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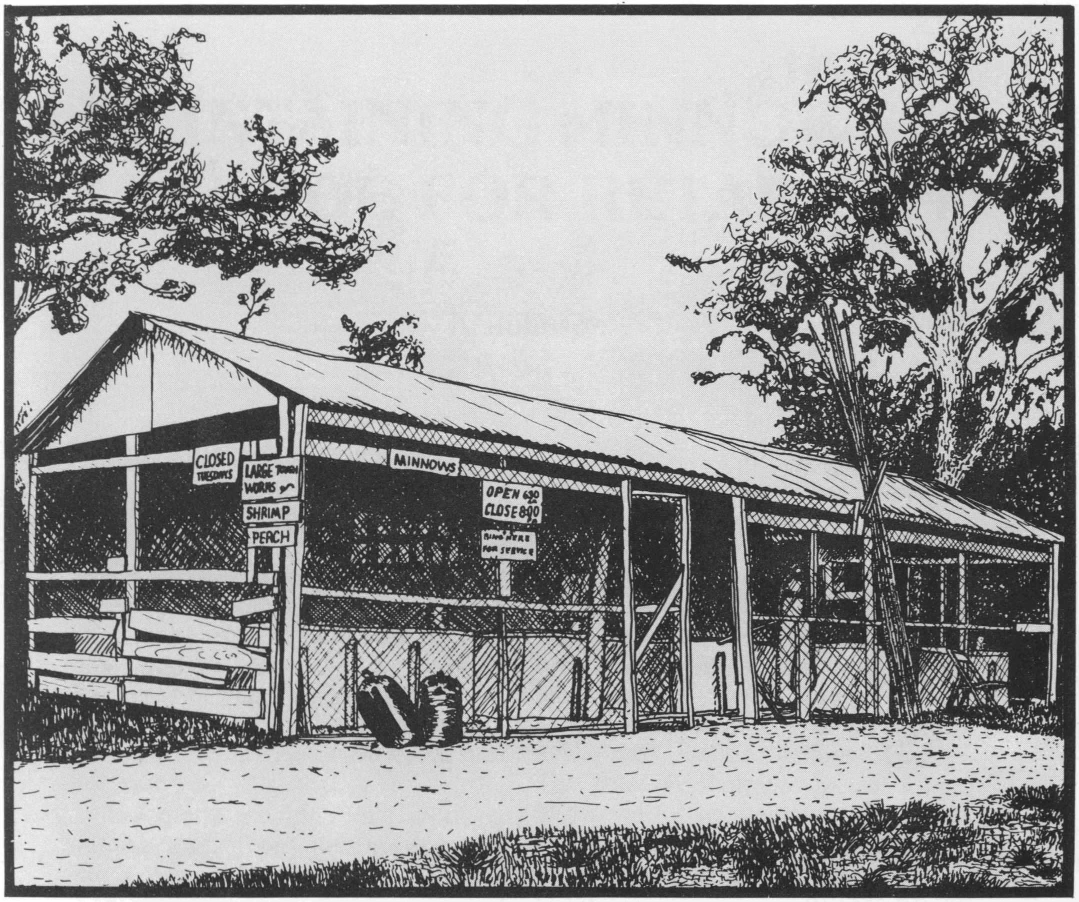

Maintaining Minnows
A Guide for Retailers

Texas Agricultural Extension Service • The Texas A&M University System
Daniel C. Pfannstiel, Director • College Station, Texas

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MAINTAINING MINNOWS — A GUIDE FOR RETAILERS

*S. K. Johnson

Minnow retailing establishments are found throughout Texas near fishing water. Minnow handling for some businesses provides a complete line of merchandise; for others, it is a vital part of the business. A weekend's sales may range from a few dollars to more than $3,000, depending on location and time of year. Many minnows are sold in Texas but substantial portions of fish stocks are lost while being held for sale.

This guide is written for baitfish retailers and gives techniques and suggestions to help reduce death loss and maintain good quality. Minnows discussed in this publication are golden shiners (*Notemigonus crysoleucas*), the principal species sold in Texas.

EQUIPMENT

Holding Vats

A typical holding facility consists of vats made of poured cement or concrete blocks under a roof to protect the vats from the sun. Vat construction supplies include wood, fiberglass or galvanized units. Vats vary in length but are generally 2 to 4 feet wide and 18 to 24 inches deep.

For poured cement or concrete block vats, grout pure concrete to the inside walls and bottom for a smoother surface. The drain is usually a 4-inch pipe collar cemented to the bottom or in an end wall. Attached to this is a stand pipe for water level maintenance and draining. New vats often release alkalis into the water and should be seasoned by adding 1 pint of glacial acetic acid per 200 gallons of water. This solution neutralizes alkalis if held in the vat for several days.

Galvanized tanks are suitable for fish maintenance in some parts of Texas. In other areas, water softness and various chemicals allow release of zinc from the vat walls. Since zinc is poisonous to fish, galvanized tanks can be lined with asphaltum paints to prevent its release.

Build wood and fiberglass tanks with adequate support. Plyboard, 1/2-inch thick, is ample for most wooden units. Use brass hardware for longer service.

