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Seasonal Changes in Cardiac Response, in *Lamellidens corrianus*, from Nandrabad Pond

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ABSTRACT

Bivalve and gastropod molluscs undergo large changes in external environmental conditions, as well as in internal state. Cardiac responses to these changing conditions have been recorded in a variety of species. There is a general tendency for heart rate, and presumably cardiac output, to increase in response to situations that would increase the load on respiratory and excretory systems. Changes in molluscan heart function in many cases appear not to be mediated directly by cardiac nerves, but rather by such in direct mechanisms as changes in blood constituents or mechanical, homodynamic affects the endogenous factors but the change in exogenous factors to affects the cardiac response. In the present investigation the heart beat rate was maximum in monsoon and minimum in winter season which has been correlated with few environmental factors.

Introduction

Environmental change poses a range of problems for species that vary between site and species. Abilities to cope with change differ from individual to species levels. Research showed that invertebrate has abilities to cope with it but focused primarily on temperature change, but other environmental factors including humidity, precipitation and wind flow patterns on land and ocean currents and local salinity in the sea are also likely to be affected [1,2]. We are clearly still in the early stages of understanding how biotas around the world will or can respond to change, but such evaluations are essential for the mitigation of deleterious effects, both for animals and the environment.

Molluscs have myogenic hearts, the rhythmic contractions of which are the result of the pacemaker activity of specialized cardiac muscle cells (Prosser 1973). Cardiac activity can be modified in response to numerous internal and external stimuli such as temperature, state of hydration and tactile stimulation. This modulation can involve direct effects on the heart musculature or may be mediated by the central nervous system (CNS). CNS modulation occurs via central cardioregulatory neurons which synapse on heart muscle fibers and modify the frequency and force of contraction (Krijgsmanand Divaris 1955). Peripheral modulation,which does not involve the CNS, can occur when the cardiac muscle cells respond directly to changes in the internal environment (Irisawa 1978). The ingestion of food has numerous effects on an animal, including an increase in oxygen consumption and metabolic rate (Prosser 1973).

Bivalves' heart is innervated from cerbrovisceral connective on each side so that the cardiac nerve enters the heart via each auricle. There are no innervations through aorta and rectum (Jones 1983). Molluscan heart muscle has been a widely used physiological preparation .Since, before the turn of the century. While part of this popularity may be attributed to the abundance of suitable specimens, another reason is that molluscan heart provides a convenient model of vertebrate heart; in both cases, excitatory and inhibitory nerve cells modulate both the rate of a myogenic pacemaker and the strength of contraction. Recent evidence suggests that this similarity may be extended to include hormonal mechanisms of control (Greenberg and Price, 1978).The effect of food intake on cardiac activity has been investigated in the marine opisthobranch, *Aplysia californica*, by Dieringer et al. (1978) and the terrestrial pulmonates *Deroceras reticulaturn* (Duval 1983) and *Limax rnaximus* but there is little information on studies on freshwater bivalves mussels in relation to external factors its impact on heart beat and morphomertic studies , hence the present investigation has been undertaken in freshwater bivalve mussels *Lamellidens corrianus*, from Nandrabad pond.

Material Methods

The adult freshwater bivalve mollusc, *Lamellidens corrianus* 95 -110 mm in shell length were collected and were the stocked in reservoirs water in laboratory for about 2-3 h. and immediately after bringing the animals to laboratory , the shells were brushed to remove the fouling algal mass the mud and other waste material. The bivalves were acclimatized in laboratory conditions and subsequent experimentation without food. The heart beat rate and morphological studies was determine in each season summer, monsoon , post-monsoon and winter season .A variety of methods have been utilized to record the cardiac activity of intact or semi-intact molluscs. The simplest is direct visual observation, either through a hole in the shell or through the skin overlying the pericardium (Feinstein *et al.*, 1977).

To determine the rate of heart beats of the individual animal of the shell length 95-110 mm, a window was made at the umbo region just above the heart of with the help of hacksaws region just. A special care was taken to avoid any type of heat stock to the animal and injury to the pericardium. The individual animals were placed in continuous flow of water. The number of heart beats per minutes was counted after the lapse of 5-8 minutes and again after 15 minutes..The average value is calculated for statically analysis.

