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A New Device for Collecting Drifting Semibuoyant Fish Eggs

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Abstract.—Several fish species in lotic systems are pelagic broadcast spawners that produce nonadhesive, semibuoyant eggs that drift downstream. This reproductive strategy and egg type appear to be common in Plains stream cyprinids in the west-central United States. Although it is relatively easy to capture semibuoyant eggs, the inability to provide species-specific identification of this life stage has hindered studies on the reproductive ecology and life history of these fishes. While drift nets have been used to collect semibuoyant eggs, the process of separating the reproductive products from other organic drift was time consuming and usually fatal for eggs. We developed a field sampling device, the Moore egg collector, that allowed for the efficient, quantitative, and nondestructive collection of large numbers of semibuoyant fish eggs and that could aid in the study of a variety of organisms that employ drift as a dispersal strategy during a portion of their life history.

In the summer of 1940, George A. Moore and students (University of Oklahoma) initiated life history studies of Arkansas River drainage cyprinids in the Cimarron River in Oklahoma. The principal objective of their study was to obtain information on breeding habits and early developmental stages of two Plains stream fishes, the Arkansas River speckled chub *Macrhybopsis aestivalis tetranemus* and the Arkansas River shiner *Notropis girardi*. Moore (1944) reported the capture of numerous nonadhesive, semibuoyant fish eggs as one of his students held a wire mesh screen (1.6-mm mesh) in the waist-deep flow of the river. In order to determine the specific identification of the eggs, Moore (1944) reared the eggs through larval developmental stages and ultimately identified them as Arkansas River shiner.

Data obtained from Moore's reared-fish collections allowed for a better understanding of aspects of the life history of Plains stream fishes. From egg type morphology and larval fish development and behavior, Moore (1944) speculated that Arkansas River shiner spawning was stimulated by intense summer rainstorm events. He also noted the rapid hatching (24 h) of the relatively large eggs (ca. 2.5 mm in diameter) and the swim-up behavior of the larvae. Bottrell et al. (1964) discovered that Arkansas River speckled chub and plains minnow *Hybognathus placitus* also produced semibuoyant eggs and that the larval fish development and behavior of these two species was similar to that noted by Moore (1944) for Arkansas River shiner. Most recently, Platania and Altenbach (1998) reported this reproductive strategy and egg type in three additional Plains stream cyprinids: Rio Grande silvery minnow *Hybognathus amarus*, Rio Grande shiner *Notropis jemezanus*, and Pecos bluntnose shiner *Notropis simus pecosensis*.

In 1993, we used drift nets to collect and determine the catch rate of semibuoyant eggs from members of this reproductive guild (plains minnow, Arkansas River speckled chub, Arkansas River shiner, Rio Grande shiner, and Pecos bluntnose shiner) in the Pecos River in New Mexico. (In this paper, the term drift net refers to a 0.5-m–diameter mouth, 4-m–long, 560 μm–bar-mesh plankton net fitted on a 36 × 46–cm rectangular frame.) The spring and summer rainstorm events that triggered spawning by guild members also delivered substantial amounts of debris into the river. We observed that the majority of semibuoyant eggs collected during the 1993 study were damaged or killed either during the collecting or the sorting process.

Moore's serendipitous collection of eggs in 1940, made with a screen, provided the impetus for the techniques we developed, techniques that have resulted in more detailed studies of this cyprinid reproductive guild. This paper reports the design of a device that passively sorts and concentrates semibuoyant eggs from instream debris so that the undamaged eggs can be easily collected and reared to an identifiable larval stage. In recognition of the pioneering efforts of G. A. Moore in the study of the ecology of this reproductive

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guild of Plains stream fishes, we name this device the Moore egg collector (MEC).

Methods

Design and construction.—The Moore egg collector is a sluice-box–like device, with a rectangular opening at its upstream end (width = 45 cm; height = 33 cm), parallel wooden sides (length = 119 cm), and an open top (Figure 1). The bottom is framed fiberglass window screen (1.6-mm mesh) that is installed at a 23° angle relative to the bottom mounting bar. Mounting bars are attached near the posterior end of the mouth and perpendicular to the sides. This device is relatively inexpensive, requiring less than US$100 in materials, all of which are available at most hardware centers, and it can be built in 1 d.

