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The population difference in sequential learning, value transfer ability of climbing perch (Anabas Testudineus-Bloch)

K. K. Sheenaja[1]*, V. B. Rakesh[2] and K. John Thomas[2]

[1]*Department of Zoology, S.H.College, Thevara, Kochi, Kerala, India*
[2]*Animal Behaviour and Wetland Research Laboratory Christ College, Irinjalakuda, Kerala, India*

ABSTRACT

Sequential learning and value transfer ability of climbing perch collected from lentic and lotic ecosystems were studied. The results indicate that the Anabas testudineus able to associate the reward with a colour and capable of transfer the value sequentially to another colour. Difference in habitat has marked influence on the ability for sequential learning and transfer of value. Fish collected from lotic ecosystem exhibited higher ability for sequential learning and value transfer as compared with fish collected from lentic ecosystem. Chemical parameters of water and sediments of aquatic ecosystem have a determinant role on the maintenance of the life of the fish, the physical parameters can alter the development of their behaviour and cognitive abilities. Importance of natural habitat and population difference in the development of learning capacity of the fish is discussed.

Key words: Anabas testudineus, Sequential learning, transitive inference, lentic and lotic ecosystem.

INTRODUCTION

Cognition, broadly defined, includes perception, learning, memory, and decision making, in other words, all ways in which animals take information about the world through the senses, process, retain, and decide to act on it can be called as cognition [1]. The fish also posses cognitive abilities like recognition of their familiar conspecifics [2] and are able to assess and take a decision according to the benefit obtained in different situations [3] to learn new foraging skill, to understand and recognize predators and to acquire internal representation of routes learned [4].

Traditionally, associative models of sequential learning have assumed that the critical factor controlling behaviour in sequential tasks is associations between events in a sequence. According to this view, the subject learns that one stimulus (an element of behaviour or an ordinal position cue) predicts the next stimulus (or behavioural element) in a sequence [5]; [6]. Thus, according to these models, sequence learning can be construed as a form of discrimination learning, and factors such as the ability for stimulus discrimination and stimulus generalization should be important determinants of sequential learning. Serial–position models assume that sequence elements become associated with their serial position [7-10]. Rule–learning (RL) models, on the other hand, stress central organizational processes. In the domain of sequential learning, for example, RL models propose that animals learn abstract “rules” to represent the structure they find in sequences [11];[12]. Computational modeling can sometimes provide unique evidence for or against the notion that simpler processes can explain complex behaviour of a given sort.

Sequential learning is an ability to encode and represent the order of discrete elements occurring in a sequence. In sequential learning, the animal learns a series of events and associates the outcome. It is suggested animal collect information and form hierarchical representations to facilitate sequential learning and memory [13-17]. Climbing perch uses landmark and egocentric movements to orient reward [18]. In fish serial learning is studied in connection with transitive inference, which involves, using known relationships to deduce unknown ones (for example, using A>B and B>C to infer A>C).An inference may be defined as “a conclusion reached on the basis of evidence and reasoning (or) the process of the mind to think, understand, and form judgments by process of logic”. This type learning explains the transfer theory where the member of each stimulus pair associated with a non reinforced response acquires secondary positive value from the positive member of the pair [19]. Thus the serial learning in fish could be attributed with the value transfer and associative learning ability.

MATERIALS AND METHODS

Climbing perch, Anabas testudineus, Bloch (1792) is found mostly in canals, lakes, ponds, swamps, medium to large rivers, brooks, flooded fields and stagnant water bodies including sluggish flowing canals .The test fish were collected from two ecosystems and were acclimatized with laboratory conditions for one week. Ecosystem I was a small channel with flowing water (lotic) with fringe vegetations and ecosystem II was shallow, murky, fowl smelling, and stagnant (lentic) water with dense aquatic vegetations.

