BIOLOGY OF THE EUROPEAN BITTERLING RHODEUS SERICEUS (PISCES: CYPRINIDAE) IN THE BRONX RIVER, NEW YORK, USA: AN APPARENTLY BENIGN EXOTIC SPECIES

R. E. SCHMIDT
R.D. No. 4, Box 208, Newton, New Jersey 07860, USA

&

J. McGURK
Biology Department, Fordham University, Bronx, New York 10458, USA

ABSTRACT

Selected aspects of the biology of the European bitterling Rhodeus sericeus in southern New York were investigated as a preliminary determination of the impact of this species on the native ecosystem. There are about 900 bitterlings in the only extant North American population. The oldest specimen was in its fourth summer (III+) and all were mature in their first year. Fecundity is low, less than 60 eggs per female. Bitterlings feed primarily on diatoms and the digestive system is typical of a surface-scraping herbivore. Impact of this exotic species on the ecosystem appears minimal. It is unlikely that the species would cause appreciable negative impact on any habitat in the northeastern United States.

INTRODUCTION

The introduction of a species into a new location always causes changes in the ecosystem as the exotic species adjusts or dies out. This change can be transitory and minor or long-lasting and major, with either positive or negative connotations. In North America some popular exotic game fish introductions have been considered economically positive. However, many negative experiences have occurred where the exotic fish caused economic damage by destroying valuable native fish populations like the carp (Shafland, 1979) and the walking catfish (Courtney & Miley, 1975) or having a negative effect on endangered species such as Crenichthys baileyi (Deacon et al., 1964). The trend in North America now is towards careful examination of potential introductions with the intention of avoiding past errors. Analysis of the effects, or lack of effect, that established exotic species have on the ecosystem could add useful data to apply to other situations.
The European bitterling, *Rhodeus sericeus* (Bloch), was introduced into natural waters of New York State around the turn of the century (Dence, 1925; Myers, 1925; Bade, 1926) and still persists in about 1.2 km of the Bronx River, Westchester County, New York (Schmidt et al., 1981). The bitterling has been a popular aquarium fish in Europe since the late 1800s and much has been published on its general behaviour (Wiepkema, 1961) and its adaptations for inserting eggs into the mantle cavity of freshwater mussels (Duyvene de Wit, 1955). There is little information on the biology of the bitterling in North America beyond its ability to breed in two native mussels (Breder, 1933). This knowledge is necessary to describe the effect, if any, this exotic species may have on sympatric fishes. The purpose of this paper is to describe the population size, age, fecundity, food habits, and incidental observations on internal anatomy of the bitterling in North America and relate these parameters to potential impacts of this exotic species on native ecosystems.

**STUDY AREA**

The distribution of the bitterling in the Bronx River is determined by the distribution of its host mussel, *Anodonta cataracta* (Schmidt et al., 1981). In the Bronx River, the mussels, and therefore the bitterlings, are located in the town of Bronxville near the southern border of Westchester County, New York. Water quality in this part of the river is generally poor, although our study area is upstream of the worst sections. There is considerable evidence of organic pollution (odours, algal growth) and debris (bottles, shopping carts) in the river bed. The water is turbid, with visibility at best about 40 cm. Native fishes collected with the bitterling were: white sucker *Catostomus commersoni*, tessellated darter *Etheostoma olmstedi*, mummichog *Fundulus heteroclitus*, redbreast sunfish *Lepomis auritus*, pumpkinseed *L. gibbosus*, golden shiner *Notemigonus crysoleucas*, common shiner *Notropis cornutus*, spottail shiner *N. hudsonius*, and blacknose dace *Rhinichthys atratulus*. Two other exotic species were collected at the same locality; goldfish *Carassius auratus* and carp *Cyprinus carpio*.

**MATERIALS AND METHODS**

We divided the study area into two shallow sections upstream and downstream of an impounded area that we could not sample. The two sections had moderate to slow currents, sandy substrate, a few rocky riffles in the upper section, and more riffles in the lower section. Most of the area was less than 1 m deep but a few pools were much deeper.