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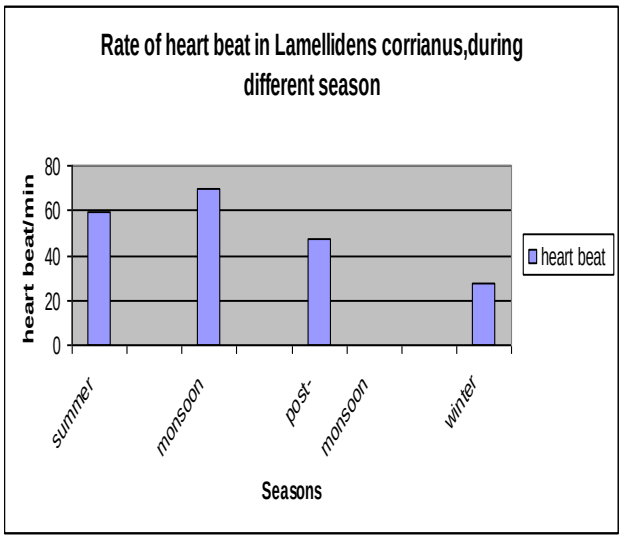
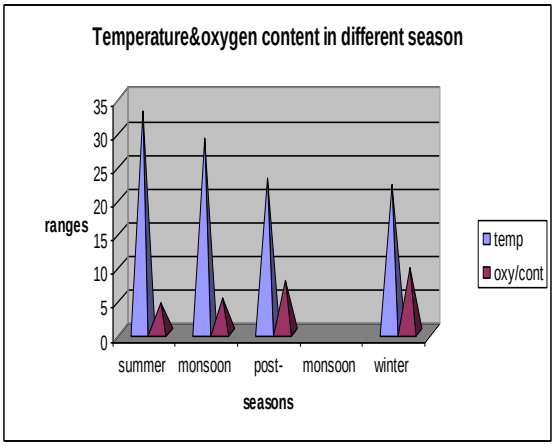
Result and Discussion

The result of heart beats are given in (Figure.1) The heart beat rate in adult 95-110mm shell length *Lamellidens corrianus* revealed that the heart beat rate was highest during monsoon season (69.5±2.50) and was lowest during winter (27.33±0.47). The heart beat rate during summer season was increased to (59.5±2.30) as compared to post-monsoon season (47.00 ± 1.41) whereas the rate decreased with lowest value during the winter season. The present result, obtained is correlated to various exogenous environmental factors and endogenous factors. As the increase in heart beat during monsoon might be due to maturation phase and spawning phase of the gonad developmental stage, and as the rise in temperature high water level and low oxygen content and plenty of food availability and starvation .Perhaps decrease in heart beat rate during winter might be due to low temperature, high oxygen content, increase in metabolic rate less availability of food and active gametogenesis, gonad ,developmental stage . Thus the rate of heart beat increase or decrease might be due the impact of exogenous and endogenous factors impact on the cardiac response in freshwater bivalve mussels.

Bivalve and gastropod molluscs undergo large changes in external environmental conditions, as well as in internal state. Cardiac responses to these changing conditions have been recorded in a variety of species. There is a general tendency for heart rate, and presumably cardiac output, to increase in response to situations that would increase the load on respiratory and excretory systems. *Cardiac behavioral pattern* of various gastropod and bivalve species to different physiological conditions (Bayne, 1976). In the few cases where data is available we consider the question of direct neural mediation of these responses. Most of the studies described were done on intact, unrestrained animals .*Nutritional level s. Mytilus edulis* shows no change in heart rate during, or immediately following, a 2 hr eating period, even though there are significant increases in Q02 and in ventilation rate (Thompson and Bayne,1972). Cutting the pericardial nerve, the motor nerve to the heart, has no effect on the increase in heart rate in the 2 hr immediately following a meal. In animals that are already in a high nutritional state, there is a transient decrease in heart rate during food ingestion. Under any given conditions, *Aplysia* heart rate appears to have an upper limit; thus stimuli that cause cardiac acceleration produce larger responses in starved animals ,which have lower base line heart rates (Dieringer *etal*., 1978).





