STUDY ON DEVELOPMENTAL STAGES OF FAIRY SHRIMP *STREPTOCEPHALUS SIMPLEX* GURNEY

P.A. Siddqui, F. Khan, T.A. Saquib, E. Habib and S. Rao

*Department of Zoology University of Karachi, Pakistan*

**ABSTRACT**

The study deals with 14 larval stages of fairy shrimp *Streptocephalus simplex* Gurney. These stages were identified by number of body segments, length and development of thoracic appendages, antenna and antennule.

**Key words:** Wild life, fresh water biology, fairy shrimp

**INTRODUCTION**

Large bodies invertebrates commonly found in temporary ponds are conspicuously absent from neighboring bodies of water that do not dry (William, 1987, Wellborn *et al.*, 1996). The crustaceans order Anostraca exemplifies this pattern. They not only have unusual morphology and life history but also exhibit some primitive and advanced characters.

In Pakistan the study of Anostraca is still in its fancy and very little information is available in the literature. Qadri and Baqai (1956) provide informations about taxonomical aspects of *Streptocephalus* species viz., *S. benghalensis*, *S. karachiensis* and *S. hardingi*. Baqai (1963) worked on the postembryonic development of the *S. seali* Ryder gave a complete series of larval stages with detail description about the musculature. Akhtar (1967) described the morphology of *S. simplex* Gurney and taxonomy of some Anostracan species of Pakistan.

Biology of Anostraca need much more attention. Eng *et al.* (1990) worked on the Biology of Anostraca, Beladjal *et al.* (2002) worked on different life stages of fairy shrimp. Some important work in this respect are that of Packard (1883), Heath (1924), Cannon (1926), HSU (1933), Leak (1933), Lownes (1933), Avery (1939), Linder (1941), Dexter and Ferguson (1943), Coopey (1950), Pai (1958), Nourisson (1959), Mossin (1986), Brendonck (1991), Bohannak and White man (1999). The present work was carried out to study the immature stages of *S. simplex* Gurney. Relative growth of these fairy shrimps have also been taken in consideration.

**MATERIAL AND METHODS**

The eggs bearing fairy shrimp were brought in laboratory from temporary ponds formed after the rainfall near the Safari Park at University road. They were kept in dishes containing pond water and are fed by suspension of yeast and powdered egg yolk daily. After 2 – 6 days eggs were laid in dishes. The eggs were collected, dried and stored in small glass tubes. Dried eggs were kept in distilled water for hatching, which took place during 20 – 24 h. Larvae were transferred to pond water. The larval stages were preserved at regular intervals in the mixture of alcohol (70%) and formaline (30%). Temporary mounts were prepared in glycerin and lactophenol. The measurement was made with an ocular micrometer.

**RESULT AND DISCUSSION**

Fourteen larval stages of *S. simplex* were studied and identified by the number of body segments and the body length as described by Weisz (1946), Baqai (1963) and Sanoamuang *et al.* (2000).

All the measurement of *S. simplex* Gurney are given in Table I. The average length of male fairy shrimp is 2.1 cm and that of female is 1.9 cm. Transparent and cylindrical body is divisible into three regions i.e. head, trunk and caudal appendages. Head bears first pair of antennules, second pair of antenna, compound stalked eyes and frontal appendages which composed of a pair of mandibles, first and second pair of maxillae and labrum. Trunk region consist of eleven thoracic appendages and nine abdominal segments. Last abdominal segment is distinct and known as telson and it bears forked caudal appendages ( cercopod). The brood pouch of female fairy shrimp has 509-734 number of eggs (av. 672). The size of egg ranges from 0.182-0.25 mm of yellowish brown color.
Table 1. Show developmental stages of fairy shrimp Streptocephalus simplex Gurney

