the overall picture on the immunoelectrophoretic patterns of different species suggests that in the evolutionary sequence the flat fish species should be placed farther away from the other fishes.

Squid lens antisera, prepared in the rabbit was found to have 4 to 5 components when tested with squid lens in immunodiffusion assays. No cross reactions, however, were noted with a number of vertebrate lenses. Similarly, antisera against vertebrate lenses failed to show any cross reaction with the squid lens. This shows that the invertebrate lens does not share any immunochemical similarity with the vertebrate lenses and that the cephalopod eye evolved along a distinct path from that of the vertebrates. The phylogenetic relations among the vertebrate lenses by the reactions obtained with antihuman lens serum and other vertebrate lenses showed a decrease in the number of shared components when they get farther and farther removed phylogenetically. In this study also, the immunoelectrophoretic patterns (Fig. 1) clearly show a decrease in the number of shared components with an increase in the phylogenetic distance. It has been found that fishes which are more closely related on a morphological basis tend to have more common antigens.

The author wishes to express her gratefulness to Dr S.Z. Qasim, Director, for continued interest and guidance throughout the work and also for the valuable suggestions in the preparation of this paper. Thanks are also due to Dr T.S.S. Rao, for critically going through the manuscript.

References


Biochemical Composition of the Bivalve Molluscs, Villorita cyprinoides var. cochinensis (Hanley) & Meretrix casta (Chemnitz)

P.T. Lakshmanan* & P N Krishnan Nambisan†
Department of Marine Sciences, University of Cochin, Cochin 682016
Received 7 April 1978; revised received 9 July 1979

Biochemical components in M. casta and V. cyprinoides, collected from Cochin Backwaters, varied with season and species. An inverse relationship between protein and carbohydrate was observed in both the species, the sum of carbohydrate and protein being a constant. Increase in lipid level was accompanied by an increase in total phosphorus of the 2 clams. Calorific values and lipid content were higher in V. cyprinoides. The carbohydrate minima in the 2 species during January-February were attributed either to spawning or low concentrations of plankters.

Meretrix casta and Villorita cyprinoides var. cochinensis comprise one of the major components of shell fisheries in the southwest coast of India. Though some information is available on the chemical composition of molluscs, detailed and systematic information on the biochemical composition of these species is lacking. Such information would be desirable to fix the best season for harvesting from the point of view of high nutritive value. Hence an attempt has been made to investigate the biochemical composition of these 2 bivalves. Interrelationships between the different biochemical components have also been worked out.

Monthly collections were made from September 1976 to August 1977. M. casta was obtained from a place about 2 km southeast of Cochin barmouth (sal; 32 ± 0.5/oo in summer and 5 ± 1/oo in rainy season) and V. cyprinoides from a place about 6 km northeast of the barmouth (sal; 20/oo in summer and 1/oo in rainy season). No data could be collected for March 1977.

The animals were brought to the laboratory and kept in sea water of habitat salinity for a day so as to remove the pseudofaecal materials. Whole soft portions from 15–20 animals of almost the same size were then removed and the wet weight of the combined material was determined. It was homogenised and dried to constant weight at 60°C, the dried material was finely powdered and an aliquot was ashed at 500-550°C in a muffle furnace. The residual weight was taken as the ash content. Various biochemical constituents were determined by standard methods: carbohydrate and lipid, nitrogen and total phosphorus were estimated. The amount of protein content was determined by the colorimetric method of Nelson[18].

*Present address: Central Institute of Fisheries Technology, Cochin 682 029
†For correspondence
was estimated by multiplying the nitrogen value by the factor 6.25. Calorific values were calculated using the appropriate calorific equivalents of 5.65 for protein, 9.45 for lipid and 4.2 for carbohydrate. Quadruplicate measurements were made for each constituent. The data are expressed on dry weight basis.

The results are presented in Table 1.

**Protein**—Protein, the major constituent in the body components of both the animals, varied markedly with season and species. In *V. cyprinoides* it was maximum in January and minimum in May. The protein level in *M. casta* varied from 43.2 to 67.01%. The present values agree well with those reported by Ansell et al. for some invertebrates from the southwest coast of India.