Heart rate increases in response to increased temperature in all species of molluscs that have been examined. In Isognomon alatus, Mya arenaria, and Crassostrea gigas, the rapidity of heart rate changes in response to step changes in ambient temperature has been taken to suggest that partially neurally mediated responses are triggered via external temperature receptors (Trueman and Lowe, 1971; Trueman etal., 1973; Lowe, 1974). The QI0 for heart rate is reduced in Mytilus edulis and in Mya arenaria in conditions of respiratory stress induced by exposure or by a decrease in ambient pO2. The rates of ventilation and oxygen uptake are reduced concomitantly(Lowe and Trueman, 1972; Widdows, 1973). Gastropods. Segal (1962) has found that in Acmaea limatida abrupt changes in ambient temperature produce changes in heart rate with initial overshoots that take several minutes to decay to the new baseline. The increase in locomotors activity is paralleled by an increase in heart rate. The quiescent phase of the activity cycle is also characterized by a significant slowing of heart rate in most bivalve species that have been examined, including Isognomon alatus, Anodonta cygnea, Anodonta anatina, My a arenaria, and Scrobicularia plana (Pecsi and Salanki, 1964; Lowe and Trueman, 1972; Trueman et al., 1973; Coleman, 1974;

Earll, 1975; Brand, 1976). A unique form of inactivity has been described for Arctica islandica. At irregular intervals this animal burrows beneath the land, clamps its valves shut and respires anaerobically. The results of the present investigation obtained support the finding as the acceleration or the inhibition of the heart beat or cardiac response is totally under the control of the exogenous factors such as temperature, tides, food availability, oxygen content etc and endogenous factors such as the hormonal , gonadal cyclic condition, starvation and the neural ganglion control.

References

1.IPCC: *Climate Change2001: The Scientific Basis. Contribution of Working*
Group I to the Third Assessment Report of the Intergovernmental Panel on
Climate Change Edited by: Houghton JT, Ding Y, Griggs DJ, Noguer M,
van der Linden PJ, Dai X, Maskell K, Johnson CA. Cambridge University
Press, Cambridge, and New York, NY; 2001.
2. UNEP: *Global Environment Outlook 3* Earthscan Publications, London;2002.
J. KOESTER, N. DlERINGER, AND D. E. MANDELBAUM AMER.(2011): Cellular Neuronal Control of Molluscan Heart ZOOL..19:103-1 16 (1979).

References

Advokat, C, T. Carew, and E. R. Kandel. 1976. Modulation of a simple reflex in *Aplysia californica* byarousal with food stimuli. Xeurosci. Abstr. 2:313.

Bayne, B. L. 1971. Ventilation, the heart beat and oxygen uptake by *Mytilm edulv** L. in declining oxygon tension. Comp. Biorhem. Phvsiol. 4O.\:1O65-1085.

Bayne, B. L. (ed.) 1976. *Marine mussels. Their ecology and physiology*. Cambridge University Press.

Brand, A. R. 1976. Heart action of the freshwater bivalve *Anodonta anatina* during activity. J. Exp. Biol. 65:685-698.

Brand, A. R., and D. Roberts. 1973. The cardiac responses of the scallop *Pecten maximus* (L.) to respiratory stress. J. Exp. Mar. Biol. Ecol. 13:29-43.

Coleman, N. 1974. The heart rate and activity of bivalve molluscs in their natural habitats. Oceanogr. Mar. Biol. Ann. Rev. 12:301-313.

Coleman, N. and E. R. Trueman. 1971. The effect of aerial exposure on the activity of the mussels *Mytilu\ tdnlis* 1.. and *Madinlus mndiolus* (1..). J. Exp. Mar. Biol. Lcol. 7:295-304..

Dieringer, N., J. Koester, and K. Weiss. 1978. Adaptive changes in heart rate of *Aplysia californica*. J. Comp. Physiol. 123:11-21.

Earll, R. 1975. Temporal variation in the heart activity of *Scrobiculana plana* (DaCosta) in constant and tidal conditions. J. Exp. Mar. Biol. Ecol. 19:257-274.

Feinstein, R., H. Pinsker, M. Schmale, and B. A. Gooden. 1977. Bradycardial response in *Aplysia* exposed to air. J. Comp. Physiol. 122:311-.

Greenberg, M. J., and D. A. Price. 1979. FMRFamide, a cardioexcitatory neuropeptide of molluscs: An agent in search of a mission. Amer. Zool. 19:163-174.

Jones, H. D. 1968. Some aspects of heart function in *Patella vulgata* L. Nature 217:1170-1172.

Lowe, G. A. and E. R. Trueman. 1972. The heart and water flow rates of *Mya arenaria* (Bivalvia:

Mollusca) at different metabolic levels. Comp. Biochem. Physiol. 41 A:487-494

Pecsi, T. and j . Salanki. 1964. The role of pressure in the periodical changes of cardiac action in the freshwater mussel *(Anodonta cygnea)*. Annal. Inst.Biol. Tihany 31:65-76 Segal, E. 1962. Initial response of the heart-rate of a

gastropod, *Acmaea limatula,* to abrupt changes in temperature. Nature 195:674-675.