<table>
<thead>
<tr>
<th>S.No</th>
<th>HOURS</th>
<th>PLATE No</th>
<th>BODY LENGTH mm</th>
<th>ANTENNULE LENGTH mm</th>
<th>ANTENNA LENGTH Mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>I-A</td>
<td>0.36</td>
<td>0.046</td>
<td>0.23</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>I-B</td>
<td>0.52</td>
<td>0.050</td>
<td>0.26</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>I-C</td>
<td>0.68</td>
<td>0.68</td>
<td>0.28</td>
</tr>
<tr>
<td>4</td>
<td>56</td>
<td>I-D</td>
<td>0.81</td>
<td>0.080</td>
<td>0.30</td>
</tr>
<tr>
<td>5</td>
<td>72</td>
<td>II-A</td>
<td>1.38</td>
<td>0.085</td>
<td>0.31</td>
</tr>
<tr>
<td>6</td>
<td>90</td>
<td>II-B</td>
<td>1.80</td>
<td>0.86</td>
<td>0.32</td>
</tr>
<tr>
<td>7</td>
<td>138 M</td>
<td>II-A</td>
<td>2.3</td>
<td>0.25</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>2.5</td>
<td>0.26</td>
<td>0.33</td>
</tr>
<tr>
<td>8</td>
<td>160 M</td>
<td>II-B</td>
<td>3.1</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>3.7</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td>9</td>
<td>210 M</td>
<td>II-B</td>
<td>4.3</td>
<td>0.51</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>4.9</td>
<td>0.62</td>
<td>0.43</td>
</tr>
<tr>
<td>10</td>
<td>306 M</td>
<td>II-B</td>
<td>8.0</td>
<td>1.04</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>8.2</td>
<td>1.30</td>
<td>0.76</td>
</tr>
<tr>
<td>11</td>
<td>387 M</td>
<td>II-B</td>
<td>12.5</td>
<td>1.49</td>
<td>1.68</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>13.0</td>
<td>1.56</td>
<td>0.88</td>
</tr>
<tr>
<td>12</td>
<td>480 M</td>
<td>II-B</td>
<td>13.0</td>
<td>1.52</td>
<td>3.06</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>13.3</td>
<td>1.58</td>
<td>0.91</td>
</tr>
<tr>
<td>13</td>
<td>570 M</td>
<td>II-B</td>
<td>15.1</td>
<td>1.55</td>
<td>4.12</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>15.3</td>
<td>1.60</td>
<td>0.96</td>
</tr>
<tr>
<td>14</td>
<td>650 M</td>
<td>II-B</td>
<td>16.26</td>
<td>1.60</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>16.3</td>
<td>1.67</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Hatching of nauplius took place during 20 to 24 h in distilled water. Hatching process was similar to that described by Myint (1956) for Artemia salina and later by Baqai (1963) for S. seali Ryder.

The 24 h larval stage shows that body consist of two regions, head and unsegmented trunk. Dorsally it is covered by plate like structure (nuchal organ). Three pairs of cephalic appendages (antennules, biramous antenna and biramous mandibles) (Plate I.A) are present. Antennules are short finger like process, unsegmented with three setae and distal end. Antenna at this stage act as swimming appendages consist of protopodite, endopodite and exopodite bearing long setae. Protopodite divided into basipodite and coxipodite. A single median pigmented eye is present at the interior end of head. Anal opening possess no external caudal setae.

The 32 h larval stage (Plate I-B) indicates that trunk region is segmented. Three segments are distinguishable in the trunk region from which two are rudiments of the maxillae; third one is the thoracic segment, which later develops into thoracic appendages. Two caudal setae begin to develop at this stage.

The 43 h larval stage (Plate I-C) shows the appearance of compound eyes begins to develop on anterior lateral part of the head. Median eyes become more prominent. Five thoracic segments with out any setae are observed.

The 56 h larval stage (Plate I-D) indicates that compound eyes become more pigmented, maxillae become more adult like with few setae. Seven thoracic segments becomes distinguishable, two more caudal setae are formed on either side of cercopod. This stage is similar in structure to the fourth larval stage of S. seali described by Baqai (1963).
The 72 h larval stage (Plate II-A) shows that nine thoracic segments are distinguishable; first six segments have well developed thoracic appendages, while the remaining three are in the form of protuberation. Four caudal setae are present on each side while the fifth larval stage of *S. seali* has only three caudal setae described by Baqai (1963).

