Determination of Anterior–Posterior Orientation of Glochidia By The Examination Of Glochidial Valves Present Within The Umbos Of Juvenile Unionid Clams (Mollusca: Bivalvia)[1]

MICHAEL A. HOGGARTH, The Ohio State University Museum of Zoology, 1813 N. High St., Columbus, OH 43210-1394

ABSTRACT. The terms anterior and posterior have been used differently by various authors working with the glochidia of the Unionidae. This report reviews the contradictory use of these terms in regard to glochidial orientation, and shows that the anterior and posterior margins of these minute parasitic larvae can be distinguished by demonstrating the morphological relationship between glochidial and juvenile shells. Glochidial valves, found upon examination of the umbos of juvenile clams, showed that the long side of the glochidium (measured from the middle of the dorsal margin to the base of the hook) corresponded to the anterior margin of the juvenile. The anterior margin of a glochidium may also be characterized as that margin closest to the single larval adductor muscle.

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INTRODUCTION

Designating directionality in the glochidium, the parasitic larval stage of the Unionidae, has not been a concern of many authors. Lea (1858, 1863, 1874) was the first to draw a series of glochidia. Since he perceived all glochidia as symmetrical about the dorsal-ventral axis, he had no need to distinguish anterior from posterior. In fact, he wrote: "The base in all species, was either angular or rounded, and always presented the anterior and posterior margins equal . . . . That is if a perpendicular line be raised from the middle of the basal margin to the middle of the dorsal line, the right and left divisions will be exactly symmetrical" (Lea 1858). Much later, Surber (1912, 1915) recognized asymmetry in glochidia, but instead of standardizing the orientation of specimens, he figured glochidia, rotated 180° from each other, within the same plate. Other authors have simply ignored the question of anterior-posterior orientation, or have provided a diagram labeled as a side view (Coker et al. 1921, Tucker 1927, Atkins 1979).

Some authors have made an attempt to determine glochidial orientation, but with contradictory results. Harms (1907) raised post-parasitic juveniles of *Anodonta cygnea* (Linnaeus 1758) (as *Anodonta piscinalis* Nilsson 1822) until considerable juvenile shell material had been deposited, and concluded that the longest side of the glochidium (i.e., from the dorsal margin to the base of the hook) was anterior. Lillie (1895) and Lefevre and Curtis (1912) also labeled the long side as anterior. Lefevre and Curtis further noted that the adductor muscle was located in the anterior portion of the shell. Wood (1974) generally agreed with the above, but appeared to have mislabeled one of her figures, thus contributing to the confusion over glochidial orientation. More recently, Clarke (1981, 1985) characterized a number of glochidia with scanning electron microscopy (SEM) and gave the long side as posterior.

MATERIALS AND METHODS

Juveniles of the Anodontinae were examined with light microscopy. Glochidial valves found upon examination of the umbos of juveniles were photographed. The outline of each glochidial valve was then measured from the middle of the dorsal margin to the base of the hook on the ventral margin. Orientation of the juvenile was determined by the position of the umbo (the umbo is anterior); orientation of the glochidium was determined by its relationship to the juvenile shell. Two juveniles of *Anodonta imbecillis* Say 1829, seven of *Anodontoides ferussacianus* (Lea 1834), and one each of *Strophitus undulatus undulatus* (Say 1817), *Lasmigona costata* (Rafinesque 1820), *L. complanata* (Barnes 1823), and *L. compressa* (Lea 1829) were examined from the collection of The Ohio State University Museum of Zoology (OSUM).

RESULTS AND DISCUSSION

In each case, the greatest length along the margin of the glochidial valve (from the middle of the dorsal margin to the base of the hook) corresponded to the anterior of the juvenile (Fig. 1). In other words, margin AE was anterior in each glochidium, where E represents the base of the hook, BD the dorsal-ventral axis, AE the long side, and CE the short side. This was clearly demonstrated in the high triangular glochidia of *A. imbecillis* (Fig. 2A,B), *A. ferussacianus* (Fig. 2C,D), *L. costata* (Fig. 2G,H), and *L. complanata* (Fig. 2I,J). The first figure in each set is a photograph of the entire right or left valve of the juvenile. The second photograph shows the position of the

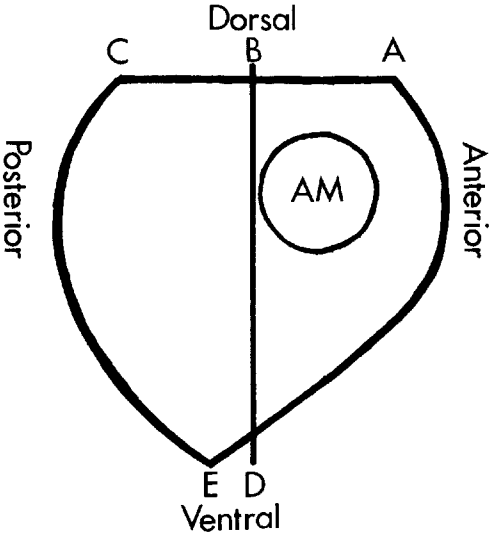

FIGURE 1. Subtriangular glochidium of the Anodontinae. Distance AB = BC; BD, dorsal-ventral axis; AE, long side; CE, short side; AM, adductor muscle.

