CIR1053

UF UNIVERSITY of FLORIDA
IFAS Extension

Culture of Earthworms for Bait or Fish Food [1]

William T. Mason, Jr., Roger W. Rottmann, and John F. Dequine[2]

The West-African nightcrawler (*Eudrilus eugeniae*) and the brandling worm (*Eisenia foetida*), also known as the English redworm, have been used in North America as bait worms since the 1940's. These earthworms are also used for composting sewage sludge and manure, and as a dietary supplement for ornamental fish or other difficult-to-raise fish species.

Earthworms are excellent food for cultured fish species. Cultures of the West-African nightcrawler and brandling worm have been used to feed Gulf of Mexico sturgeon (*Acipenser oxyrhynchus desotoi*), reared at the U.S. Fish and Wildlife Service's National Fisheries Research Center, located adjacent to the University of Florida, Department of Fisheries and Aquatic Sciences, Gainesville, Florida. In addition, earthworms have been used alone and in combination with other foods, such as commercial feeds, in diets of other fish species at these laboratories. The advantages of earthworms in the diets of cultured fish have been demonstrated. For example, carp fed dried nightcrawlers supplemented with sardine oil grew better than those fed a fish meal diet.

The West-African nightcrawler and brandling worm are prolific in warm climates and can be cultured outdoors throughout the southern United States; however, most commercial worm beds are indoors. Most information concerning commercial-scale methods for earthworm culture is difficult to obtain because it is in old mimeograph documents, out-of-print pamphlets and books, or other scarce publications. Methods for the culture of live foods for laboratory fish culture and for tropical fish hobbyists are contained in several general texts (e.g., Masters, C. O. 1975. Encyclopedia of Live Foods. T.F.H. Publications, Inc., Ltd., Neptune City, NJ. 336 pp. and Jocker, W. 1973. Live Foods for the Aquarium and Terrarium. T.F.H. Publications, Inc., Ltd., Neptune City, NJ. 128 pp.) These texts focus on the collection and culture of a variety of live fish foods, but do not describe commercial invertebrate culture methods.

Biology

Description of the life histories of the West-African nightcrawler and brandling worm are found in several publications. Both species obtain nutrition from organic matter, such as manure or

1. This document is Circular 1053, one of a series of the Department of Fisheries and Aquatic Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published: March 1992. Reviewed: September 2006. Please visit the EDIS Web site at **http://edis.ifas.ufl.edu**.

2. William T. Mason, Jr., Leader, Benthic Studies, National Fisheries Research Center, U.S Fish and Wildlife Service, Gainesville; Roger W. Rottmann, Senior Biological Scientist, Dept. of Fisheries and Aquatic Sciences, IFAS; and John F. Dequine, President of Southern Fish Culturists Inc., Leesburg, FL. Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

activated sludge. The West-African nightcrawler grows well at a temperature of 75-85°F (24-29°C). Maximum weight (11 worms per ounce) occurs within 8-10 weeks. Optimal cocoon production is obtained when there are 150 adults per cubic foot, and increased mortality due to overcrowding occurs at 300 adults / cubic foot. In a 20-week period, one West-African nightcrawler produces an average of 173 offspring. The brandling worm produces about 223 offspring per individual in the same period at 68-77°F (20-25°C). The dry weight analysis of the brandling worm is 61% crude protein, 9% fat, and 5% ash.

The West-African nightcrawler and brandling worm can be grown in the same bed and are easily distinguished. The nightcrawler has a uniform purple-grey sheen and the posterior segments are evenly tapered to a point. The segments of the brandling worm alternate reddish-orange and brown; the posterior segments do not taper, and the final segment is blunt. Experiences with mixed cultures reveal that the brandling worm is more tolerant than the West-African nightcrawler of anoxic conditions (lacking oxygen), becoming dominant if the beds are not turned and aerated regularly. Optimum production of a mixed culture of these earthworms occurs at temperatures between 70 and 85°F (21-29°C). Temperatures less than 60°F (16°C) or greater than 86°F (300°C) for extended periods may be fatal. Temperatures less than 45°F (7°C) or greater than 95°F (35°C) are usually immediately fatal to the West-African nightcrawler.

Construction of Worm Beds

The worms are grown in containers or frames constructed of plastic, wood, or concrete block. Where the demand is low, the worms can be grown in 5- or 6-foot diameter, plastic "kiddy" wading pools. Additional rigidity can be provided by placing one pool inside another of the same size. The pools should rest on wooden pallets positioned on the floor or on waist-high platforms near the fish holding tanks for easy access and comfortable working height (Figure 1). The pallets may be moved by forklift or dolly to suit changing work space needs. Worm growers may also use wooden crates that can be stacked to conserve space. However, access, maintenance, and harvesting of the worms may be more difficult with stacked crates. Commercial worm farms, producing thousands of pounds of worms annually, use beds constructed of rectangular frames approximately 4 feet wide and 30 feet or more long. Wooden frames are constructed of 1-inch x 8 to 10-inch boards. Concrete blocks laid end to end also make an excellent frame for worm beds. The frames rest directly on the soil for good drainage and are separated by access aisles.

