tested methods to grow white worms.

Resources: There are only a few published references about white worms, which we've taken the liberty to include in this Fact Sheet. We recommend:

Fairchild, E. A., A. M. Bergman, & J. T. Trushenski. 2017. Production and nutritional composition of white worms *Enchytraeus albidus* fed different low-cost feeds. Aquaculture 481: 16-24.

Fairchild, E. A., M. L. Walsh, J. T. Trushenski, K. L. Cullen, & M. Chambers. 2017. White worms – a low cost live feed for the ornamental industry. NRAC Fact Sheet No. 224-2017.

Ivleva, I. V. 1973. *Enchytraeus albidus*, in: Mass Cultivation of Invertebrates: Biology and Methods. Published for the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Washington, D. C. by the Israel Program for Scientific Translations. Translated from Russian. pp. 8-38.

Memiş, D., M. S. Celikkale, & E. Ercan. 2004. The effect of different diets on the white worm (*Enchytraeus albidus* Henle, 1837) reproduction. Turkish Journal of Fisheries and Aquatic Sciences 4: 5–7.

Walsh, M. L. 2012. Potential of white worms, *Enchytraeus albidus*, as a component for aquaculture and stock enhancement feeds. World Aquaculture Magazine 43(3): 44-46.

In addition, many aquarium hobbyists post DIY white worm information online.

White worm cultivation methods

Container: Plastic shoe boxes purchased from any big box store like Walmart are a good option; they are cheap, and easy to get, maneuver, and stack. We like clear-bottomed ones so you can view the worm culture condition from the bottom without having to open the lid. Make sure the containers have close-fitting (but not air tight) lids.

Media: Fill the container 2-5 cm deep with the starter culture and sieved potting soil (remove small sticks and soil clumps). We use organic soil at UNH but this isn't necessary. Mix the contents thoroughly and moisten so that the media is damp but not muddy. A spray bottle of freshwater works nicely for this. The new soil will absorb the water quickly so check on the culture every few days to remoisten as needed. Preferred soil moisture is 20-25%.

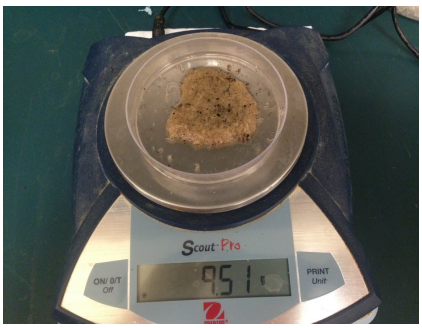
Feeding: White worms are not fussy eaters and will eat just about anything you give them. Avoid meat products since they tend to attract flying insects and will smell. The worms especially thrive on yeasty products so old bread is an easy feed, or spent brewing grains if you have a microbrewery nearby. Worm biomass and nutritional content will vary depending on what you feed them. In general, white worm cultures fed coffee grounds, stale bread, and spent brewing grains will have higher production yields than cultures fed produce. Nutritional content of white worms is high in protein (49-69%) and lipids (10-27%), and low in ash (5-8%). Worm fatty acid content can be altered by adding supplements into the standard worm feed and harvesting the worms 10-12 hours later.

To feed the worms, mince up the feed, either by hand or in a food processor/blender, add a bit of water to make a paste. For feedings, part the soil down the center of the container, making a trough to the bottom, put the food in the trough (only need approx. ¼ c feed for a well-established worm culture in a shoe box sized container), and cover up completely with soil. This way, flying insects will be less attracted to the feed and you can check on the worm culture by peeking through the clear container bottom to see if the worms have eaten all the feed. Generally, we only refeed the worms once all the previous feed has been consumed, every 1-2 weeks. Unearthing half-eaten feed before it has been consumed tends to release potent smells of feed decomposition. This is fine for the worms as they are composters and thrive on rotting feedstuffs; however, it is highly unpleasant for the worm culturist.

Environmental Variables: White worms prefer darkness so keep the containers either in a dark place or cover them. At UNH, we surround the shelves holding the worm cultures with black plastic sheeting. The optimal temperature for worm growth and reproduction is 15-21 °C, but they can survive at lower temps and as warm as 25 °C. White worms can tolerate pH fluctuations but prefer a 6.2-6.7 pH range. If you use industry waste products to feed the worms, the pH of the feed will vary, however, in our experience, this has not been harmful to our worm cultures. You'll know when something is not right when massive numbers of worms start crawling up the sides of the culture container, avoiding the soil. If this happens, you can scoop the worms out and transfer them into a new container.