Reliable information is not available on coatings for inside surfaces of minnow vats. Problems include bubbling, cracking and poisoning the fish. Avoid marine paints with built-in antifouling agents such as copper. Available coatings include the following products:

- Epoxy paints — Some do not hold under water. After applying, allow tanks to dry for a week, fill

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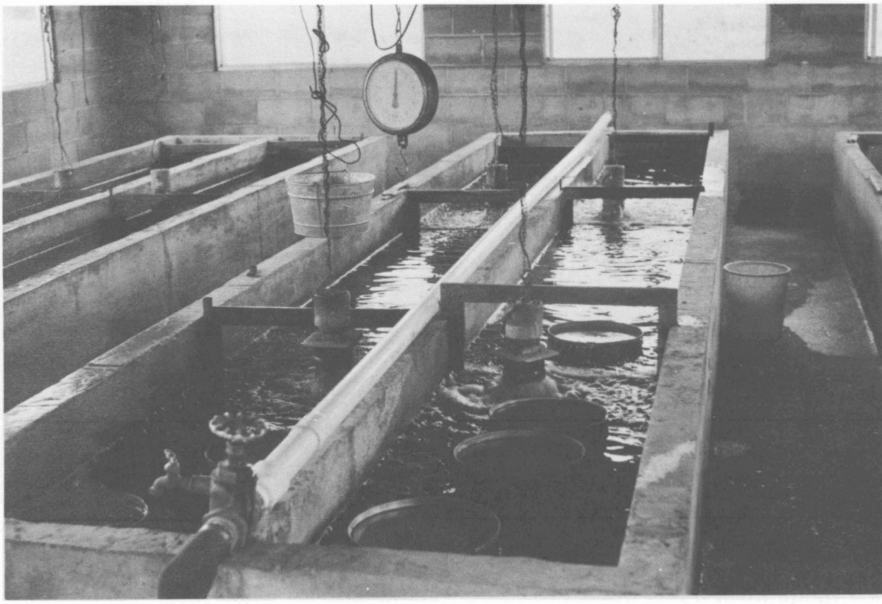

Fig. 1. Concrete holding vat with agitators suspended from ceiling. Blocking screens are also in place.

with water for a week, flush and begin using.

- Polyester resin — This is toxic for about 2 weeks after application and filling. Most resins require pigment for protection from ultraviolet radiation.
- Asphaltum paint — After drying, fill with water for several days for curing purposes.
- Block filler — Avoid latex fillers on cinder blocks, and use products that have passed water tests. After applying nonpigmented epoxy block filler, use an epoxy paint that fills pin holes. After drying, fill with water for a few days. Empty and refill for use.

Agitators

Suspend agitators from the ceiling by a strong chain or cord. This allows easy removal from the work area and keeps the agitator from falling into the vat. Mount electrical supply boxes on the ceiling in appropriate places. Space agitators 4 to 5 feet apart along the vat. A typical vat agitator has a 110-volt, 1,500 rpm, 1/20 hp fan-cooled motor which pulls 1 1/2 amps.

Nets

Square or rectangular dip nets with a 15-inch square steel frame, nylon netting of 3/16-inch mesh and a 20-inch wooden handle work well in bottoms and corners of the vats.

Plastic Bags

Use deep plastic bags with at least 0.002 inch (2 ml) thickness. A 10- by 20-inch bag is most commonly used, and costs about 5 cents.

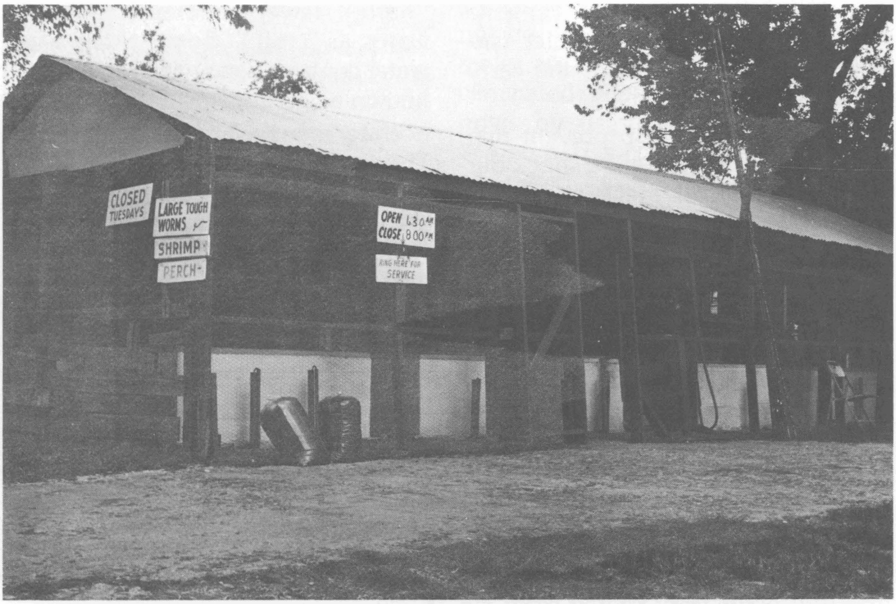

Fig. 2. Minnow shed. Roof protects from sun and screened walls allow for proper ventilation.

Oxygen

Obtain oxygen in a cylinder from a local supplier. A regulator (medical type) that delivers a slow release works best. The valve will have a nipple with a 2- to 3-foot rubber hose attached. Attach the cylinder to a wall or ceiling support for safety.

Partitions

Partitions are used to separate grades of minnows within the same vat. Partitions made of hardware cloth or mesh netting framed with wood should fit snugly within the walls or in the grooves of the vat.

TEMPERATURE

Since fish are cold-blooded, their body temperature is dependent on environmental temperature. Sudden temperature changes have an adverse effect on fish and can cause death. Temperature change causes the greatest loss of minnows for retailers.

Minnow loss is greatest for Texas retailers during August and September when the temperature of holding tank waters reaches the maximum. Normally, minnows transported to the retailer during this period are at a temperature much lower than the water of the receiving tank. Research indicates that the best transport temperature to ensure quality minnows at delivery is between 60 and 63 degrees F.