The apparatus for testing sequential learning was made in a large aquarium (85 × 32 × 32 cm) which was divided into 2 chambers ‘A’ (40 × 32 × 32 cm), and ‘B’ (45 × 32 × 32 cm). The chamber ‘B’ was further subdivided into 2 chambers; ‘B1’ (45 × 16 × 32 cm) and ‘C’ (45 × 16 × 32 cm). Chamber ‘C’ was further divided into ‘C1’ (30 × 16 × 32 cm) and ‘C2’ (15 × 16 × 32 cm) as given in the figure (I). The partition between the ‘C2’ and ‘B1’ was transparent but partition wall of ‘C1’ and ‘C2’ and ‘C1’ and ‘B1’ was opaque. All the four sides of the aquarium were covered with black paper in order to prevent any sort of disturbance. The chamber ‘C1’ and ‘B1’ remained connected with chamber ‘A’ via doors (8 × 4 cm). The aquarium was filled with pond water up to the height of 20 cm. The light source of this experiment was a CFL lamp (11 watts) hung on the top of the apparatus.

Five laminated colour charts were used for assessing the sequential associative learning ability of the fish. These charts were attached on the partition wall between ‘A’ and ‘C1’ and ‘A’ and 'B1’ leaving the space for the doors.

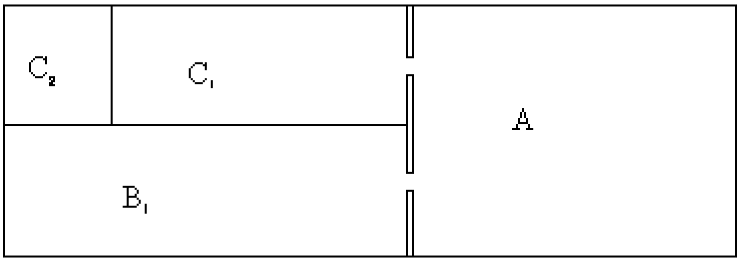

Figure.1 : Diagrammatic representation of the apparatus used to test the sequential learning ability: Top view.

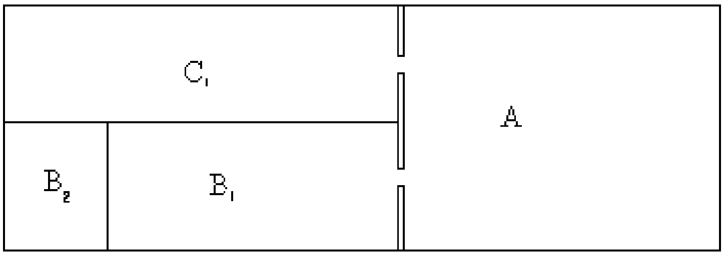

Figure. 2 : Diagrammatic representation of the apparatus used to test the sequential learning ability: Top view when experimental set up reversed.

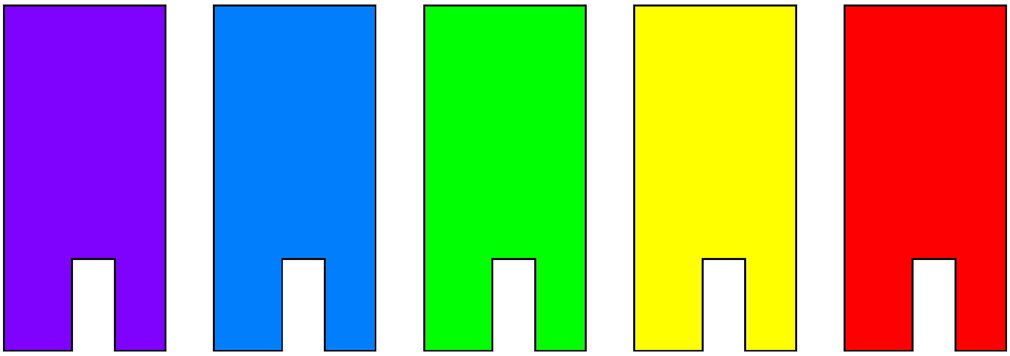

Figure.3: Color charts

The test fish was introduced into the presentation cage (28 × 14 × 10 cm) using a hand net and two minutes were given for the acclimation with the apparatus. The cage was raised and fish was released in to the experimental arena and six minutes were given for exploring the apparatus. After this familiarization schedule the fish was taken back to its home tank. In order to avoid the side bias, next day the partition wall between ‘C1’ and ‘C2’ was shifted to chamber B1, so as to form a small chamber ‘B2’. The test fish was released into chamber ‘A’ using the presentation cage. This familiarization protocol was continued for five days.