The MEC is constructed of 9.5-mm–thick C : D-grade plywood, 25 × 51–mm pine furring strips, and zinc-plated wood screws, and it weighs about 6.8 kg. Aluminum screen framing (7.94 × 19.06 mm) and plastic screen corners are used to make the 43 × 104–cm filtering screen. Damaged screens can be easily replaced, and different mesh sizes can be used to suit individual study objectives. The screen frame is fastened with small wood screws to the parallel pine furring strips that are attached to the interior wall at the base of the MEC. The wedge-shaped water diverter is 90 mm tall at the edges, 130 mm high at the creased (150°) midpoint, and is cut from 2.4-mm aluminum plate. Angled (90°) mounting brackets, bolted with machine screws to both the back of the diverter and top of the flume, hold this piece in place.

The illustrated version of the sample holding cup comprises two relatively simple polyvinyl chloride (PVC) components (Figure 1) and can be easily modified by users to accommodate their needs. We attached a 50.8 mm–diameter PVC plug to the posterior cross-member (with wood screws) and cemented a 50.8 mm–diameter coupling to the plug. The sample holding cup is made of a 152.5-mm segment of schedule 40 PVC (50.8 mm diameter) pipe sealed at the bottom by a test cap and silicon and at the top by a pressure cap. The holding cup is held in place by the coupling sleeve. The upper and lower ends (exteriors) of the PVC pipe (=sample holding cup) are sanded so that neither the fit of the pressure cap nor its fit in the coupling is too tight.

Flowmeters can be easily attached by placing mounting holes in the walls of the mouth of the MEC or by attaching small pieces (ca. 4 × 4 cm) of aluminum plate, with a predrilled attachment hole that overhangs the mouth by about 2 cm, into the tops or sides (not illustrated). Flowmeters can be mounted top to bottom (as illustrated) or side to side. As with construction of the sample holding cup, individuals can modify the flowmeter attachment mechanism. In order to extend the life of the collecting device, all wood surfaces should receive multiple coats of high-quality marine varnish.

Field application.—During operation, the MEC is held in place by the force of the water that is pushing the device against metal fence posts (t-posts) that are driven into the stream bottom (Figure 2). Electric fence insulating brackets are fastened, as per manufacture's instructions, at about the same level on each t-post. The brackets support the weight of the MEC and allow for its vertical adjustment. Operating the device just below the water's surface prevents collection of floating debris and allows the aluminum water diverter, positioned on top, to reduce drag under high-velocity conditions. The posterior t-post and electric fence insulating bracket support the downstream end of the collecting device. Drift that enters the MEC becomes impinged on the screen, while the current pushes the spherical, semibuoyant fish eggs up the inclined screen. Eggs accumulate at the water–air-screen interface, where they can be easily gathered, counted, and collected with an eyedropper before being placed in the water-filled (and removable) sample holding cup.

Particulate matter that accumulates on the screen and impedes the flow of water can easily be removed either by hand or by immersing the downstream end of the MEC into the water. The interim between screen cleaning is dependent on the amount of debris in suspension and on the velocity of water being sampled, but in our experience, this interim ranged between 30 s and several hours. Capture rate of drift by the MEC should be determined based on the volume of water (i.e., catch per unit effort [CPUE]) filtered as opposed to sampling duration. This is accomplished by mounting a flowmeter in the mouth of the MEC and by calculating CPUE using the area of the mouth and the appropriate formula for the flowmeter employed.

