Rediscovery of Labidesthes sicculus (Atherinidae) in Lake Texoma (Oklahoma-Texas)

Kerri E. Pratt; Chad W. Hargrave; Keith B. Gido


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1986), cliff swallows (*Petrochelidon pyrrhonota—* Holthuijzen et al., 1987), and European starlings (*Sturnus vulgaris—*White, 1962) in aerial pursuits. However, these observations were of multiple high-angle dives by the falcon through flocks of birds, whereas the observation reported here is of a single low-angle stoop. None of the other sightings noted the roll-over behavior that I observed.

There are 2 documented accounts of other species of falcons taking swifts in flight. Arnold (1942) observed a pair of large falcons thought to be peregrines (*Falco peregrinus*) working together to capture a white-throated swift. One falcon chased the swift, while the other dove on it from above and made the capture. The second account (Johansson and White, 1995) involved an American kestrel (*Falco sparverius*) that approached a white-throated swift head-on and slightly below. As the swift climbed, the kestrel flared upward and made the capture.

**Resumen**—Observé a un halcón mexicano (*Falco mexicanus*) capturar a un vencejo en vuelo. El halcón se acercó al vencejo desde atrás hasta que estuvo un poco debajo de su propuesta presa. Como el vencejo subía para evitar la depredación, el halcón se volteó justo debajo del vencejo y con sus garras agarró su presa. Aunque el halcón es principalmente un cazador de mamíferos y aves que suelen andar en el suelo, esta observación testifica las habilidades aéreas del halcón.

**LITERATURE CITED**

Arnold, L. W. 1942. The aerial capture of a white-throated swift by a pair of falcons. Condor 44: 280.


Associate Editor was William H. Balosser.

**REDISCOVERY OF LABIDESTHES SICCUS (ATHERINIDAE) IN LAKE TEXOMA (OKLAHOMA–TEXAS)**

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Displacement of native species from their habitats has been linked to the introduction of nonindigenous species (Ross, 1991; Townsend and Crowl, 1991; Douglas et al., 1994). An example of this occurred in Lake Texoma (Oklahoma–Texas) where the abundance of native *Labidesthes sicculus* (brook silverside) decreased after the arrival of *Menidia beryllina* (inland silverside) in 1953. Riggs and Bonn (1959) reported *L. sicculus* as one of the most common species, second only to *Dorosoma cepedianum* (gizzard shad), in Lake Texoma from 1948 through 1952. However, it declined rapidly over the next 3 years, though it was still abundant in tributaries to the reservoir in 1955 (Dowell, 1956; Riggs and Bonn, 1959). By
1958, Riggs and Bonn (1959) no longer found specimens in the tributaries or reservoir despite considerable collecting effort. Contrary to this finding, in 1967, 2 adults were taken from the Buncombe Creek arm of the reservoir (Mense, 1967), and Smith and Powell (1971) collected a few individuals in Brier Creek, a tributary to Lake Texoma, suggesting that *L. sicculus* remained in the reservoir and tributary creeks, albeit in low abundance. However, W. J. Matthews (pers. comm.) stated that in more than 20 years of sampling Brier Creek, no *L. sicculus* have been taken, and a thorough sampling of Buncombe Creek in 1995 failed to produce a single specimen (Lienesch et al., 2000).

Because the decline of *L. sicculus* was coincidental with the introduction of *M. beryllina*, competitive exclusion was suggested as a possible mechanism (Riggs and Bonn, 1959; McComas and Drenner, 1982). In a series of laboratory experiments, McComas and Drenner (1982) showed that *M. beryllina* more successfully foraged on copepods than did *L. sicculus* because the mouth morphology of *M. beryllina* allows more efficient suction feeding. Because McComas and Drenner (1982) could not show that food resources were limiting in Lake Texoma, they could only speculate that competition between the species caused the decline of *L. sicculus*. However, in early summer, crustacean zooplankton often occur in densities of less than 100 individuals per liter, which is sufficiently low to result in possible competition (W. J. Matthews, pers. comm.).