In this experiment the task given to the focal fish was to associate blue colour with the presence of conspecific. For that on the sixth day, a conspecific was introduced into chamber ‘C2’ and colour charts were attached to the doors opening to chamber ‘B1’ and ‘C1’. The door leading to ‘B1’ was associated with Blue colour and that of ‘C1’ was with Green colour. If the fish enters into the chamber ‘B1’ through the door attached with Blue colour, the fish can see a conspecific (Blue+). For a shoal living fish like climbing perch [3] interaction with the conspecific is considered as a reward. If the fish enters into the chamber ‘C1’, through the door attached with Green colour it will not get any reward (Green–). Here also six minutes were given to the fish for exploration of the apparatus. On the seventh day the partition wall between ‘C1’ and ‘C2’ was shifted to chamber ‘B1’ to form a small chamber ‘B2’ (15 × 16 × 32 cm) and the colour charts (Blue and Green) were interchanged. The conspecific was placed in the small chamber ‘B2’. This alteration was done in order to avoid the body centered learning of the position of conspecific [20], which may alter the associative learning of the Blue colour with reward (conspecific).

Sequential learning phase–I: On the eighth day of experiment, the time taken by the focal fish to enter into any one of the chamber was recorded. These fish were segregated into two groups. (a) Those who have taken the correct decision (fish that entered the chamber with conspecific) and (b) those who failed to take correct decision (fish that entered the chamber without conspecific). The percentage of fish that have taken proper decision and the average time taken by the test fish to take a proper decision was also noted. Those fish that were able to associate Blue colour with the presence of conspecific were tested in sequential learning phase II.

Sequential learning phase II: The colour associated with reward was changed to Green (+), and yellow chart (–) was placed at the door indicating no reward. On the third day the experimental set up was again reversed and the fish were tested. Fish that were able to associate Green colour with the presence reward were tested in Phase III of sequential learning.

Phase III Fish were tested with Yellow (+) vs. Red (–) colour. The fish that were able to associate Yellow colour with presence of reward in phase III were similarly tested using another combination of colour i.e., Red (+) vs. Violet (–) in phase IV. Sixteen individual fish from each ecosystem (I and II) were tested using the above procedure.

RESULTS

Analysis of sequential learning ability of fish collected from ecosystem I and ecosystem II shows that there was no significant variation in the swiftness with which a decision is taken during a binary choice situation (Mann Whitney U Test, $U=180;N=16:P>0.05$: Fig.III). However, the percentage of individual fish taken the correct decision varied significantly in fish collected from lentic ecosystem compared to those from lotic ecosystem (Kolmogorov–Smirnov Test; phase I $D=0.5;N=16;P<0.05$,phaseII $D=0.3;N=16;P>0.05$,phaseIII $D=0.63;N=16;P<0.05$,phaseIV $D=0.43;N=16;P>0.05$). 68 % fish collected from ecosystem I (Lotic) was able to select the chamber with conspecific in phase I. When the colour associated with the chamber with conspecific was changed (value transfer) during II, III and IV phases, respectively 50 %, 37.5 % and 31.25 % fishes successfully associated and transferred the value with presence of conspecific respectively. By contrast, only 37.5 % of the fish collected from ecosystem II (Lentic) were able to associate colour with the presence of conspecific during phase I. The percentage of fish successfully associated and transferred the value with presence of conspecific in a sequential learning task and the number of fish taking correct decision further decreased to 31.25 % (phase II), 25 % (phase III) and 6.25 % (phase IV) respectively.