Seasonal variations in the biochemical constituents may be attributed to spawning and food availability. In *V. cyprinoides* and *M. casta* protein value reaches maximum during the height of the reproductive cycle and declined after spawning. Salih has reported 2 spawning periods (January and October) for *M. casta*. Panikkar and Aiyar have observed that breeding in *M. casta* was discontinuous and often interrupted by season. Two breeding seasons (January to February and June to August) are observed for *V. cyprinoides*.

**Lipid**—*V. cyprinoides* contained more lipid than *M. casta*. In *M. casta*, the variation in lipid content was more marked (4.53 to 12.76%) compared to the other species (9.2 to 14.11%). Lipid level in *M. casta* varied directly with variations in protein. The maxima and minima in lipid levels roughly coincided with those of protein. The lipid values of the 2 species are comparatively more than those reported by Ansell et al.

**Carbohydrate**—In both the species carbohydrate registered marked variation. The carbohydrate content falls rapidly during the spawning period. Ansell has reported that spawning is accompanied by a rapid decline in total carbon and that the carbohydrate resources may be rapidly utilised under unfavourable conditions. The large variations found in carbohydrate level in the 2 species under study may be due to fluctuations in conditions affecting the nutrition of the animal in addition to that arising from spawning. The phytoplankton, which serves as the source of food, is minimum during the period of carbohydrate minima.

Table 1—Biochemical Composition of Tissues of *V. cyprinoides* var. *cochinesnsis* and *M. casta* Collected from the Cochin Backwaters during 1976-77

<table>
<thead>
<tr>
<th>Date of collection</th>
<th>Length (mm)</th>
<th>Water (%)</th>
<th>Dry wt (%)</th>
<th>N (mg/g dry wt)</th>
<th>Protein (%)</th>
<th>Carbohydrate (%)</th>
<th>Lipid (%)</th>
<th>Ash (%)</th>
<th>P (mg/g dry wt)</th>
<th>Calorific values (kcal/g dry wt)</th>
<th>Carbohydrate + Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>V. cyprinoides</em> var. <em>cochinesnsis</em></td>
<td>2.9.1976</td>
<td>30±0.5</td>
<td>80.727</td>
<td>19.273</td>
<td>71.93</td>
<td>44.96</td>
<td>39.13</td>
<td>12.3</td>
<td>3.375</td>
<td>7.33</td>
<td>5.3037</td>
</tr>
<tr>
<td></td>
<td>1.10.1976</td>
<td>30±0.5</td>
<td>82.332</td>
<td>17.668</td>
<td>84.76</td>
<td>52.98</td>
<td>27.39</td>
<td>13.19</td>
<td>4.507</td>
<td>9.94</td>
<td>5.3626</td>
</tr>
<tr>
<td></td>
<td>1.11.1976</td>
<td>30±1</td>
<td>82.564</td>
<td>17.436</td>
<td>92.86</td>
<td>58.04</td>
<td>23.44</td>
<td>13.27</td>
<td>4.85</td>
<td>12.4</td>
<td>5.4942</td>
</tr>
<tr>
<td></td>
<td>1.12.1976</td>
<td>30.5±0.5</td>
<td>82.75</td>
<td>17.25</td>
<td>92.24</td>
<td>57.65</td>
<td>22.32</td>
<td>14.11</td>
<td>4.922</td>
<td>15.54</td>
<td>5.5056</td>
</tr>
<tr>
<td></td>
<td>2.1.1977</td>
<td>30±0.5</td>
<td>88.058</td>
<td>11.942</td>
<td>117.85</td>
<td>73.66</td>
<td>58.04</td>
<td>13.27</td>
<td>4.85</td>
<td>12.4</td>
<td>5.5356</td>
</tr>
<tr>
<td></td>
<td>1.2.1977</td>
<td>32±1</td>
<td>77.103</td>
<td>22.897</td>
<td>84.94</td>
<td>53.09</td>
<td>27.92</td>
<td>13.19</td>
<td>4.507</td>
<td>9.94</td>
<td>5.0495</td>
</tr>
<tr>
<td></td>
<td>6.4.1977</td>
<td>34±1</td>
<td>76.463</td>
<td>23.537</td>
<td>75.8</td>
<td>47.38</td>
<td>31.57</td>
<td>13.27</td>
<td>4.85</td>
<td>12.4</td>
<td>5.2441</td>
</tr>
<tr>
<td></td>
<td>2.5.1977</td>
<td>34±1</td>
<td>80.384</td>
<td>19.616</td>
<td>66.14</td>
<td>41.34</td>
<td>34.04</td>
<td>13.27</td>
<td>4.85</td>
<td>12.4</td>
<td>5.0173</td>
</tr>
<tr>
<td></td>
<td>1.6.1977</td>
<td>35±0.5</td>
<td>80.166</td>
<td>19.834</td>
<td>88.88</td>
<td>55.55</td>
<td>29.49</td>
<td>13.27</td>
<td>4.85</td>
<td>12.4</td>
<td>5.2173</td>
</tr>
<tr>
<td></td>
<td>13.7.1977</td>
<td>36±2</td>
<td>78.693</td>
<td>21.307</td>
<td>80.58</td>
<td>50.36</td>
<td>32.97</td>
<td>13.27</td>
<td>4.85</td>
<td>12.4</td>
<td>5.1977</td>
</tr>
<tr>
<td></td>
<td>2.8.1977</td>
<td>36±2</td>
<td>81.829</td>
<td>18.171</td>
<td>79.93</td>
<td>49.96</td>
<td>32.74</td>
<td>13.27</td>
<td>4.85</td>
<td>12.4</td>
<td>5.2055</td>
</tr>
<tr>
<td>Mean</td>
<td>32.54±1</td>
<td>81.006</td>
<td>18.993</td>
<td>85.08</td>
<td>53.18</td>
<td>27.73</td>
<td>12.12</td>
<td>5.014</td>
<td>10.32</td>
<td>5.2865</td>
<td>80.91</td>
</tr>
</tbody>
</table>