Despite reports of its extirpation, *L. sicculus* either has remained present or has reinvaded restricted habitats of the reservoir. Herein, we report the occurrence of *L. sicculus* at 7 locations in Lake Texoma based on shoreline seineing in summer 1999.

Fishes were collected at 41 sites on Lake Texoma (Fig. 1) with a 7.62-m × 1.8-m bag seine (4.8-mm mesh) and a 4.6-m × 1.2-m straight seine (3.2-mm mesh) from 14 to 26 July 1999. Four adjacent 25-m reaches were sampled at each site. For each sample, the bag seine was hauled offshore parallel to the shoreline at 1.0 to 1.5-m depth for 25-m, and the straight seine was used to sample all shoreline habitats in this same reach. Samples from each of the 4 reaches were pooled for each site.

Physical and chemical variables were measured concurrent with fish sampling to examine the relationship between environmental parameters and distribution of silversides. Dissolved oxygen concentration, conductivity, and pH were measured with a HydroLab Scout 11, and water transparency was estimated with a Secchi disk at each site. In addition, one person followed the seiners and noted the occurrence of major substrate types for each 25-m reach sampled. Only substrates that occupied >30% of the area were included. Substrate categories included silt (<0.12-mm), sand (0.12 to 1-mm), gravel-cobble (1 to 256-mm) and boulder (>256-mm). The number of reaches containing each substrate type was divided by 4 (total number of reaches sampled) to give a percent occurrence of each substrate type for that site (i.e., 0%, 25%, 50%, 75%, 100%). Fish specimens were preserved in 10% formalin and, after fixation, transferred to 50% isopropyl alcohol for permanent storage at the Sam Noble Oklahoma Museum of Natural History.

Analysis of variance (ANOVA) was used to test for differences in mean Secchi depth, conductivity, dissolved oxygen, abundance of *M. beryllina*, and percent occurrence of major substrate types among: 1) coves with *L. sicculus*; 2) coves without *L. sicculus*; and 3) exposed sites without *L. sicculus*.
Table 1—Percent volume of different food items found in guts of L. sicculus and M. beryllina. All specimens were taken in July 1999 from sheltered coves where these species co-occurred in Lake Texoma.

<table>
<thead>
<tr>
<th>Food item</th>
<th>L. sicculus (n = 19)</th>
<th>M. beryllina (n = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial insects</td>
<td>81.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Rotifers</td>
<td>7.4</td>
<td>19.3</td>
</tr>
<tr>
<td>Seeds</td>
<td>0.0</td>
<td>13.9</td>
</tr>
<tr>
<td>Algae</td>
<td>0.0</td>
<td>33.0</td>
</tr>
<tr>
<td>Aquatic insects</td>
<td>7.9</td>
<td>17.2</td>
</tr>
<tr>
<td>Fish</td>
<td>3.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Detritus</td>
<td>0.0</td>
<td>11.9</td>
</tr>
</tbody>
</table>

present; 2) coves without L. sicculus present; and 3) exposed sites without L. sicculus present. If a difference was detected with ANOVA, post-hoc pairwise comparisons between habitats were tested using Tukey’s multiple-comparison procedure (Toothaker, 1993). Percent occurrence of major substrate types was arcsine transformed prior to analysis to better approximate normality.

Ovary development and egg stages were classified for 5 female L. sicculus based on criteria defined by Heins and Rabito (1986). Nine males also were rated as either mature or immature based on testes development. In addition, the anterior third of the intestine from 15 M. beryllina and 19 L. sicculus was examined for gut contents using a stereoscope. All individuals examined were from sites where both species occurred. Gut contents were spread on a Petri dish with a reference grid, and relative volume of food items was estimated by approximating the area occupied by each item. Food items were classified into major resource groups (Table 1) and Schoener’s index was used to assess dietary overlap between the species (Schoener, 1971) based on relative volumes of items found in their diet.