Results and Discussion

Comparison of Drift Net and MEC Catch Rates

A comparative investigation of drift net and MEC egg-catch rates was performed on nine oc-

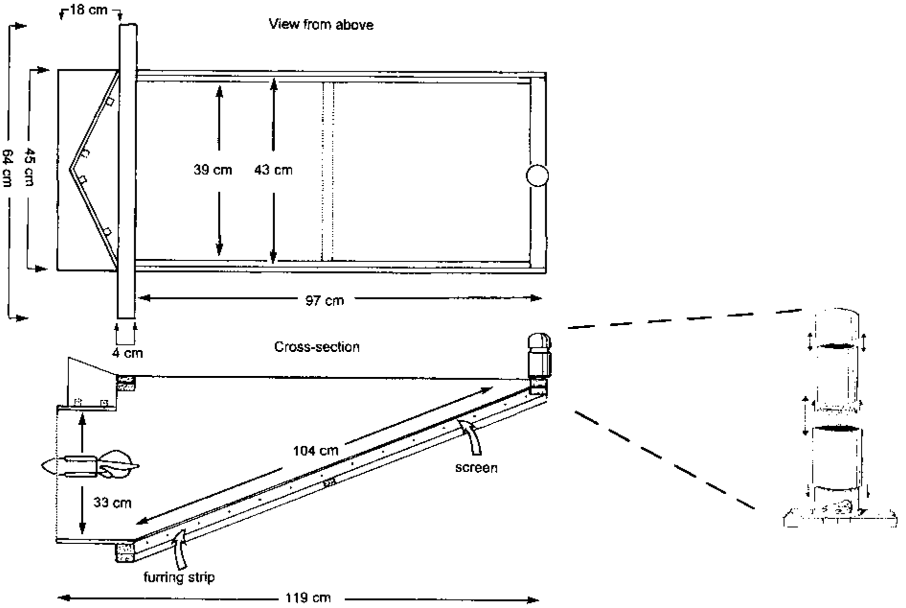

FIGURE 1.—Schematic of the Moore egg collector showing top and horizontal or side views.

casions in the Pecos River (New Mexico) during the period of 9–14 June 1997. The two devices were set simultaneously in similar velocity habitats and within 1 m of each other. About 19,000 eggs were taken in the 18 samples of this preliminary study. More than four times as many eggs were collected in the MEC compared with the drift net, despite the fact that we sampled similar volumes of water. The amount of time that the two devices were operated was not comparable, as the drift net was fished almost twice as long as the MEC in order to sample the equivalent volume of water. A paired two-sample *t* test of this data set demonstrated significant differences ($P = 0.0090$) in CPUE between the drift net and MEC (Table 1).

Frequent screen cleaning of the MEC improved the sampling efficiency of the device and resulted in larger collections of semibuoyant eggs than were obtained with drift nets, even though similar volumes of water were sampled. As debris accumulated in the drift net, filtering efficiency decreased, likely in response to increased resistance to flow through the net. The number of eggs collected in a given volume of water began to decrease once there was a noticeable resistance to flow through the drift net, and this decrease became marked when instream debris levels were high. A potential explanation for the differences in catch rate between devices was that the natural hydrologic path followed by drifting fish eggs approaching the drift net was altered because that device accumulated debris. This ultimately resulted in a situation in which fewer semibuoyant fish eggs entered the drift net.

Conclusion

The MEC is more cost effective, efficient, and informative (=quantitative) than fine-mesh seines or drift nets in terms of the collection of drifting semibuoyant fish eggs. Two people are required to operate a seine, and any eggs collected are difficult to locate and remove. Since the volume of flowing water sampled during seining cannot be quantified, an accurate catch rate cannot be determined. Conversely, while catch in a drift net can be quantified, the eggs are collected with large amounts of debris. The process of separating eggs from unwanted drift is time consuming and costly, and ichthyoplankton collected in the drift net are usually damaged or killed, either during the set or removal of the net. Continual cleaning of a drift net would likely improve its filtering efficiency and result in increased capture rates of semibuoyant eggs, but this would not be practical. Although it is generally easy to capture semibuoyant fish eggs using these two sampling methods (seines and drift nets), the inability of these methods to provide both accurate and quantitative catch rates and live specimens for subsequent