We sampled bitterlings once a week for four consecutive weeks in late April and May 1980. We collected with a 3.3 m seine and concentrated our efforts in locations
that regularly yielded specimens. The bitterlings were anaesthetized with Tricaine methanosulphonate. Each was measured (standard length, SL), one scale was removed from individuals selected to represent the range of sizes in the population for ageing, and sex was recorded. The individuals in the upper section were marked by clipping the tip of the upper lobe of the caudal fin, those in the lower section had the lower lobe clipped. Fish were retained in a tub of water until they regained equilibrium and appeared normal, then were released. Population size was calculated with the Schumacher technique (Ricker, 1975).

Five specimens (four females and one male) were killed from the last sample and returned to the laboratory. They were measured, dissected, and some scales were removed. Gut contents were examined and the ovaries were removed from the females. Fecundity was estimated by counting all the large deep orange ova in the ovaries. All scale samples were mounted between glass slides and examined for annuli with a Bausch and Lomb microprojector.

RESULTS

A total of 138 specimens was collected during the study (44 males and 94 females). All but seven bitterlings were collected in the upper study area; we will therefore consider only that area. The population estimate for females was 449 (95% confidence interval, 352–622) and for males was 96 (53–582). The apparent skewed sex ratio is probably a result of different distribution patterns of the territorial males. The estimate was done during the breeding season when males should be guarding territories around freshwater mussels. Therefore, the marked males are less likely to mix randomly than the more mobile females. The results would be a much lower estimate for the males compared with the females. Also, our collecting was selective because we sampled areas that yielded the most specimens. There were some deep pools within this area that were not sampled. Males that may have established territories in the pools or in areas with few bitterlings were excluded. Assuming a 1:1 sex ratio, double the female population estimate gives a total estimate of 900 bitterlings.

Scales were taken from 27 specimens but, because only one scale was removed, only 21 were decipherable (11♀ and 10♂). Most of these (14) had no annuli and the largest specimen was III+ (Table 1). Since collecting was done in the spring and all specimens were mature, annulus formation probably had not occurred and the 0+ individuals were in their second summer (yearlings). Holcik (1959) reported bitterlings at V+ in Czechoslovakia. Individuals as old as this could probably be found in the Bronx River with further sampling. The range of lengths of the aged specimens was similar to the range of all specimens collected. The mode of the length frequency distribution was 48 mm, which corresponds with bitterlings in their third summer (Fig. 1).
Mean egg number of the four females examined was 41 (range, 31–53). None of these females had annuli on their scales. We examined too few specimens to comment on size-related changes in fecundity. The low fecundity is presumably related to high survivorship of the eggs and larvae within the mussels.

The intestines of the five preserved specimens contained masses of diatom tests and unidentified detritus. Nikolsky (1954) mentioned that all members of the subfamily Rhodeinae are primarily herbivores and commented on the very long intestine which is typical of herbivorous fishes. The intestine of *Rhodeus sericeus* is
TABLE 1
MEAN AND RANGE (IN PARENTHESES) OF STANDARD LENGTHS OF EACH AGE CLASS OF
EUROPEAN BITTERLINGS FROM THE BRONX RIVER, NEW YORK. DATA ARE FROM 21
SPECIMENS COLLECTED IN SPRING 1980

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number of annuli</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>45.7 (42-50)</td>
<td>50.0 (45-55)</td>
<td>58.0 (--)</td>
<td>65.0 (--)</td>
</tr>
<tr>
<td>♀</td>
<td></td>
<td>45.3 (39-50)</td>
<td>48.7 (48-50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>♂</td>
<td></td>
<td>45.3 (39-50)</td>
<td>48.7 (48-50)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The intestinal mass is oriented vertically in the body cavity and parallel to the fish's longitudinal axis. The pharyngeal teeth are also typical of herbivores with flat grinding surfaces (figured in von Siebold, 1863), similar to the herbivorous North American *Hybognathus*. Presumably, bitterlings obtain the diatoms by scraping them from submerged surfaces. The mouth protrudes anteroventrally (Fig. 2) which exposes the hard, sharp dentary bone (a scraper?).

DISCUSSION

Because the European bitterling is an exotic animal, it is important to determine what actual or potential effects the species may have on the native ecosystem. It has probably survived in the Bronx River since at least the 1920s (Schmidt *et al.*, 1981). The bitterling's small size and herbivorous diet preclude the species from being a serious predator on other fishes. It is unlikely that it would compete with native species for food since only the golden shiner may possibly utilize the same food source (Scott & Crossman, 1979). Its small population size would indicate that the bitterling could not possibly reduce the standing crop of diatoms in the river.

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