We collected 189 L. sicculus at 7 of the 41 sites on Lake Texoma. Overall, L. sicculus was ninth in abundance of 41 species captured. All sites where L. sicculus was captured were located in sheltered coves with marinas. Because L. sicculus occurred only in these coves, comparisons of M. beryllina abundance and environmental variables were made among 3 groups of sites: 1) coves with L. sicculus present (n = 7); 2) coves without L. sicculus (n = 8); and 3) exposed shorelines without L. sicculus (n = 26).

Although mean abundance of M. beryllina was lowest in coves with L. sicculus present, there was no significant difference among the 3 habitats (ANOVA, F = 1.33, P = 0.275; Fig. 2). There was a significant difference (F = 10.66, P < 0.001) in Secchi depth among habitats. Tukey’s multiple-comparison tests indicated that coves without L. sicculus had significantly lower Secchi depth than either exposed sites or coves with L. sicculus. No significant difference was found among habitats for conductivity (F = 0.09, P = 0.918), or dissolved oxygen (F = 1.63, P = 0.210). There were significant differences among sites in the proportions of silt (F = 5.61, P = 0.007), sand (F = 4.21, P = 0.022), and cobble-boulder (F = 3.84, P = 0.030; Fig. 3). Tukey’s multiple-comparison tests indicated that exposed sites had a lower proportion of silt than sites without L. sicculus, and that coves with L. sicculus had a higher proportion of cobble-boulder than coves without L. sicculus. Although the overall ANOVA indicated a significant difference in proportion of sand among habitats, Tukey’s tests failed to detect a difference among groups. No significant difference was found in proportion of gravel among sites (F = 0.71, P = 0.498).

Of the 5 females examined, 4 had mature gonads. In addition, the fifth individual had ripe eggs. Of the 9 males examined, 7 had mature testes.

There was little overlap in the diets of L. sicculus and M. beryllina (Schoener’s index = 0.20). Terrestrial invertebrates were most abundant in the diet of L. sicculus, whereas M. beryllina consumed a variety of items including algae, rotifers, cladocera, and detritus (Table 1). Labidesthes sicculus and M. beryllina both have been reported to consume a wide range of foods including aquatic invertebrates, zooplankton, and small terrestrial invertebrates (e.g., Robison and Buchanan, 1988).

Finding moderate numbers of L. sicculus with M. beryllina in Lake Texoma suggests these species coexist in this reservoir. Although L. sicculus once was broadly distributed in the reservoir (Riggs and Bonn, 1959), we found it only in sheltered habitats, whereas M. beryllina was broadly distributed. The fact that water transparency and substrate composition dif-
**Fig. 2**—Comparisons of *M. beryllina* abundance and environmental variables from exposed sites without *L. sicculus*, coves with *L. sicculus*, and coves without *L. sicculus*. Error bars represent 1 SE. Bars with identical letters are not statistically different based on Tukey’s multiple-comparison procedure.

**Fig. 3**—Comparisons of percentage of reaches containing each substrate type within exposed sites, sites in coves with *L. sicculus* present, and sites in coves without *L. sicculus* present. Error bars represent 1 SE. Bars with identical letters are not statistically different based on Tukey’s multiple-comparison procedure.
ferred between sites with *L. sicculus* and sites without *L. sicculus* suggests that environmental factors may regulate the abundance and distribution of this species in Lake Texoma. In a smaller, Texas reservoir, Bettoli et al. (1991) showed that *M. beryllina* and *L. sicculus* were able to coexist in the presence of dense vegetation, but when the vegetation was removed by grass carp (*Ctenopharyngodon idella*) *L. sicculus* abundance declined. It seems the introduction of *M. beryllina* reduced the distribution rather than extirpated *L. sicculus* from Lake Texoma.