The 90 h larval stage (Plate II-B) indicates labrum is reduced in size and becomes adult like. Eleven thoracic segments are differentiated of which nine segments have well developed thoracic appendages, tenth and eleventh are protuberance, posterior to thoracic segments, and first three abdominal segments are distinguishable which were two in *S. seali*. On each side six caudal setae with setules are present. The sixth larval stage of *S. seali* have four pair of caudal setae.

The 138 h larval stage shows paired compound eyes with well developed eye stalk are present. The rate of growth of female antennules is slightly greater than male. In male antenna the whole endopodite and setae on protopodite and exopodite are completely degenerated. From the distal end of basal joint of antenna a tentacle like process is originated in female antenna (Plate V –A) the setae on protopodite is completely degenerated and setae on exopodite are present in reduce form. Eleven thoracic and nine abdominal segments are present. Nine setae with setules on each developing cercopod.

The 160 h larval stage (Plate III-B, V-B, VII-B) indicates all the eleven thoracic appendages has six endite. The cercopod increased in length with sixteen setae while nine larval stages of *S. seali* have eight setae (Baqai 1963).

The 210 h larval stage (Plate III-C, V-C) shows that the development of thoracic appendages completed. The abdominal segments further grow in size. Thirty-four setae on each developing cercopod. This stage is equivalent to the eleventh larval stage of *S. seali*, which has twenty-six setae on each of developing cercopod.

The 306 h larval stage (Plate III-D) shows that movement of male and female antenna to anterior portion of the head is completed. The male antenna becomes longer and three segments are completely differentiated from the second segment, which was tenticular process in the previous stage. Hand of the antenna is originated. The upper and lower lip of female egg pouch is now clearly differentiated which were not clearly differentiated in *S. seali*. At this stage, developing cercopod has sixty two setae with setules, while the thirteen larval stages of *S. seali* has sixty setae on each cercopod (Baqai 1963).

The 387 h larval stage (Plate III-E) indicates that antenna of male increases in length and it becomes coiled. Third segment becomes distinct with with long ventral branch bifurcates into two process. The lateral protuberance of the basal segment fused basally and it is median in position, while the female antenna shows no apparent change. The genitalia of both sexes increase in size and becomes longer than the previous stage. Each developing cercopod has eighty setae with setules. This larval stage is similar to fifteen larval stage of *S. seali* (Baqai, 1963).

The 480 h larval stage (Plate III-F) shows the spur (hook), which is originated from the ventral surface of the basal segment is curved. Second segment of the antenna is curved, and from its proximal end a projection originates which is rudiment of the membranous process which is the diagnostic character of *S. simplex*. The genitalia has no minute setae on the ventral side of the cithonous spur and minute spine on the inner side of the membranous part of the penis. The developing cercopod have eighty-eight setae with setules on each side of anus. While the sixteen larval stages of *S. seali* has the same number of setae as in the fifteen larval stages.

The 570 h larval stage (Plate IV-A, IV-C, IV-F) indicates the genitalia of both sexes increase in length, egg pouch becomes longer, penis of male genitalia is still devoid of setae and developing cercopod has ninety-three setae with setules.

The 650 h larval stage (Plate IV-B, IVD,IVG) shows that from the lateral side of aedgi of male genitalia, a protuberance develops which later develops into lateral lobe of female genitalia. The long eversible penis carries on its outer surface a row of spines. Each developing cercopod has ninety-five setae with setules. The eighteenth larval stage of *S. seali* has different number of setae on the cercopod of male and female but in *S. simplex* the male and female has same number of setae.