Biosecurity: White worm diagnostic testing has been done at Kennebec River Biosciences (Richmond, ME). Of the 31 viral, bacterial, and parasitic agents tested common to finfish and crustaceans, all assays were negative.



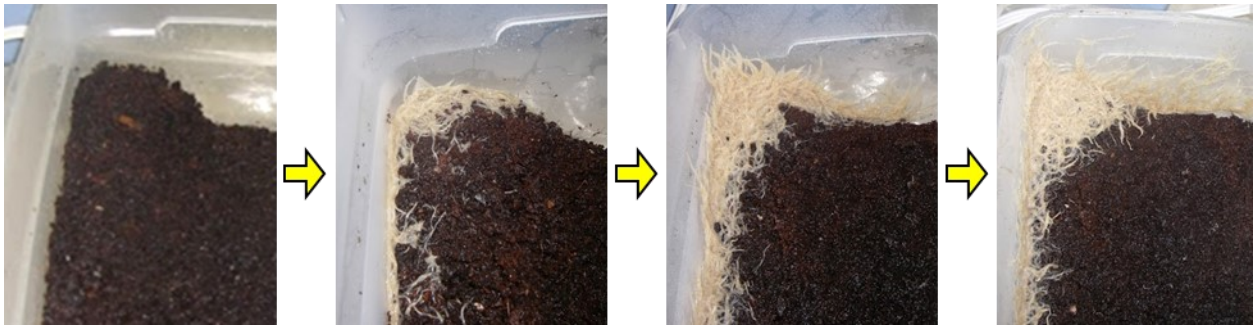


From L to R: white worm cultures at UNH; dense white worm culture; freshly-harvested sample of white worms.

Harvesting & feeding out white worms

Culture maturity: Healthy worm cultures are fecund. The life span of an individual white worm is 8-9 months, during which time it produces about 1,000 viable eggs of which 93-95 % develop successfully. The eggs are laid in cocoons that may contain 2-35 eggs, depending on the age and condition of the worms. Mature cultures will need regular harvesting or splitting to keep the worm population from becoming too dense.

Harvesting worms: The biggest bottleneck to commercial white worm production is an efficient harvesting system, something we are working on at UNH. In the meantime, for small scale worm growers, using a heat source, like a heating pad placed underneath the worm container, will drive the worms away from the heat and to the top of the soil surface (see Walsh 2012 for full description and photos). At 25 °C, worms will start to migrate away from the heat source, but will die if the media is kept at >30 °C. After approx. 1 hour using a heating pad at the warmest setting, the worms can be collected easily with a small spatula by scraping them off the sides of the container and soil surface where they will accumulate. If soil is accidentally collected too, then the harvested worms and soil can be immersed in water, and the worms will ball up and can be removed with tweezers, and the soil can be flushed out. For a healthy, large worm population, withholding food for a few weeks also will drive the worms to the surface.



Harvesting white worms using a heat source beneath the culture: the worms will migrate away from the heat and to the surface over time. Photos originally from Walsh 2012.

Splitting worm cultures: You can split cultures at any time to increase your worm population. Worms like already worked-through soil rather than brand-new soil. To split a culture, scoop out half of the soil + worms into a new container. Add new soil to both the old culture and the new culture, mix thoroughly, add feed, and spray with water, if necessary. We tend to split cultures when they are visibly very dense (worms climbing up the sides and top of container), if the soil has gotten too wet (shiny, muddy look), or if the soil has become too organic over time with worm castings/manure (soil clumps into round balls that the worms wrap themselves around making harvest difficult). This is usually at least 2+ months from the start of the culture. If you fear that something might be wrong with the soil (very smelly, fungal growth, pest infestation, etc.), do not split the culture. Instead, either terminate the worm culture or harvest the worms and start a new culture, using a new container and media (but keep a close eye on the worms to ensure the prior problems do not persist).

Feeding out worms: For maximum nutritional impact, we recommend feeding out the worms immediately after harvesting. They can be stored in water in a cool place for up to 3 days post-harvest, however, survival may be affected and nutritional content may change. Worms can be directly added to aquaria or stocked into a worm cone feeder, which essentially is a sieve that limits the amount of worms in the water column and thus, extends the feeding time for aquatic organisms.

Acknowledgments

The authors wish to thank the many students and technicians involved with this research, as well as Smuttynose Brewery of Portsmouth, New Hampshire, USA which donates spent brewing grains. This work was supported by the Northeast Regional Aquaculture Center [15061Z5659002]; the New Hampshire Agricultural Experiment Station (NH AES); and the United States Department of Agriculture National Institute of Food and Agriculture [Hatch Project 1003418].