Some aspect of sheltered coves allows *M. beryllina* and *L. sicculus* to co-occur. A high proportion of terrestrial invertebrates in the diet of *L. sicculus* suggests this resource may be more abundant in sheltered coves than at exposed sites. Moreover, because these habitats all had marinas, it is possible that artificial lights attracted midges which supplemented the diet of *L. sicculus*. In general, coves have been described as mesocosms within reservoirs, with environmental gradients independent of the main body (Kimmel et al., 1990). They are habitats sheltered from wind, have high productivity, have high input of allochthonous material, and often have different fish assemblages from open-water areas (Matthews, 1998).

Shifts in the feeding niche by *L. sicculus* may help further explain the low overlap in diet between *L. sicculus* and *M. beryllina* in Lake Texoma. Whereas both species are reported as having similar food habits (Robison and Buchanan, 1988), changes in feeding niches of fishes in response to competitors have been reported in natural (Macan, 1977) and experimental systems (Werner and Hall, 1976). A shift in feeding niche often reflects the feeding morphology of 1 of the competing species and the resources it is able to exploit (Gerking, 1994). Mouth morphology of *L. sicculus* restricts this species to a feeding niche composed primarily of terrestrial insects when in the presence of *M. beryllina*.

It is possible the occurrence of *L. sicculus* in Lake Texoma is a result of immigration from nearby tributaries; however, the coves in which *L. sicculus* occurred were not connected directly to perennial streams; thus, the fish would have to travel across the main body of the lake, from perennial streams, to reach these habitats. Moreover, the current distribution of *L. sicculus* may exist because of bait-bucket introductions. The presence of adults with mature eggs suggests that *L. sicculus* reproduce in these habitats and are likely self-sustaining populations.

Reservoirs provide unique, constructed environments that have been colonized by numerous fish species (e.g., Gido et al., 2000). Whereas some species thrive under these conditions, others (such as *L. sicculus*) may only thrive in the absence of competitors (e.g., Riggs and Bonn, 1959; McComas and Drenner, 1982; and this study) or in the presence of certain habitats (e.g., Bettoli et al. 1991; this study). For example, T. M. Buchanan (in litt.) found *L. sicculus* in 28 of 31 Arkansas reservoirs; however, *M. beryllina* occurred in only 6 of the 28 reservoirs in which *L. sicculus* was present. Thus, if a competitor, such as *M. beryllina*, is present, *L. sicculus* may only be able to sustain populations in restricted habitats. Our supposition is that *L. sicculus*, which was once widespread in the reservoir, cannot sustain a large population in Lake Texoma due to the presence of *M. beryllina*. However, the species are able to coexist in coves where water transparency is higher and substrate is coarse. Course substrate may provide suitable spawning substrate for adhesive eggs that sink to the bottom and adhere to submerged objects (Robison and Buchanan, 1988). Furthermore, sheltered coves, and possibly artificial lights from marinas, may provide an abundant source of terrestrial insects for adult *L. sicculus*. It is likely that a combination of spawning habitat and food resources in these coves is important for the survival of *L. sicculus* in Lake Texoma.

Resumen—La pérdida de especies nativas puede ser causada por la introducción de especies no nativas en hábitats específicos. Un ejemplo ocurrió en el Lago Texoma (Oklahoma–Texas), donde la abundancia del pez nativo, *Labidesthes sicculus*, disminuyó en el embalse después de la llegada de *Menidia beryllina* en 1953. En contra de las afirmaciones de la extinción completa, de *L. sicculus*, se la especie está todavía o reinvió el lago y se encuentra en las habitats restringidos del embalse. El descubrimiento de números moderados de *L. sicculus* junto con *M. beryllina* en el Lago
Texoma sugiere que estas especies pueden coexistir. Aunque *L. sicculus* estaba distribuida anteriormente por todas partes en el embalse, se encuentra ahora sólo en habitats cubiertos, y *M. beryllina* se distribuye por todas partes. Porque no encontramos una diferencia en las variables de la química del agua, parece que las características físicas de los habitats y la interacción con *M. beryllina* determinan la distribución de *L. sicculus*. Parece que la introducción de *M. beryllina* solamente redujo la distribución de *L. sicculus* en vez de extirparla del embalse.

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**LITERATURE CITED**


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