The development of male antenna from nauplius to 306 hours of larval stage resembles the antenna of *Branchipus grubei* (Oechmichen 1921), *S. texanus*, B. stagnalis (Packard 1883) and *S. seali* (Baqai 1963), Eriksen and Belk (1999). The antennal exopodite in *S. texanus* have fifteen long setae Packard (1883) and in *S. seali* they were thirteen in numbers described by Baqai (1963) but in *S. simplex* fourteen long setae in the antennal exopodite. Baird (1852), Claus (1873, 1886), Alcock (1896), Daday and Dees (1910), Weaver (1943), Moore (1957), Baqai (1963), Dabourn (1972), Sanoamuang (2001) reported that male antenna of *Streptocephalus* species has three segments but Lindor (1941) and Beladjal et al. (2002) observed two segments and has called the spur an epical joint which has shifted from its usual direction by the distal out growth from the basal segment.

The development of male antenna from 480 to 650 h larval stages shows the development of membranous process on the proximal end and the finger like projections on the ventral side of the intermediate segment. These
projections were only indicated by Qadri and Baqi (1956) and Beladjal et al (2002), in of S. benghalensis but the intermediate segment of S. seali was devoid of membranous process and finger like projections.

Plate 1 A-D. Development of different larval stages of fairy shrimp Streptocephalus simplex Gurney at different time periods.

Key for plates 1 - 5. Abd = Abdomen; Abdsg = Abdominal segment; An = Anus; Ant = Antenna; Antl = Antennule; Bsg = Basal segment; Bspd = Basipodite; Cer = Cercopod; Chpr = Chitonous process; Ce = Compound eye; Dbr = Dorsal branch; Dhbr = Distal hook bristle of protopodite; Dsg = Distal segment of antenna; Dse = Distal setae of the second maxillae; End P = Endopodite; Epd = Epipodite; Exp = Exopodite; Fg, P = Flabellum; F.app = Frontal appendages; Hlt = Hooklet; Hd = Hand, chela or III joint; Inpr = Inner process; Intsg = Intermediate segment of the Antenna; Lm = Labrum; Md = Mandible; Me = Median eye; Mempr = Membranous process; Mx1 = First maxilla; Mx2 = Second maxilla; Phbr = Proximal hook bristle of the protopodite; Plp = Palp; Prd = Protopodite; Sbr = Selender branch; Se = Setae; Sp = Spine; Sspmd = Sensory spine of the mandible; Spr = Spur; St = Stalk; Tel = Telson; Thapp bd = Thoracic appendage bud; Tpr = Tentacular process; Vbr = Ventral branch; 1 – 11 = Thoracic appendages.
Plate II A-B. Development of different larval stages of fairy shrimp *Streptocephalus simplex* Gurney at different time periods.
Plate III: Development of different larval stages of fairy shrimp *Streptocephalus simplex* Gurney at different time periods.

A. Male antenna and antennule of 210 hours larval stage (Anterior view).
B. Head region of 160 hours larval stage (Anterior view).
C. Male antenna and antennule of 210 hours larval stage (Ventral view).
D. Head region of 138 hours larval stage (Ventral view).
E. Male antenna and antennule of 387 hours larval stage (Anterior view).
F. Male antenna and antennule of 480 hours larval stage (Anterior view).
Plate IV A-B. Development of different larval stages of fairy shrimp *Streptocephalus simplex* Gurney at different time periods.
Plate V A-D. Development of different larval stages of fairy shrimp *Streptocephalus simplex* Gurney at different time periods.
The study of genitalia development in *S. simplex* shows that the genitalia developed from the first and second abdominal segments. This conclusion is drawn from the 138 h larval stage of *S. simplex*, when the genitalia developed as two independent outgrowths from the ventral side of the first and second abdominal segments. The authors, therefore, agreed with those of Spangenberg (1875), Packard (1883), Claus (1886), HSU (1933), Linder (1941), Baqai (1963) and Sanoamuang et al. (2001).

**CONCLUSION**

Studies were made to describe the post-embryonic development of *S. simplex* its rate of growth of larval stages and their cephalic appendages at various periods. It was concluded that development of frontal appendages originate from the basal segment of the male antenna, which was then coalesced with the head and fused medially and the male antenna was composed of three segments. The genital segments were modified from the first two abdominal segments. The rate of growth in female larvae is faster than the male.

**REFERENCES**


Williams D.D (1987). The ecology of temporary water. Timbers. ???

(Accepted for publication 20 June 2004)