The oxygen requirement is reduced by lower temperatures. The transporter can then carry a much larger number of minnows in suitable condition to the destination. There is less loss of fish maintained in refrigerated vats or within air-conditioned buildings during late summer than conventional outside holding units. As water temperature becomes warmer, the carrying capacity is reduced.

The retailer can help prevent minnow loss from temperature shock during hot weather. Here are a few suggestions:

- Use an inexpensive pocket thermometer with a range of 30 to 120 degrees F.
- Determine what temperature the hauler will be using for transport waters so adjustments can be made.
- Use ice to cool the holding tank water to a temperature similar to that of the delivery truck.
- Temper the fish by mixing water from both vats.
- Use fresh drawn water which is cooler than water that has been standing for some time. Be sure a suitable oxygen level is present.
- Avoid direct sunlight to prevent unnecessary warming of the tank water.
- Use one or more of the various evaporative cooling devices such as room fans, spray nozzles, and drip towers.

WATER CHEMISTRY

Water supply for most retail vats comes from a well on the premises of the business or from a supplier that pipes in water for domestic use.

Water contains ingredients other than hydrogen and oxygen found in the familiar H_2O formula. Water from the tap will contain dissolved gases such as oxygen (O_2), carbon dioxide (CO_2), nitrogen (N_2) and dissolved minerals such as calcium, magnesium, iron and sodium. If the water contains many minerals, it is referred to as "hard;" fewer minerals classify the water as "soft." Some shallow-well water contains a gas with a strong odor known as hydrogen sulfide (H_2S).

Water may be acid, basic or neutral. The measurement called pH provides a test of the water's condition. Water used in minnow vats should have pH values from 6.0 to 9.0 Neutral water has a pH of 7.0 with acid waters measuring a lower number and basic a higher number.

Chemically speaking, primary concerns to the minnow retailer are pH and the presence of dissolved oxygen, carbon dioxide, ammonia, chlorine and hydrogen sulfide in the water.

pH

A sudden change in pH can be harmful to fish. This can occur when fish are transferred from one water to the next and the pH value changes two units or more. This situation usually exists in minnow retailing when fish in soft water have produced a large amount of carbon dioxide and are then placed into a tank of different water. The carbon dioxide causes a low pH in the soft water and the difference in pH between waters may be quite large.

Oxygen

Tanks with normal loads of minnows should be equipped with 1 aeration agitator per 4 feet of tank length. This allows the tank to be saturated with oxygen. Minnow deaths will occur when a tank is filled with well water devoid of oxygen and used before giving the aeration devices a chance to oxygenate the water. Minnows swimming at the surface and "gulping" air indicate an oxygen shortage.

Carbon Dioxide

Ground water often will have undesirable levels of carbon dioxide. It is best to aerate water before minnows arrive to eliminate excess carbon dioxide.

Ammonia

Ammonia is the most important water impurity present in minnow vats. Because of its relatively strong attraction to water, ammonia levels in the vat water climb steadily upward while other gases such as oxygen and carbon dioxide remain low. Ammonia is usually absent from well and community water. It accumulates in vat water from minnow waste and decomposing material. Decomposing fish and feed in a vat will cause a marked rise in ammonia content. Dead fish should be removed whenever possible to prevent ammonia buildup and increasing bacterial numbers.

The best way to handle an ammonia buildup in the minnow tank is to replace part of the water daily. Most retail water is basic (high pH), and ammonia becomes more toxic in basic water. Prolonged exposures to low levels of ammonia have been noted to be detrimental to fishes. Water measurements of many minnow vats in Texas revealed that over half contained enough ammonia to cause problems. Ammonia is probably a major cause of the gradual or "dozen-a-day" minnow die-off experienced by many retailers.

Chlorine

Chlorine is added in water treatment practices to make water drinkable. Unfortunately, chlorine is quite toxic to fish at concentrations normally found in water from community suppliers. Unless expensive charcoal filtration is used on incoming water, a constant flow of chlorine-free water cannot be provided to the vat. Usually, tanks are filled and the chlorine is eliminated prior to addition of minnows by using sodium thiosulfate, "Hypo." This chemical is available as powdered "fixer" from photography suppliers, at an approximate cost of $1 per pound. One or two tablespoons per vat is sufficient. The commonly suggested practice of allowing water to stand for a period of time so the chlorine will dissipate often proves disastrous.

Hydrogen sulfide

Hydrogen sulfide is harmful to fishes and is present in some well waters. It has an offensive odor and is easily detected. To eliminate the gas, allow the water to pass over baffles and then into the vat by gravity flow. Hydrogen sulfide is considered of minor importance to retailers in most areas.

HELPFUL TEST CHEMICALS

Two useful tests can be used to check chlorine and ammonia concentrations. Orthotolidine Reagent and Nessler's Reagent are both available from most chemical suppliers:

Chlorine Test: Simply apply one part Orthotolidine to 25 parts of water and observe for yellow color. The intensity of the color indicates the magnitude of chlorine that is present. If the yellow color does not appear, there is no chlorine present.

Ammonia Test: Procedure is the same as the chlorine test, but Nessler's Reagent is used as the test chemical. A yellow color also is produced in this test.

Precautions should be taken to avoid contact with eyes and mouth when using these chemicals. Keep chemicals out of the reach of children.

ACCUMULATION OF WASTES DURING TRANSPORT

Two poisonous gases, carbon dioxide and ammonia, accumulate in transport water as fish are hauled. Their sources are the fish and end products from the decomposition of solid wastes. Fish that are fed and loaded for transport on the same day will release enough solid waste to foul the water with excess carbon dioxide and ammonia. Overloading also will cause excess accumulation of these poisonous gases.