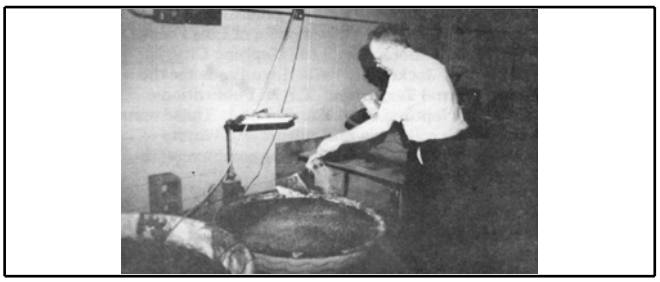

Figure 1 .

Housing is recommended for continuous culture of earthworms. Buildings not only allow daily adjustments for local climate control, but also provide shade and protection against pests. Sheds, garages, and out-buildings all work well for earthworm culture. If possible, buildings should have moveable side panels or doors on all sides for ventilation and moisture control. Depending on the prevailing winds, exhaust fans may be needed to draw air across the beds for evaporative cooling. The building should be heated with oil or gas furnaces, heat pumps, or solar panels in winter to maintain temperatures above 65°F (18°C). If the building is not insulated, sheets of plastic can be attached to the walls and ceiling in winter to reduce heat loss and heating expense.

Some of the primary pests that invade worm beds are insects, slugs, birds, reptiles, amphibians, and mammals. Ant invasions can ruin the beds in a few days; close watch and quick treatment are required. If ants are a problem use a granular insecticide at the ant nest and trails to the bed. Small worm beds may be placed on platforms with their legs resting in containers of water. Screening the buildings or beds will help reduce losses to birds, rodents, and raccoons.

Starting, Feeding, and Care of Worm Cultures

Unoxidized peat is the preferred bedding and can be obtained from peat mining companies. The bed material should be loose, moist, and well aerated. To start a new worm bed, peat is placed to a depth of about 3 inches and leveled with a rake. Hardwood sawdust, ground peanut hulls, sand (< 2% by weight) or other organic material can be mixed into the peat to minimize compaction. Small quantities of agricultural grade dolomite limestone are added gradually over a period of days to adjust the pH to about 6.5-6.8. Uncontaminated groundwater (total hardness <250 mg/l $CaCO_3$) is lightly sprinkled on the bedding for a few seconds until the surface first glistens. Adult worms (about 2 pounds per 100 square feet of bed) are placed along the central midline of the bed. Within a few minutes, the worms work their way into the bedding, and in a few days they gradually spread evenly throughout the bed.

Most cultured earthworms live in the top 2 inches of bedding. They are active at night and will crawl out of the beds in dimly lit or dark rooms. The worms are light sensitive (photophobic) and thus overhead illumination discourages their movements; the lights also help heat the beds in winter. A small fluorescent light about 2 feet above the bed keeps the worms in the bed without the expense of a large bank of electrical lights.

The moisture content of the bed is a critical factor affecting worm production. Earthworms prefer moist but not saturated conditions. Excess water causes the food to rot and fungus to develop. This can reduce production and cause mortality if the condition persists. Excess moisture can also cause the bedding materials to cling to the worm's body, affecting respiration and production. Watering procedures vary with each site. Large commercial beds are usually lightly watered daily with a hose nozzle, preferably in the morning. Small plastic pools that have no drainage are not watered on weekends to allow the bed to dry out. This routine does not cause any perceptible change in worm production and reduces labor.

Immediately after watering, a high fiber content food (e.g., Purina Earthworm Chow®) is broadcast (Figure 1) by hand or mechanical applicator evenly over the bed's surface at a daily rate of approximately 0.5 pounds per square yard. Applied properly, the bed material should be faintly visible through the layer of food. The food will absorb some water and become moist, but not soggy. The worms migrate to the surface and begin to feed within the hour. Uneaten food may indicate too high a feeding rate or detrimental environmental conditions in the bed (e.g., too much or too little moisture, lack of oxygen, improper temperature).

Uneaten lumps of food become moldy and attract unwanted pests; therefore, before the next feeding, any food that is uneaten should be gently worked into the surface of the bedding by hand with a tine hoe. This action also helps to aerate the bedding material, preventing anaerobic conditions. To optimize worm production and facilitate harvesting, the peat bedding should be loosened at least every month with a tine hoe. Gently turning the bed does not harm the worms and keeps the bed oxygenated.