| *M. casta* | 2.9.1976 | 29.5±0.5 | 77.101 | 22.899 | 76.52 | 47.83 | 39.13 | 12.3 | 3.375 | 7.33 | 5.3037 | 84.09 |
| | 1.10.1976 | 30±0.5 | 82.332 | 17.668 | 84.76 | 52.98 | 27.39 | 13.19 | 4.507 | 9.94 | 5.3626 | 80.37 |
| | 1.11.1976 | 30±1 | 82.564 | 17.436 | 92.86 | 58.04 | 23.44 | 13.27 | 4.85 | 12.4 | 5.4942 | 81.48 |
| | 1.12.1976 | 30.5±0.5 | 82.75 | 17.25 | 92.24 | 57.65 | 22.32 | 14.11 | 4.922 | 15.54 | 5.5056 | 79.97 |
| | 2.1.1977 | 30±0.5 | 88.058 | 11.942 | 117.85 | 73.66 | 58.04 | 13.27 | 4.85 | 12.4 | 5.5356 | 77.71 |
| | 1.2.1977 | 32±1 | 77.103 | 22.897 | 84.94 | 53.09 | 27.92 | 13.19 | 4.507 | 9.94 | 5.0495 | 81.01 |
| | 6.4.1977 | 34±1 | 76.463 | 23.537 | 75.8 | 47.38 | 31.57 | 13.27 | 4.85 | 12.4 | 5.2441 | 78.95 |
| | 2.5.1977 | 34±1 | 80.384 | 19.616 | 66.14 | 41.34 | 34.04 | 13.27 | 4.85 | 12.4 | 5.0173 | 85.04 |
| | 1.6.1977 | 35±0.5 | 80.166 | 19.834 | 88.88 | 55.55 | 29.49 | 13.27 | 4.85 | 12.4 | 5.2173 | 85.04 |
| | 13.7.1977 | 36±2 | 78.693 | 21.307 | 80.58 | 50.36 | 32.97 | 13.27 | 4.85 | 12.4 | 5.1977 | 83.33 |
| | 2.8.1977 | 36±2 | 81.829 | 18.171 | 79.93 | 49.96 | 32.74 | 13.27 | 4.85 | 12.4 | 5.2055 | 82.7 |
| Mean | 31.18±1 | 81.012 | 18.987 | 87.127 | 54.45 | 27.35 | 12.12 | 5.014 | 10.32 | 5.2865 | 80.91 |
in the clams. Similar striking changes in carbohydrate levels in molluscs have already been reported. In the present study an important relationship was observed between carbohydrate and protein in both the species. The sum of carbohydrate and protein (C + P) was nearly constant always. The average values of (C + P) in V. cyprinoides and M. casta were 80.91 and 81.81 respectively. A significant negative correlation \(-0.95, -0.97, P = 0.001\) was observed between carbohydrate and protein in both the species. The respective linear relations were:

\[V. \text{cyprinoides: } Y = -1.0276X + 83.3777\]
\[M. \text{casta: } Y = -1.6689X + 119.371\]

where \(Y\) is protein (\(\%\)) and \(X\) is carbohydrate (\(\%\)).

Ash content—Ash content in \(V. \text{cyprinoides}\) was rather low compared to \(M. \text{casta}\). The ash content increased with increase in protein content in both the clams (Table 1). The increased ash content may possibly be due to an increased inorganic content in the body constituents.

Phosphorus—Its content varied with season as well as with species. In general, a higher percentage of phosphorus was always accompanied by a higher percentage of lipid. Similar trend was also reported by Jafri et al. and Khawaja in some carps, cat-fishes, eels, etc. They attributed this to the formation of phospho-lipids.

Calorific values—The calorific values (Table 1) showed little variation with season in both the species.

The authors thank P.of C.V. Kurian, Head of the Department for the help and facilities. Thanks are also due to Mr T.M. Sankaran for his help in the statistical analysis. Financial assistance from the UGC is thankfully acknowledged.

References


Length-Weight Relationship & Condition Factor of the Sciaenid Fish, Johnieops osseus (Day)

VIJAYAKUMAR M BARAGI & P S B R JAMES*
University of Agricultural Sciences, College of Fisheries, Mangalore

Received 15 March 1979; revised received 6 August 1979

Length-weight relationship of \(J. \text{osseus}\) indicated an allometric form of growth. Seasonal variations in the condition of fish could not be attributed to any particular factor.

The present observations, which form a part of the general study of the biology of \(J. \text{osseus}\) (the most abundant sciaenid of the South Kanara coast) deal with the length-weight relationship and condition factor, the information on which is meagre.

Total length and weight of 1539 fishes of all sizes, collected from trawl landings at Mangalore and Malpe during 1976-77 were recorded. Length and weight were plotted in the form of a scatter to note the relationship between the two. This suggests a relationship of the form, \(Y = A + BX\), where \(Y = \log W\), \(A = \log a\), \(B = b\) and \(X = \log L\). The values of \(A\) and \(B\) were estimated by the method of least squares. The length-weight relationship, computed from the above equation, for the 2 sexes at each of the locality is Mangalore—females: \(\log W = -5.3097 + 3.1877 \log L\); males: \(\log W = -5.2294 + 3.1497 \log L\) and Malpe—females: \(\log W = -5.1201 + 3.1071 \log L\); males: \(\log W = -5.0059 + 3.0468 \log L\).

Analysis of covariance applied to test the difference in the values of \(B\), for the 2 sexes at the 2 localities showed no significant difference at 5% level. Since difference was also not seen between the values of \(B\) obtained for the 2 localities, a common regression equation of \(\log W = -5.2341 + 3.1540 \log L\) was obtained for the 2 places. The \(t\) test, used to test the

*'Present address: Mandapam Regional Centre of Central Marine Fisheries Research Institute, P.O. Marine Fisheries 623520 Mandapam Camp