Carbon dioxide will harm the fishes and cause some deaths when they are exposed to more than 20 ppm carbon dioxide during hauling or for short periods of time. (See page 15 for ppm information.) Ammonia will begin to show adverse effects when levels exceed 2 ppm and especially when pH measures high, oxygen levels are low, and temperature of the water increases.

Accumulation of carbon dioxide will cause a lowering of pH when water is soft and has little buffering capacity. Exposing fish suddenly to water with a high pH characteristic may shock the fish and death may occur.

During transport, organic material in the form of released mucous and solid excrement will be present in the water. Bacteria use such material for food as they break it into simple compounds during the decomposition process. Because bacteria flourish in foul water and may be capable of causing infec-

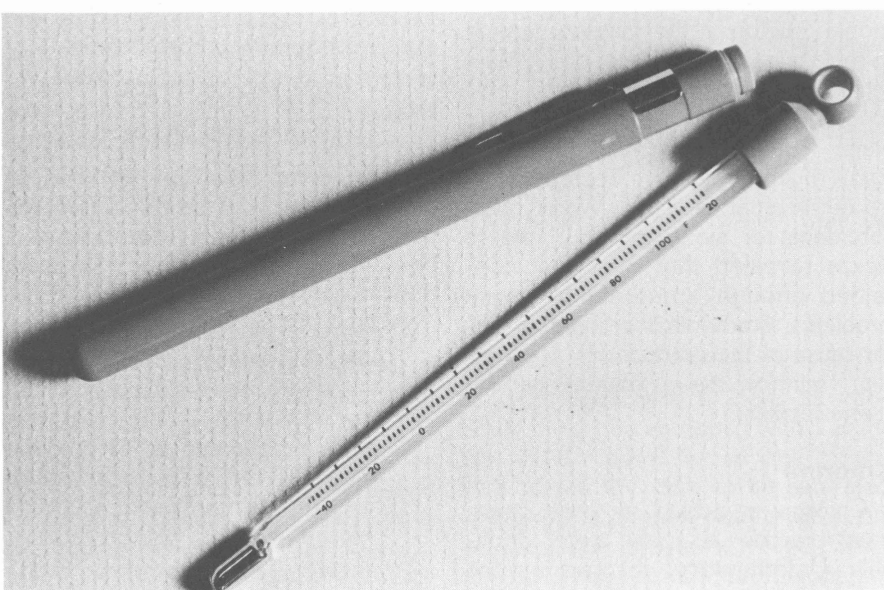

Fig. 3. An inexpensive pocket thermometer with a range of 30° to 120° F. is a handy tool.

tion in fish, it is a good idea to add antibacterial chemicals to the transport water.

STARVATION

Minnows can do without food for several days but if food is withheld for more than a week some loss can be expected. Fish should be fed when holding time is expected to be longer than 1 week or if fish appear to be in starved condition upon arrival. Feed minnows for maintenance and not for growth because wastes will increase ammonia levels in the vat. Fish can be maintained by supplying feed daily in the proportion of 0.5 to 1.0 percent of total fish weight.

DISEASE AGENTS

Living agents that cause disease in fishes are commonly broken down into the following categories: viruses, bacteria, fungi, protozoa and larger parasites. Minnows are threatened by a number of agents from some of these groups.

Regretfully, the truck, the vat and the bucket are not the most desirable places for minnow life. In such situations, the fish are under stress and the usual result is a weakening of normal body defenses. Fish in these conditions are more prone to attack by pathogens. The following discussion includes ways the retailer can enhance minnow condition or otherwise curtail attack by disease agents.

Bacteria

Bacteria are one-celled organisms which multiply by simple division and can only be seen with a microscope.

The typical minnow retailer uses water from a private well or purchased

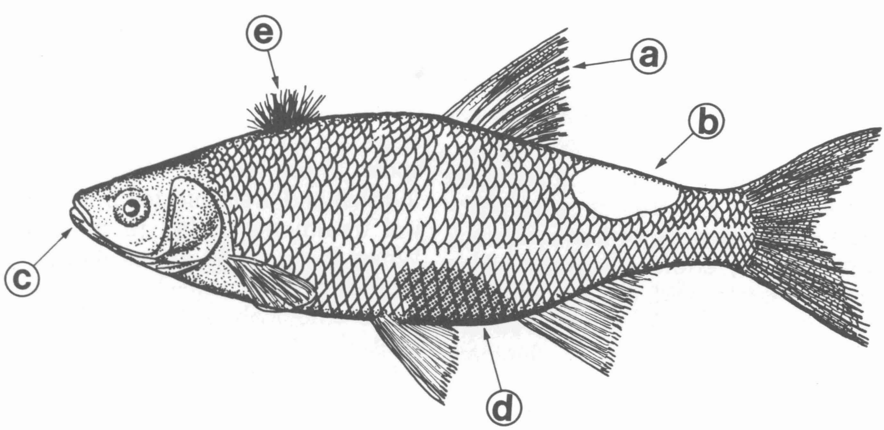

Fig. 4. Signs of bacterial disease in minnows: (a) frayed fins; (b) open sores or discolored areas of body; (c) whitish lips; (d) reddish vent; (e) a fungus patch, cottony in appearance and not a sign of bacterial disease.

from a water supplier. Water of this type contains little or no bacteria, especially if chlorine is used. There is only a small amount of organic material present in this water that could serve as food for growth of bacteria.