Sommerville, B. A. 1973. The circulatory physiology *of Helix pomatia*. I. Observations on the mechanism by which *Helix* emerges from its shell and on the effects of body movement on cardiac function. J.Exp. Biol. 59:275-282. Sommerville, B. A. 1975. Factors affecting the heart activity and blood pressure of the swan Thompson, R. J. and B. L. Bayne. 1972. Active

metabolism associated with feeding in the mussel *Mytilus edulis*. J. Exp. Mar. Biol. Ecol. 9:111-124.

Trueman, E. R. 1967. Activity and heart rate of bivalve molluscs in their natural habitat. Nature 214:832-833.

Trueman, E. R. 1968. The burrowing activities of bivalves. Symp. Zool. Soc. Lond. 22:167-186.

Trueman, E. R.,J. G. Blatchford, H. D.Jones, and G. A. Lowe. 1973. Recordings of the heart rate and activity of molluscs in their natural habitat.

Malacologia 14:377-383.mussel *Anodonta cygnea*. J. Exp. Biol. 62:341-355

Widdows, J. 1973. Effect of temperature and food onthe heart beat, ventilation rate and oxygen uptake *of Mytilus edulis*. Mar. Biol. 20:269-276.

Identification of neurons in the abdominal ganglion using behavioral criteria. Br. Research 121:1-20.

Koester, J., E. Mayeri, G. Liebeswar, and E. R. Kandel. 1974. Neural control of circulation in *Aplysia*. II. Interneurons. J. Neurophysiol. 37: 476-496.

Kupfermann, I. and T. J. Carew. 1974. Behavioral patterns *of Aplysia californica* in its natural environment. Behav. Biol. 12:317-337.

Kuwasawa, K. 1978. Effects of ACh and IJPs on the A-V valve and the ventricle of *Dolabella auncularia*. Amer. Zool. 19:129-143.

Kuwasawa, K., H. Neal, and R. B. Hill. 1975. Afferentpathways in the innervation of the ventricle of a prosobranch gastropod, *Busycon canahculatum*. J. Comp. Physiol. 73-83.

Liebeswar, G., J. E. Goldman, J. Koester, and E. Mayeri. 1975. Neural control of circulation in *Aplysia*. III. Neurotransmitters. J. Neurophysiol. 38:767-779.

Loveland, R. E. 1963. 5-hydroxytryptamine, the probable mediator of excitation in the heart of *Mercenana (Venus) Mercenaria*. Comp. Biochem. Physiol. 9:95-104.

Lowe, G. A. 1974. Effect of temperature change on the heart rate ol *Crassostrea gigas* and *Mya arenaria* (Bivalvia). Proc. Malac. Soc. Lond. 41:29-36.

Lowe, G. A. and E. R. Trueman. 1972. The heart and water flow rates of *Mya arenaria* (Bivalvia: Mollusca) at different metabolic levels. Comp. Biochem. Physiol. 41 A:487-494.

MacKay, A. R., and S. A. Gelperin. 1972. Pharmacology and reflex responsiveness in the giant garden slug, *Limax maximus*. Comp. Biochem. Physiol., A 43:877-896.

Martin, R. 1969. On the swimming behavior and biology of *Notarchus punctatus* Philippi (Gastropoda, Opisthobranchia) Publ. Zool. Napol. 35:61-75.

Mayeri, E., J. Koester, I. Kupfermann, G. Liebeswar, and E. Mayeri. 1974. Neural control of circulation *\n Aplysia.]*. Neurophysiol. 37:458-475.

Mellon, DeF. 1969. The reflex control of rhythmic motor swimming in the scallop. Z. Vergl. Physiol. 62:318-336.

Morton, B.S.I 969. Studies on the biology of*Dreissena polymorpha* Pall II. Correlation of the rhythms of adductor activity, digestion and excretion. Proc. Malac. Soc. Lond. 38:401-414.

Morton, B. 1970. The rhythmical behaviour of *Anodonta cygnea* L. and *Unto pictorum* L. and its biological significance. Forma et Functio 2:110-120.

Pecsi, T. and j . Salanki. 1964. The role of pressure in the periodical changes of cardiac action in the freshwater mussel *(Anodonta cygnea)*. Annal. Inst. Biol. Tihany 31:65-76.

Perlman, A. 1975. Neural control of the siphon in *Aplysia*. Ph.D. Diss., New York University. Pinsker, H., I. Kupfermann, V. Castellucci, and E. R. Kandel. 1970. Habituation and dishabituation of the gill-withdrawal reflex in *Aplysia*. Science, 167:1740-1742.