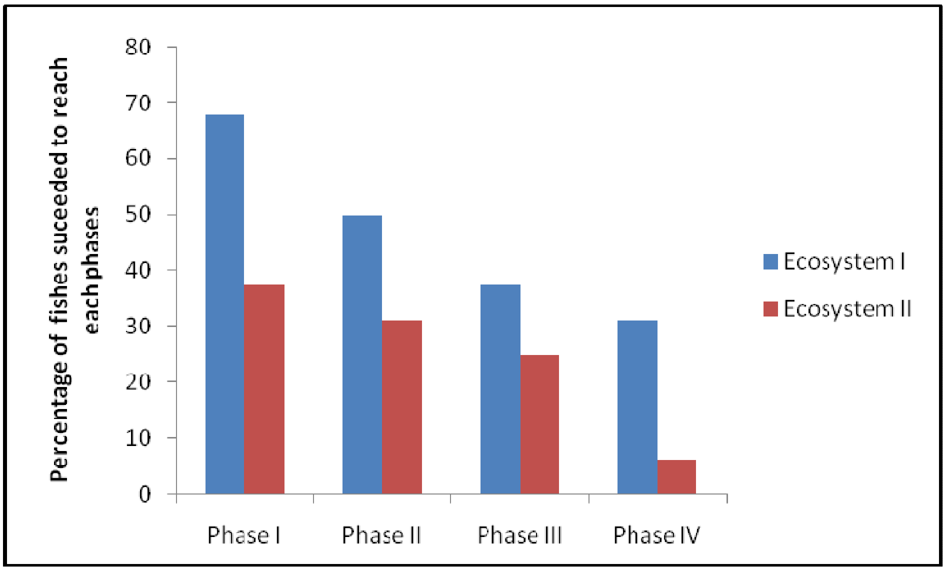

Figure 4: Percentage of climbing perch exhibited sequential learning.

(A) PHYSICO–CHEMICAL PARAMETERS

(a)WATER

1. pH

In both ecosystems pH was around 6 which are slightly acidic. In ecosystem I pH was 5.99 and in ecosystem II pH was 5.89.

2. TEMPERATURE

In two ecosystems studied, the temperature was within the range of 28ºC to 32ºC. The temperature of ecosystem I was 30ºC and in the second ecosystem it was 29ºC.

3. ACIDITY

Acidity of water taken from ecosystem I was 4 mg/ litre and of ecosystem II it was 3 mg/ litre

4. ALKALINITY

Alkalinity of water sample from the ecosystem I was 6 mg/ liters and in the ecosystem II it was 7 mg/ litre

5. HARDNESS

The estimation of the hardness was shown a slight variation. The ecosystem I showed a hardness of 28.8 mg CaCo3 / litre and in the ecosystem II it was 25.2 mg CaCo3 / litre.

6. CHLORIDE

The chloride content of water from ecosystem I have shown a value of 13.7 mg/ litre and in ecosystem II it was 14.7 mg/ litre.

7. SALINITY

Salinity has shown almost similar value in both ecosystems. In ecosystem I salinity was 0.4065 ppm and in ecosystem II the value was 0.4607 ppm.

8. DISSOLVED OXYGEN

Dissolved oxygen showed a slight variation between the two ecosystems studied. The first ecosystem showed a value of 7.2 mg/ litre and in ecosystem II it was 5.0 mg/ litre.

9. CHEMICAL OXYGEN DEMAND

Chemical oxygen demand showed marked variation between ecosystem I and ecosystem II. In the ecosystem it COD was absent and in the ecosystem II the value of COD was 4.0 mg/ litre