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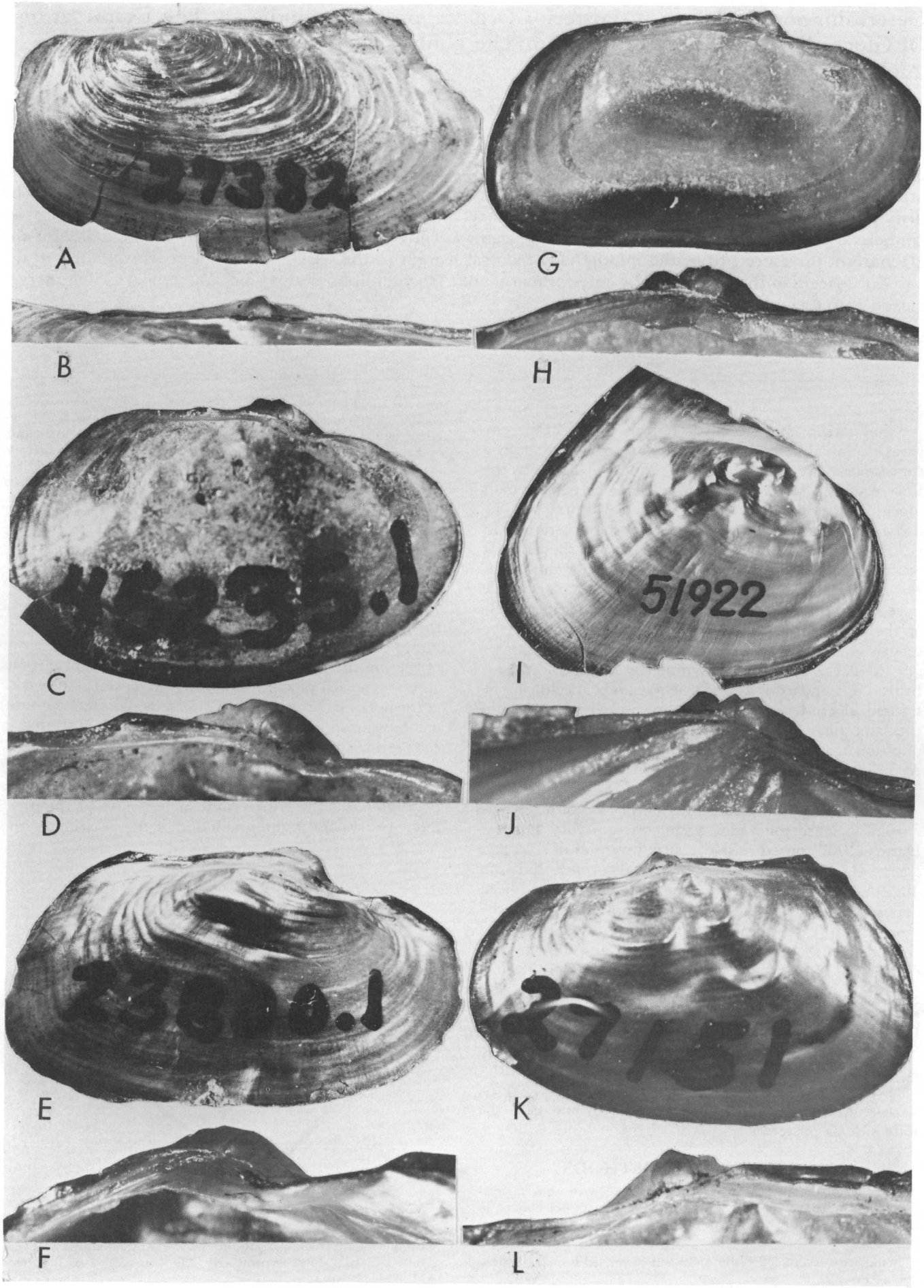
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glochidial valve within the umbo of the juvenile. Glochidia of *S. u. undulatus* (Fig. 2E,F) and *L. compressa* (Fig. 2K,L) possessed shells with smaller heights in relation to length than the other glochidia examined. However, they demonstrated the same glochidial orientation as above.

It appears from these data that the long side is indeed anterior in the glochidia of the Anodontinae. Generally, the adductor muscle was also located in the anterior portion of the shell (in area ABD, Fig. 1), but crossed the dorsal-ventral axis in the morphologically depressed glochidia. The position of the adductor muscle, however, was always closer to the anterior margin than the posterior margin, and can therefore be used to determine the orientation of a glochidium. These data are therefore in agreement with Lillie (1895), Harms (1907) and Lefevre and Curtis (1912), but are contrary to the findings of Clarke (1981, 1985).

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FIGURE 2. A. *Anodonta imbecillis* Say, 1829; right valve (OSUM 27382), 14.7 mm long × 7.6 mm high. B. Hinge of *A. imbecillis* (OSUM 27382). C. *Anodontoides ferussacianus* (Lea, 1834); left valve (OSUM 45235.1), 8.5 mm long × 5.0 mm high. D. Hinge of *A. ferussacianus* (OSUM 45235.1). E. *Strophitus undulatus undulatus* (Say, 1817); left valve (OSUM 23800.1), 13.6 mm long × 7.7 mm high. F. Hinge of *S. u. undulatus* (OSUM 23800.1). G. *Lasmigona costata* (Rafinesque, 1820); left valve (OSUM 20550), 9.3 mm long × 5.0 mm high. H. Hinge of *L. costata* (OSUM 20550). I. *Lasmigona complanata* (Barnes, 1823); left valve (OSUM 51992), 25.9 mm long × 21.5 mm high. J. Hinge of *L. complanata* (OSUM 51992). K. *Lasmigona compressa* (Lea, 1829); right valve (OSUM 27151), 9.4 mm long × 5.9 mm high. L. Hinge of *L. compressa* (OSUM 27151).