S.-R6zsa, K. 1976. Neuronal network underlying the regulation of heart beat in *Helix pomatia* L. *Neurobiology of invertebrates*, pp. 597-613.

Tihany. S.-R6zsa, K. and J. Salanki. 1973. Single neurone responses to tactile stimulation of the heart in the snail, *Helix pomatia* L. J. Comp. Physiol. 84:267-279.

Salanki, J. 1966. Comparative studies on the regulation of periodic activity in marine lamellibranchs. Comp. Biochem. Physiol. 18:829-843.

Salanki, J. and F. Lukacsovics. 1967. Filtration and O2 consumption related to the periodic activity of freshwater mussel *(Anodonta cygnea* L.). Annal. Biol. Tihany 34:85-98.

Salanki, J. and I. Varanka. 1972. Central determination of the rhythmic adductor activity in the freshwater mussel *Anodonta cygnea* L., Pelecypoda. Comp. Biochem. Physiol. 41A:465-474.

Sanger, J. W. 1979. Cardiac fine structure in selected arthropods and molluscs. Amer. Zool. 19:9-27.

Segal, E. 1962. Initial response of the heart-rate of a gastropod, *Acmaea limatula,* to abrupt changes in temperature. Nature 195:674-675.

Sommerville, B. A. 1973. The circulatory physiology *of Helix pomatia*. I. Observations on the mechanism by which *Helix* emerges from its shell and on the effects of body movement on cardiac function. J. Exp. Biol. 59:275-282.

Sommerville, B. A. 1975. Factors affecting the heart activity and blood pressure of the swan mussel *Anodonta cygnea*. J. Exp. Biol. 62:341-355.

Susswein, A., K. R. Weiss, and 1. Kupfermann. 1978. The effects of food arousal on the latency of biting *in Aplysia*. J. Comp. Physiol. 123:31-41.

Taylor, A. C. 1976a. Burrowing behaviour and anaerobiosis in the bivalve *Arctica islandica* (L.). J. Mar. Biol. Ass. U.K. 56:95-109.

Taylor, A. C. 19766. The cardiac responses to shell opening and closure in the bivalve *Arctica islandica* (L.). J. Exp. Biol. 64:751-759.

Taylor, A. C. and A. R. Brand. 1975. A comparative study of the bivalves *Arctica islandica* (L.) and *Mytilus edulis* L. to declining oxypen tension. Proc. Roy. Soc. Lond. B. 190:443-456.

Thompson, R. J. and B. L. Bayne. 1972. Active metabolism associated with feeding in the mussel *Mytilus edulis*. J. Exp. Mar. Biol. Ecol. 9:111-124.

Trueman, E. R. 1967. Activity and heart rate of bivalve molluscs in their natural habitat. Nature 214:832-833.

Trueman, E. R. 1968. The burrowing activities of bivalves. Symp. Zool. Soc. Lond. 22:167-186.

Trueman, E. R.,J. G. Blatchford, H. D.Jones, and G. A. Lowe. 1973. Recordings of the heart rate and activity of molluscs in their natural habitat. Malacologia 14:377-383.

Trueman, E. R. and A. C. Brown. 1976. Locomotion, pedal retraction and extension, and the hydraulic systems of *Bullia* (Gastropoda:Nasseridae). J. Zool., Lond. 178:365-384.

Trueman, E. R., and G. A. Lowe. 1971. The effect of temperature and littoral exposure on the heart rate of a bivalve mollusc, *Isognomon alatus*, in tropical conditions. Comp. Biochem. Physiol., A 38:555-564.

Weiss, K. R., J. L. Cohen, and I. Kupfermann. 1978a. Modulatory control of buccal musculature by a serotonergic neuron (metacerebral cell) in *Aplysia*. J. Neurophysiol. 41:181-203.

Weiss, K. R., M. Schonberg, D. E. Mandelbaum and I. Kupfermann. 1978A. Activity of an individual serotonergic neurone in *Aplysia* enhances synthesis of cyclic adenosine monophosphate. Nature. 272:727-728.

Widdows, J. 1973. Effect of temperature and food on the heart beat, ventilation rate and oxygen uptake *of Mytilus edulis*. Mar. Biol. 20:269-276.

Wolleman, M. and K. S.-R6zsa. 1975. Effects of serotonin and catecholamines on the adenylate cyclase of molluscan heart. Comp. Biochem. Physiol. 516: 63-66.