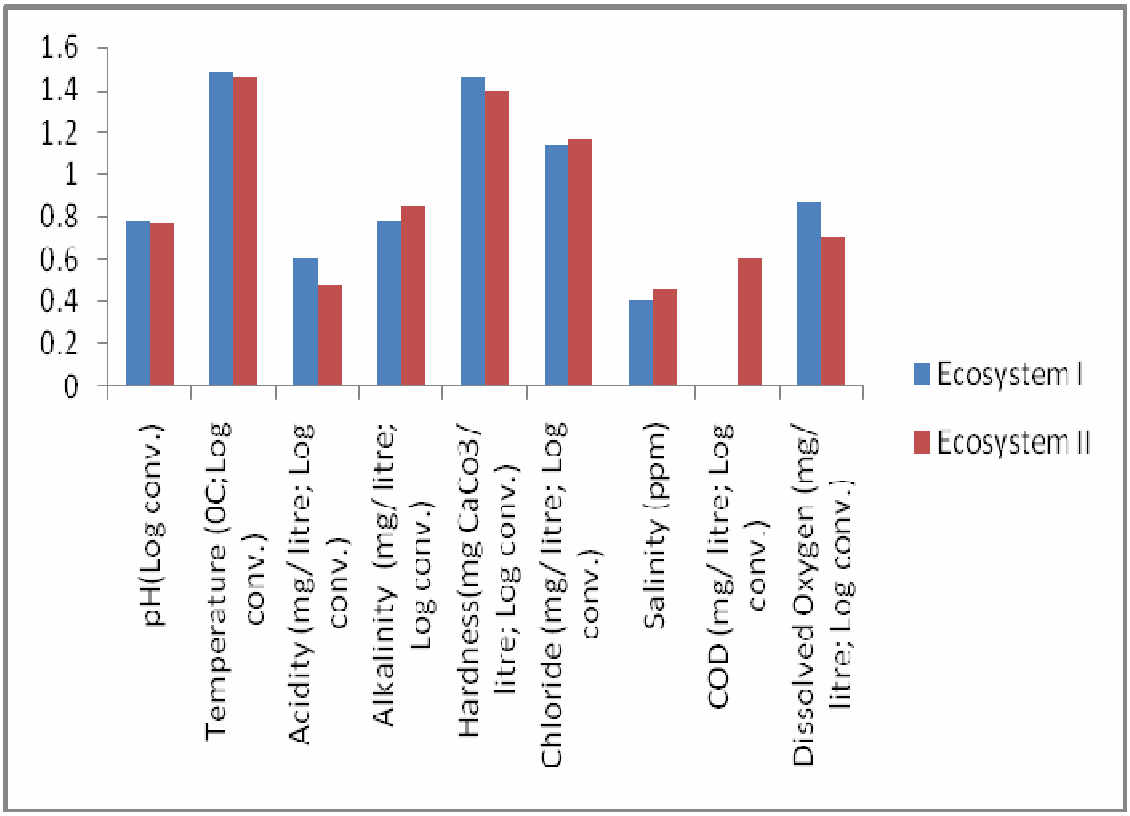

Figure 5: Physico Chemical Parameters of water from ecosystem I and ecosystem II.

(b)SEDIMENTS

1. PH

PH was near 6 in the soils of both ecosystems. In the ecosystem I the pH was 6.4 where as in ecosystem II it was 6.2

2. TOTAL SUSPENDED SOLIDS (TSS)
The total suspended solids in the soil of ecosystem I was 0.4 mhos / cm and it was 0.5 mhos / cm in ecosystem II.

3. ORGANIC CARBON
The amount of organic carbon in the soil of ecosystem I and ecosystem II studied was 0.50% and 0.40% respectively.