When minnows are placed in a vat of this water, the food supply for bacteria is the excrements or other organic material from the fishes. If harmful bacteria flourish by consuming this fresh food supply, fish loss may occur. Losses will be more prevalent if the fish have been weakened by transport or inadequate maintenance.

Retailers may curb the frequency of bacteria problems by:

- Cleaning vats that display turbid or cloudy water
- Providing a continuous flow of good quality well water through the vats
- Adding salt to water to strengthen the condition of the fish, thus increasing their resistance

Fungi

Fungi that affect fish are microscopic organisms that accumulate as elongated filaments. These appear "fluffy" or "cottony" on a fish in water. Fungi multiply by forming spores that are capable of forming new individuals.

Detrimental fungus infections spread slowly and do not cause problems during periods of frequent stock turnover. In cooler weather when turnover is not rapid, fish are usually in good health and resistance levels are high. Disinfect the tank to eliminate persistant occurrence of fungus infection.

Protozoa

Parasitic protozoa are typically single-celled microscopic organisms. Within the group, a few types may even be seen with a keen eye when viewed in water with proper lighting. Multiplication may result from simple splitting of the protozoa to form two new individuals or by more complex procedures that provide for a multitude of new individuals.

Unlike fungus, infestations by parasitic protozoans develop rapidly. Management of protozoan disease in minnow vats can be approached by eradication or by hindering multiplication. Both approaches utilize what is known as "selective toxicity" or "selective poisoning." A chemical is added to the water at a concentration that will damage the protozoa but not the fish.

Depending on the chemical and concentrations used, the treatment may result in killing all or a portion of the protozoa. Treatments may be for short periods of a few minutes, followed by flushing; or extended treatments, such as the length of time a particular stock is held. The method that is currently used by most retailers is one that hinders multiplication and keeps the treatment in the tank for the duration of holding.

The most severe protozoan is *Ichthyophthirius* or "Ich." Ich infestations become obvious after four or five days when the parasite, in its feeding stage, becomes visible as minute white spots. These feeding stages lie under the skin and are protected from chemical treatments added to the water. When the parasite leaves the fish to reproduce and complete the life cycle, some chemicals are effective. Since spots do not appear immediately after infestation, it is often difficult to determine if minnows are infested.

Protozoa, other than Ich, occur on the surface of the skin. It is difficult to determine when a batch of minnows may harbor an infestation because the protozoa are almost invisible. Infested fish stocks in good condition usually do not show extensive loss. For insurance, retailers have used chemicals on a prolonged basis for hinderance of protozoan developments. Salt added to the water at a level of 0.2 percent will stop development of protozoa.

Tanks that are not cleaned between stocks will eventually show a buildup of harmful protozoa. Disinfect tanks with chlorine (household bleach) or calcium hypochlorite. This practice should be followed by a complete water rinse before refilling.

Larger Parasites

The larger parasites that attack minnows are not much of a problem to retailers. Sometimes *Lernaea,* the "Anchor Parasite," is an exception. When present in large numbers in the stock, this parasite may be responsible for secondary infection at the attachment sites. There is not a chemical available that the retailer can use to remove the parasite. Treatments for *Lernaea* are directed towards the free-living larval stage and not the attached adult.

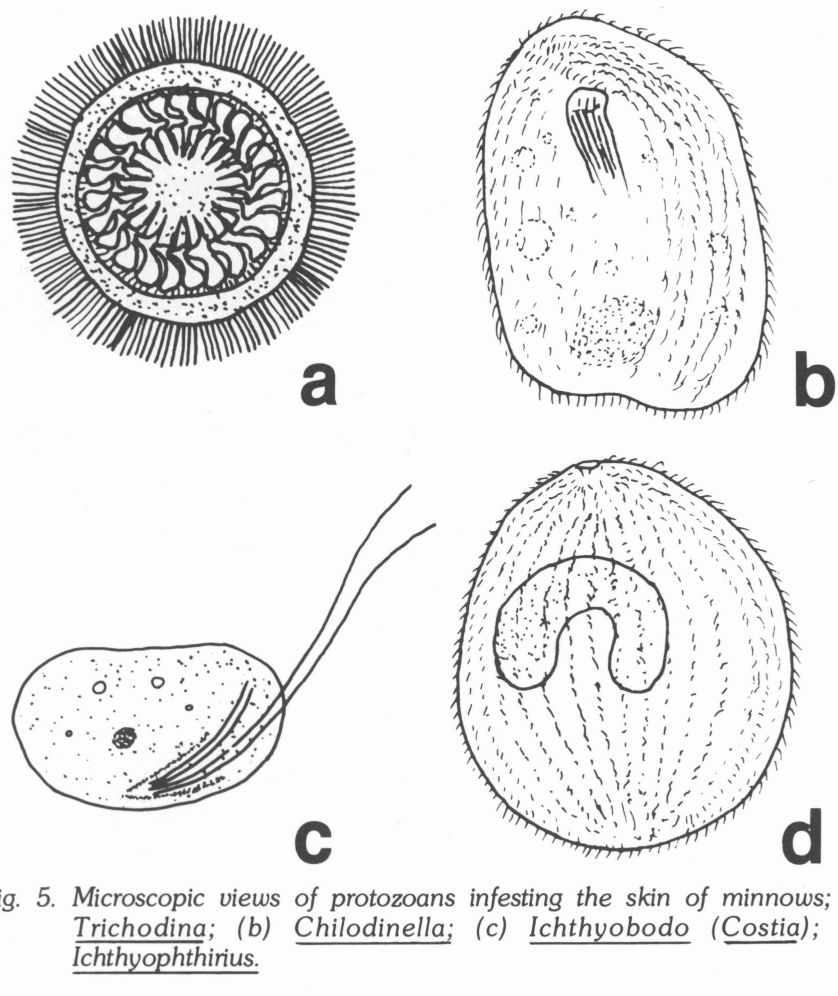

Fig. 5. Microscopic views of protozoans infesting the skin of minnows; (a) Trichodina; (b) Chilodinella; (c) Ichthyobodo (Costia); (d) Ichthyophthirius.