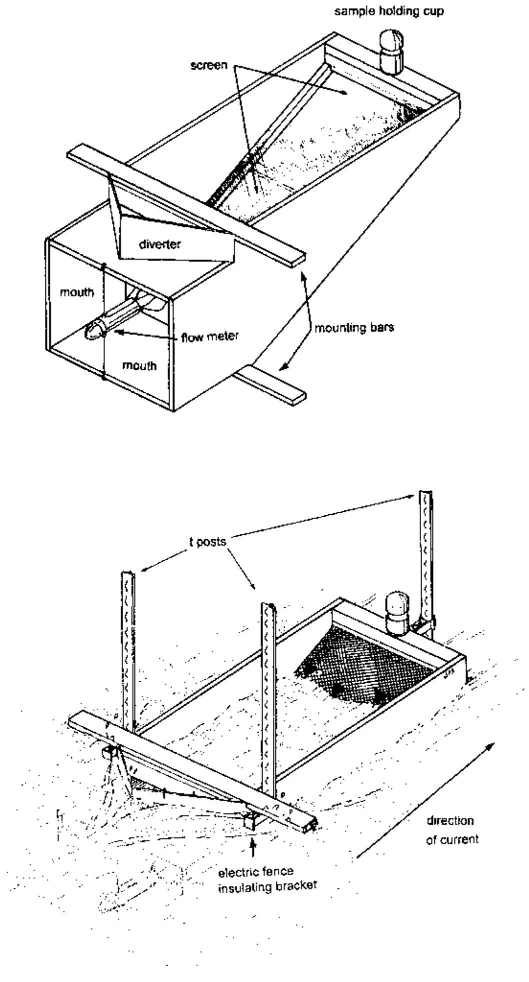

FIGURE 2.—Three-dimensional view of the Moore egg collector and a view with the collector in place in the river. The large arrowheads in the lower drawing indicate the area of semibuoyant egg accumulation.

TABLE 1.—Comparison between drift net and Moore egg collector (MEC) catch rates of semibuoyant eggs.

Measurement	Drift net	MEC
CPUE[a] for sample number:		
1	32.68	84.98
2	3.53	17.50
3	3.72	29.90
4	1.19	5.75
5	1.25	10.79
6	1.72	8.00
7	0.86	6.53
8	0.93	12.40
9	0.60	7.41
Number of semibuoyant eggs collected	3,416	15,580
Total volume (m^3) of water sampled	1,090	1,051

[a] Catch per unit effort (CPUE) was calculated per cubic meter of water sampled; sample times are not comparable.

species-specific identification of early life stages limits the utility of these sampling techniques in determining specifics of the reproductive ecology and life history of these fishes.

The MEC is designed for the rapid, quantitative, and nondestructive collection of large numbers of drifting semibuoyant eggs. It is a relatively inexpensive item that requires only one person to operate, and it can be employed effectively in both high- and low-velocity conditions. Most investigations will require that an individual remain with the MEC throughout the sampling period (i.e., 1–2 h). However, we found that when instream debris levels were low, the MEC could be left unattended for several hours, and it would still remain an efficient collecting device.

Although we designed and used this device to study the periodicity and magnitude of spawning by Plains stream cyprinids that produce semibuoyant eggs, its utility may benefit other ichthyological and ecological studies. There are numerous fish taxa other than Plains stream cyprinids that produce eggs that remain in suspension in the water column while drifting (e.g., Hiodontidae, Clupeidae, grass carp *Ctenopharyngodon idella,* striped bass *Morone saxatilis,* and freshwater drum *Aplodinotus grunniens*). The MEC also collects drifting larval fishes and aquatic invertebrates and may be applicable for studies that investigate the timing, duration, and magnitude of their drift.

We are currently experimenting with several design modifications of the MEC. Changes in screen type and configuration are being tested in an attempt to increase the ease of collection of larval fishes; we continue to refine the overall structure of the MEC with the goal of providing a more automated sampling device. Detailed quantitative laboratory and field studies designed to assess and explain differences in semibuoyant egg-capture rates related to drift nets and the MEC are ongoing.

Acknowledgments

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