4. PHOSPHORUS (P)
The amount of Phosphorus in the soil of ecosystem I was 16.2 kg/ha and 34.5 kg / ha in ecosystem II

5. POTASSIUM (K)
The amount of Potassium in ecosystem I was 105 kg / ha and in ecosystem II it was 210 kg / ha.

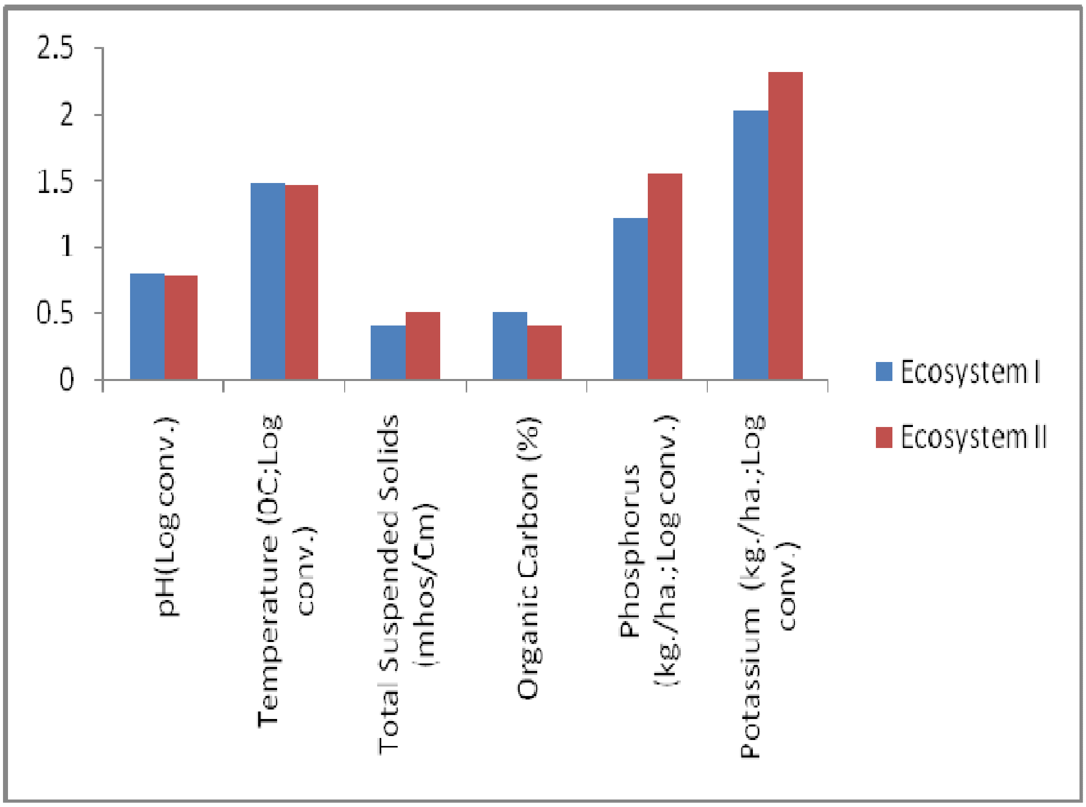

Figure.6: Physico Chemical parameters of sediments from the ecosystem I and ecosystem II.

DISCUSSION

Here the chemical nature of the water and sediments collected from these two ecosystems were almost similar. However the depth, water velocity, density of vegetation, turbidity, transparency, and organic content of water and sediment were different (Figure.4 and figure.5). The Ecosystem I was with clear flowing (lotic) water with fringe vegetations. By contrast ecosystem II was shallow, murky, fowl smelling, and stagnant (lentic) water with dense aquatic vegetations .[21] Reported that behavior links physiological function with ecological process. In another study of Clarias gariepinus exposure to lethal and sublethal concentration of soaps and detergent effluents showed marked behavioural changes [22].

It is possible that one of the major reasons for the difference observed in the correlation of cognitive abilities of the climbing perches is the degree of complexity seen in ecosystem I & II. Further intense analysis is needed for unraveling the scientific basis of environmental influence on the cognitive abilities of animals. The result of present study shows that even though various chemical properties of the water body in which the fish live remain the same, the variation in the physical factors can alter the cognitive abilities of the fish. Additionally these results supports the view that difference in degree of cognitive abilities exhibited by the same species residing in the different ecosystems to cope with the different levels of selection pressure present in that ecosystem [23]. A result comparable to that of the present study was obtained by [24] using cod larvae. The larvae reared in water with same physico–chemical parameters but different spatial properties have shown a significant variation in their cognitive abilities.

The results of the present study show that climbing perch possess the ability for sequential learning. They were able to associate the reward with a colour and were capable of transferring, the value sequentially to another colour. In ecosystem I, the percentage of learners was high in each phase of the experiment compared to ecosystem II. In ecosystem I, 31.25% of the fish was able to transfer the value up to four combinations of colours; whereas in ecosystem II the percentage of fish that were able to reach the fourth phase was very low i.e., only 6.25 % (Figure.3).

This study complements similar work by [25] with cichlid where focal males were shown pair wise fights between five individuals (AtoE) over the course of several days. When presented with A and E or B and D, the focal males spent more time beside the less threatening, subordinate male. Likewise Chickadee songs posses a number of individually-distinctive structural characteristics which conspecifics can use to discriminate between individuals [26].Focal males should therefore have been able to perceive the stimuli as separate individuals, internalize the relative rank of those individuals(through the song contests)and then subsequently recall and apply that information in novel situation(i.e. solo singing)

[27] Reported that only 4% of world's fresh water resources are available in india and it could be concluded that though the chemical parameters of water and sediments of aquatic ecosystem have a determinant role on the maintenance of the life of the fish, the physical parameters can alter the development of their behaviour and cognitive abilities. Hence future works will elucidate a clear picture of evolution of cognitive abilities in fish and its role in adaptation to different environmental conditions. The result of the present study points to the role of the nature of environment in shaping of behaviour and cognitive abilities of the fish, climbing perch. Hence future work is needed to elucidate evolution of cognitive abilities in fish and its role in adaptation to different environmental conditions.

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