Viruses

Viruses are small infective agents that cannot be seen with the average microscope. They multiply within living cells and are responsible for numerous fish diseases; however, they have not been detected as a disease factor in minnows.

PREPARING FOR AND HANDLING NEW STOCK

Preparing Tank

It is a good practice to provide a new batch of minnows with unused "clean" water. Old fish should be removed prior to arrival of the new stock. They may be moved to a second vat or bagged. An aerator may be used to build up oxygen and remove excess carbon dioxide from freshly drawn water. If chlorine is present, remove it by adding sodium thiosulfate.

Unloading

If the water temperature is within 5 degrees F. of the delivery tank water and the pH of the two waters is within 1 unit difference, then the fish may be unloaded without fear of "new-water

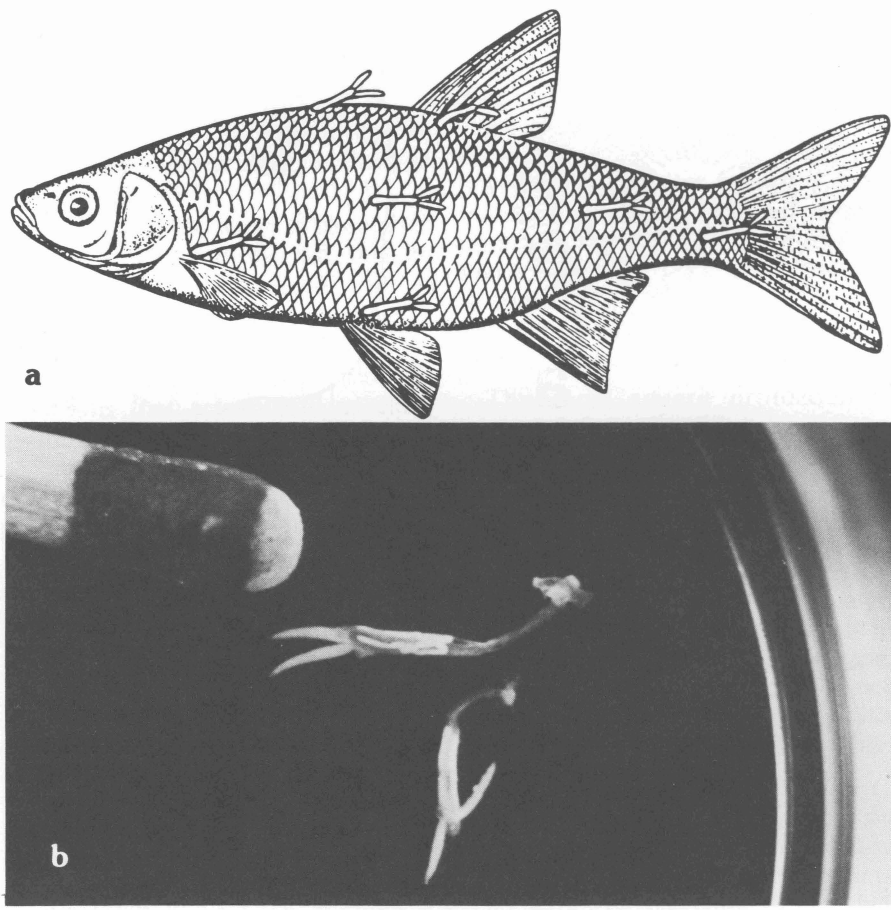

Fig. 6. Lernaea or "Anchor Parasite:" (a) Lernaea attached to minnow, (b) microscopic view of detached parasites.

shock." If the differences are greater, then the water should be tempered by adding vat water to the delivery water. Utilize as much time as practical in bringing the hauling water pH and temperature to that of the vat water.

Avoid rough handling of any sort. Care should be taken to prevent sudden jarring of fish while in or being removed from dip nets. Scale loss may occur during handling, especially if the water is warm. Prolonged exposure to the air is dangerous because of the lack of proper gas exchange and body temperature change. Minnows are easily excitable after delivery. Avoid bumping the sides of the vat or otherwise causing disturbances.

Bagging

While bagging, try to handle minnows in the water as much as possible. There are many methods of bagging. Here is an example: Fill a gallon tin can one-third full of vat water and set in or near the water. Dip fish into the can and count. When counting is completed hold the bag over the can opening and invert the can. Supply oxygen to give about two-thirds gas and one-third water and fish. Close the bag by twisting the opening down to "balloon" the bag and sealing with a rubber band. These bags will easily hold three dozen crappie minnows for 24 hours.

Cleaning

Vats should be cleaned periodically by scrubbing the sides with chlorine solution. Chlorine for this purpose is available as sodium hypochlorite (household bleach) or calcium hypochlorite (swimming pool powder). Rinse thoroughly to remove chlorine residue. The chemical test procedure on page 7 may be used as a check.

Delivery in Bags

Minnows are usually hauled in vats on trucks. Sometimes large plastic bags are used as hauling containers. Fish are distributed 1,000 per bag and the bag is inflated with oxygen above the water. The water is then chilled to a temperature between 60 and 63 degrees F. When the minnows arrive, bags are floated in the vats for a few minutes. This allows a gradual elevation in temperature. When the temperature becomes equal in bag and vat, the bag is opened and vat water is mixed half and half with bag water. After 5 minutes the fish are netted out of the bags and added directly to the vat. Bag water is then discarded.