The buildup of ammonia from wastes can retard worm production; therefore, a new layer (2-3 inches) of clean bedding is spread over the surface about every 3 months. After the new bedding is added, the worms migrate up into it. When the frame or container is eventually filled with spent bedding and becomes anoxic, the beds are harvested, and breeder worms are transferred to a new bed.

Worms on the bed's surface while the bed is lit is a sign of excessive water or overcrowding. Listless and stunted worms indicate disease, fungus, or overcrowding. The worms are in good condition if, when the surface of the bedding is touched, the surface layer ripples as the worms quickly retract.

Harvesting

Removing worms from the beds at regular intervals reduces overcrowding, increases production, and prevents stunted worms. Worms are initially harvested from new beds after 3 months. They can then be harvested every 2-4 weeks. Large quantities of worms can be snagged on the tines of a pitchfork that is slowly run through the top layer of bedding.

The worms are then dropped from the pitchfork into a tub or wheelbarrow. To completely harvest a bed, a tine hoe is used to gather the top 4 inches of bedding into a heap in the middle of the bed; the bedding and worms are transferred with a flat blade shovel into a tub, wheelbarrow, or wagon.

Harvested worms are usually still covered with bedding material that clings to their bodies. This may pose a problem if the worms are to be fed to fish that require clean food and if fish tank cleaning is a problem. For small cultures, a woodenframed sieve 13 x 18 x 7 inches deep with 118 inch hardware cloth screen (Figure 2) is helpful for separating the bedding from the worms. To rid the worms of excess bedding on a commercial scale, they are placed in an electrically-rotated basket 9 feet long x 2.5 feet diameter made of 118-inch hardware cloth stretched over a metal frame. The basket is inclined at 10-12° (Figure 3). As the mass of worms slides down the basket, excess bedding is scrapped away by the abrasion of the hardware cloth. The spent bedding falls into containers underneath the basket.

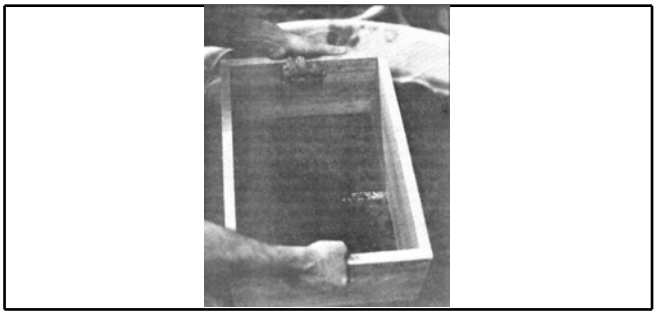

Figure 2 .

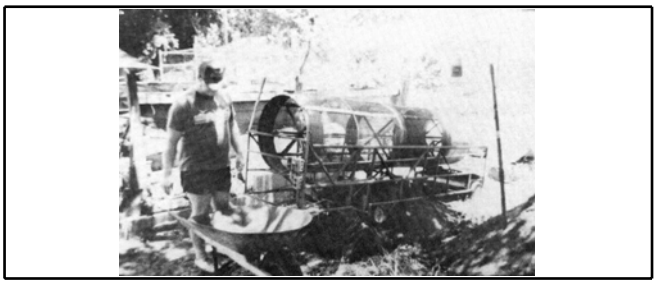

Figure 3 .

Spent bedding and worm castings from either partial or total harvest are removed and used as garden fertilizer. The spent bedding also makes excellent plant potting medium or fertilizer for other invertebrate cultures.

Worm farms in Central Florida have an annual production approaching 50,000 pounds per acre. One person-year of labor is required for approximately 0.5 acre of worm beds.

Summary

The West-African nightcrawler and the brandling worm have been used in North America as bait worms since the 1940's. These earthworms are also used for composting sewage sludge and manure, and as dietary supplements for ornamental fish or other difficult-to-raise fish species. The worms are grown in containers or frames of plastic, wood, or concrete block. The West-African nightcrawler and brandling worm are prolific in warm climates and can be cultured outdoors throughout the southern United States; however, most commercial worm beds are indoors to facilitate climate and predator control. Unoxidized peat mixed with sand and organic material is used as bedding. The bedding material should be kept loose, moist, and well aerated. A commercial worm feed is spread over the surface of the bed daily. The worms are harvested every 2-4 weeks.

Acknowledgments

We wish to thank James I. Maxwell, U.S. Fish and Wildlife Service, National Fish Hatchery, Welaka, Fl and Dr. Charles E. Cichra, University of Florida, Department of Fisheries and Aquatic Sciences, Gainesville, FL, for editorial suggestions.