TREATMENT CHEMICALS

Several chemicals are presently being used by bait retailers to aid in curbing minnow loss caused by disease. Usually these chemicals are added to the vat water at filling and remain in the vat water until the batch of fish is sold. This is known as static treatment.

Wholesalers find merit in flush treatments. The fish are bathed in a strong solution for a certain length of time, depending on the chemical, and the water is quickly replaced. An example of this type of treatment is exposure to formalin at 150 ppm for 30 to 45 minutes. This treatment is designed to eliminate external protozoan parasites other than *Ichthyophthirius.*

Formalin is not considered a very good treatment in minnow vats when prolonged treatment is used. Some treatments such as methylene blue reduce bacterial numbers, but will have an adverse effect on the minnows after prolonged exposure. Other treatments become dangerous if even slightly over used. Table 1 gives results of tests where golden shiners were given a

Fig. 7. Typical bagging procedure: (a) counting by adding to can; (b) adding counted minnows to bag; (c) filling bag with oxygen; (d) tying bag.

single dose of chemical and deaths recorded for five days.

CALCULATING CHEMICAL CONCENTRATIONS FOR FISH VATS

A variety of treatments are used in maintaining minnows in different vat sizes. Information on accurate measurement and application of treatment chemicals follows. Once a treatment procedure is derived for a particular chemical, that procedure may be used continuously.

What is a ppm?

This is an abbreviation for "parts per million." In treatment of baitfish water 1 ppm means one part treatment chemical per million parts of water.

Problem: A vat is 10 feet long and 4 feet wide with a water depth of 3 feet. How much chemical should be added to attain a concentration of 1 ppm?

First calculate the weight of the water in the tank:

Water weight — $L \times W \times D \times 62.4$

$10 \times 4 \times 3 \times 62.4 = 7{,}488$ pounds

L = length, W = width, D = depth, 62.4 pounds/foot^3

Table I. Results of Toxicity Tests* With Several Chemicals and Golden Shiners

Chemical	Level of Normal Use**	Test Results
Salt (NaCl)	Less than 0.2%	More than 0.4% caused some deaths after 96 hours
Potassium Permanganate ($KMnO_4$)	2 ppm	Deaths at more than 6 ppm
Copper Sulfate ($CuSO_4$ $5H_2O$)	0.5-1.0 ppm	Results unpredictable, some lost at less than 1 ppm
Formalin	25 ppm	Deaths at more than 25 ppm
Malachite Green	0.1 ppm	Deaths unpredictable at more than 0.075 ppm
Methylene Blue	1.0 ppm or more	At more than 2 ppm, deaths exceeded controls at 8-10/day
Acriflavine	0.1-1 ppm	Some deaths as low as 0.1 ppm treatment
Potassium Dichromate ($K_2Cr_2O_7$)	1-10 ppm	Unable to kill after 96 hours at less than 5 ppm. Total kills not experienced at 5 to 150 ppm
Oxytetracycline	1-3 ppm	Unpredictable deaths at more than 50 ppm
Chlortetracycline	1-3 ppm	Unpredictable deaths at more than 50 ppm
Nifurpirinol	1-5 ppm	Deaths at more than 5 ppm
Nitrofurazone	1-5 ppm	Deaths at more than 25 ppm
Furazolidone	1-5 ppm	Deaths at more than 50 ppm

*One dose of indefinite duration in static water
**By Texas Retailers

Next calculate the weight of chemical needed by comparing the known ratio and the unknown ratio:

N = unknown value

$$1 \text{ ppm} = \frac{1}{1{,}000{,}000}$$

$$\frac{1}{1{,}000{,}000} = \frac{\text{(N) pounds}}{7{,}488 \text{ pounds}}$$

By cross multiplication the following is obtained:

$$1{,}000{,}000 \times \text{(N)} = 1 \times 7{,}488$$

$$N = \frac{7{,}488}{1{,}000{,}000} = .007 \text{ pounds}$$

There are 454 grams in a pound and 16 ounces in a pound.

.007 pound in grams is:

$.007 \times 454 = 3.2$ grams

in ounces:

$.007 \times 16 = 0.112$ ounce

Adding Chemicals

Weighing small amounts usually is impractical. For best results, weigh 10 times the amount needed and add it to a specific amount of water. Then take 10 percent of this solution and add to your vat.

For example: Use a measuring pitcher to measure 8 ounces. Add 1.1 ounces of chemical to make a solution. Fill to 10 ounces. Add 1 ounce of the solution to the vat. Actually, 0.11 ounce of the chemical has been added to the vat.

The purpose of this procedure is to allow for the initial accurate weighing of the chemical since commonly available balances are not scaled to small amounts.

Type of Balance

A balance for use in baitfish establishments should have three main features: the ability to weigh small amounts; maintain a high degree of accuracy; and maintain low cost. These features are characteristics of the balances used by sportsmen in weighing powder for ammunition reloading. They are available from most sporting goods stores.

Adding Chemical Mixtures

Example: A chemical contains 10 grams active material in a 6.4-ounce (181 grams) package. In the previous problem 3.2 grams were needed for a 1 ppm concentration in the vat.

The amount needed may be calculated by comparing the known ratio to the unknown ratio:

$$\frac{3.2 \text{ grams}}{\text{(N) ounce}} = \frac{10 \text{ grams}}{6.4 \text{ ounces}}$$

$$N = 3.2 \times \frac{6.4}{10} = 2.05 \text{ ounces} = \text{amount needed}$$

Adding Formalin

Formalin is used as if it were a 100 percent active chemical. Because it is a liquid and is close in weight to water, the concentration may be figured on a volume-to-volume basis instead of a weight basis shown in the initial problem.

Applying the Chemicals

Chemicals may be applied as solids or liquids. If the application rate is large enough for the chemical to be added without the use of a stock solution, it is possible to add the powder directly to the tank. A method often used is mixing this measured amount of powder with approximately 1 quart of water and then pour it evenly into the tank. This will prevent a "hot spot" that could adversely affect the fish.

If the chemical is applied as a stock solution, a syringe with the needle removed is a helpful device.

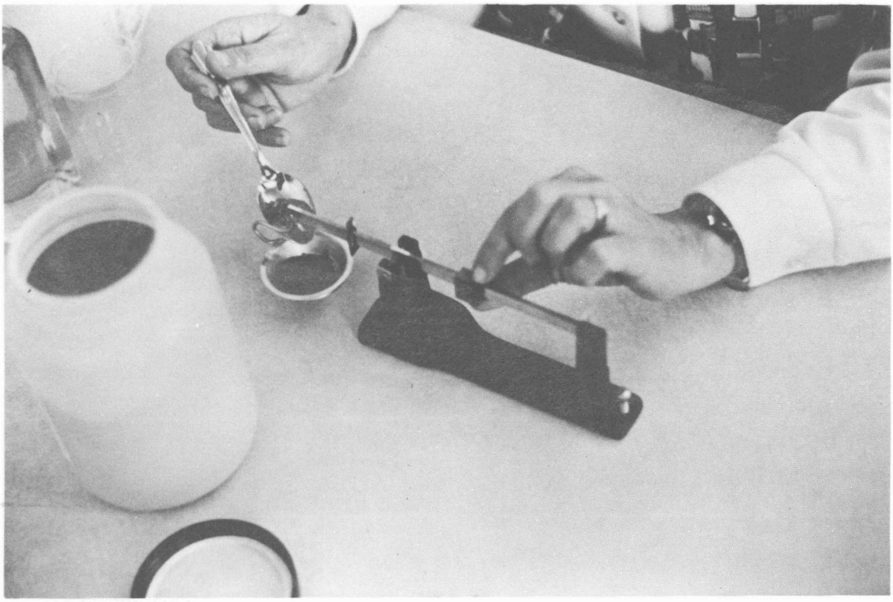

Fig. 8. A balance used by sportsmen for ammunition reloading is an inexpensive but accurate instrument for measuring minnow treatment chemicals.

Table II. Average Weight Per Thousand of Minnows of Various Size Groups

Total length in inches	Weight per 1,000 in pounds
Golden shiners	
2	3.9
2 1/2	5.4
3	8.6
3 1/2	13.5
4	19.0
4 1/2	31.5
5	44.0
5 1/2	60.0
Goldfish	
1 1/2	2.9
2	5.4
2 1/2	9.0
3	17.0
3 1/2	24.5
4	40.0

Table III. Conversion Factors
(Volumes to weights [avoirdupois] are for water)

1 cubic foot = 7.5 gallons = 62.4 pounds = 28,355 grams	
1 cubic inch = 16.4 cubic centimeters = 0.004 gallon = 0.016 liter = 16.4 grams	
1 gallon = 8.34 pounds = 231 cubic inches = 0.03 cubic foot = 3.785 liters = 3,785 grams	
1 pound = 453.6 grams = 16 ounces	
1 ounce = 28.35 grams = 437.5 grains = 16 drams	
1 dram = 27.3 grains = 1.77 grams	
1 grain = 0.065 grams	
1 teaspoon = 1 1/3 drams = 36.4 grains = 1/3 tablespoon = 1/6 ounce	
1 ppm = 0.0038 grams per gallon	= 1 gram in 1,000,000 grams
= 0.028 grams per cubic foot	= 1 grain in 1,000,000 grains
= 1 pound in 1,000,000 pounds	= .059 grains per gallon

SELECTED REFERENCES

L-1210, *Ich Disease of Fishes,* Texas Agricultural Extension Service, Texas A&M University, College Station, Texas, 1974.

B-1311, *Raising Minnows,* Texas Agricultural Extension Service, Texas A&M University, College Station, Texas, 1976.

L-1409, *Anchor Parasites of Fishes,* Texas Agricultural Extension Service, Texas A&M University, College Station, Texas, 1975.

Minnow Propagation, Its Problems and Commercial Possibilities, Parks and Wildlife Department, John H. Reagan Building, Austin, Texas.

Production of Bait Minnows in the Southeast, Agricultural Experiment Station, Auburn University, Auburn, Alabama, 1954. Circular 112.

Publication No. FDDL-F2, *Temperature Change As A Cause of Retail Minnow Death,* Fish Disease Diagnostic Laboratory, Texas A&M University, College Station, Texas, 1974.

Publication No. FDDL-F14, *Transport of Live Fish,* Fish Disease Diagnostic Laboratory, Texas A&M University, College Station, Texas, 1979.

Publication No. FDDL-F3, *Bacterial Infection in Golden Shiners of Texas Retailing Establishments,* Fish Disease Diagnostic Laboratory, Texas A&M University, College Station, Texas, 1974.

Publication No. FDDL-F5, *Water Chemistry of Retail Minnow Vats,* Fish Disease Diagnostic Laboratory, Texas A&M University, College Station, Texas, 1974.

Publication No. FDDL-F7, *Parasite Infestation in Golden Shiners of Texas Retailing Establishments,* Fish Disease Diagnostic Laboratory, Texas A&M University, College Station, Texas, 1975.

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