with best wishes

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Fluctuations in some hydrological factors and the condition index of *Aspatharia sinuata* (Bivalvia, Unionacea) in a small Nigerian reservoir

By John Blay, Jr.[1]

With 2 figures in the text

Abstract

The relationship between the fluctuations in some environmental factors and the tissue condition of the tropical bivalve, *Aspatharia sinuata* occurring in a small Nigerian man-made lake has been investigated. The condition index (meat : shell ratio) of the bivalves was high in December—May when the water was generally characterized by high temperatures, low silt content, high calcium and dissolved oxygen concentrations, high conductivities, and neutral/alkaline conditions. In June—November, the index was low and this seemed related to the slightly reduced temperatures, high silt content, low calcium and oxygen concentrations, low conductivities, and acid waters which occurred for most part of the interval. Personal observations indicate that reproductive activity may have played a less significant role in determining the pattern of changes in the condition index of the population, presumably because they maintained a high gonadal activity throughout the year.

Introduction

The condition index of a bivalve species is an important measure of its meat quality. Although both environmental and physiological factors, particularly reproductive activity, have been observed to determine the cycles in the condition of bivalves, the latter has received prominence in most reported works on temperate and subtropical marine and estuarine bivalves (e.g. Ansell, Loosmore & Lander, 1964; Hancock & Franklin, 1972; Ruddy, Feng & Campbell, 1975; Hughes-Games, 1977; Yankson, 1986). In fact, there is no reported study on the variations in the tissue condition of African freshwater bivalves, although such data are of pragmatic utility as indicators of the appropriate harvest period of economically important species (see Hancock & Franklin, 1972; Hughes-Games, 1977).

The mutelid bivalve, *Aspatharia sinuata* abounds in many freshwater habitats in Nigeria, and is exploited as a source of protein in certain localities.

[1] Address of the author: Department of Biological Sciences, University of Ilorin, Ilorin, Nigeria.

Present address: Department of Zoology, University of Cape Coast, Cape Coast, Ghana.

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However, little is known of the biology and ecology of this shellfish of potential economic value. Investigations have recently been conducted on various aspects of the biology of some populations of the bivalve occurring in Nigeria (BLAY & YOLOYE, 1987; BLAY, in press; BLAY & YOLOYE, in press).

This study examines the variations in some factors of the aquatic environment and their probable influence on changes in the tissue condition of a population of the bivalves occurring in a man-made lake in Nigeria.

The study area

The study was conducted in Oyun Reservoir, a small man-made lake at Offa (approximately, 8 N and 5 E), a town located 67 km south-east of Ilorin, the capital city of Kwara State, Nigeria. It has a surface are of about 20.8 ha. The reeds *Typha latifolia* constitute the predominant littoral vegetation. Other plants in the littoral zone are *Ipomoea* sp., *Sagittaria* sp., and many grasses and sedges.

The lake exhibits distinct seasonal fluctuations in water levels dictated by the annual rainfall pattern. Low water levels occur from February to early June (3.5—4.5 m) and high water levels from mid-June to January (5.0—6.5 m). During the period of reduced water levels, about 60 % of the bivalves in the littoral zone are exposed to air; such individuals survive the ensuing drought by aestivating (personal observation).

Materials and methods

Water samples were collected with a 1 litre non-metallic Kemmerer water sampler. Temperature was measured with a mercury thermometer installed permanently in the water sampler. Transparency was measured with a 20 cm Secchi disc, and conductivity with a conductivity meter (Model MC-1. Mark V by electric Instruments Ltd.) Dissolved oxygen was determined by the Winkler method and calcium hardness by EDTA titrations (FLASCHKA, 1964). The pH of the water was measured in the field using a Lamotte Limnology Test Kit comparator and a wide range (3.0—11.0) pH indicator.

The condition index of the bivalves was determined in submerged specimens only. Specimens in monthly samples were measured for length (longest antero-posterior shell distance) and whole weight to the nearest 0.01 cm and 0.01 g, respectively. The tissue of each animal was removed from its shell, and both dried in an oven at 60 °C to constant weight. They were then weighed to the nearest 0.01 g. The tissue condition was determined from the relation:

$$\text{Condition index} = \frac{\text{dry tissue weight}}{\text{dry shell weight}} \times 1000$$

(AGIUS, JACCARINI & RITZ, 1978; WALNE & MILLICAN, 1979).

Results

Fluctuation in the environmental factors

Fig. 1 shows the monthly variations in some physical and chemical environmental parameters of the reservoir during the study period. Water tem-

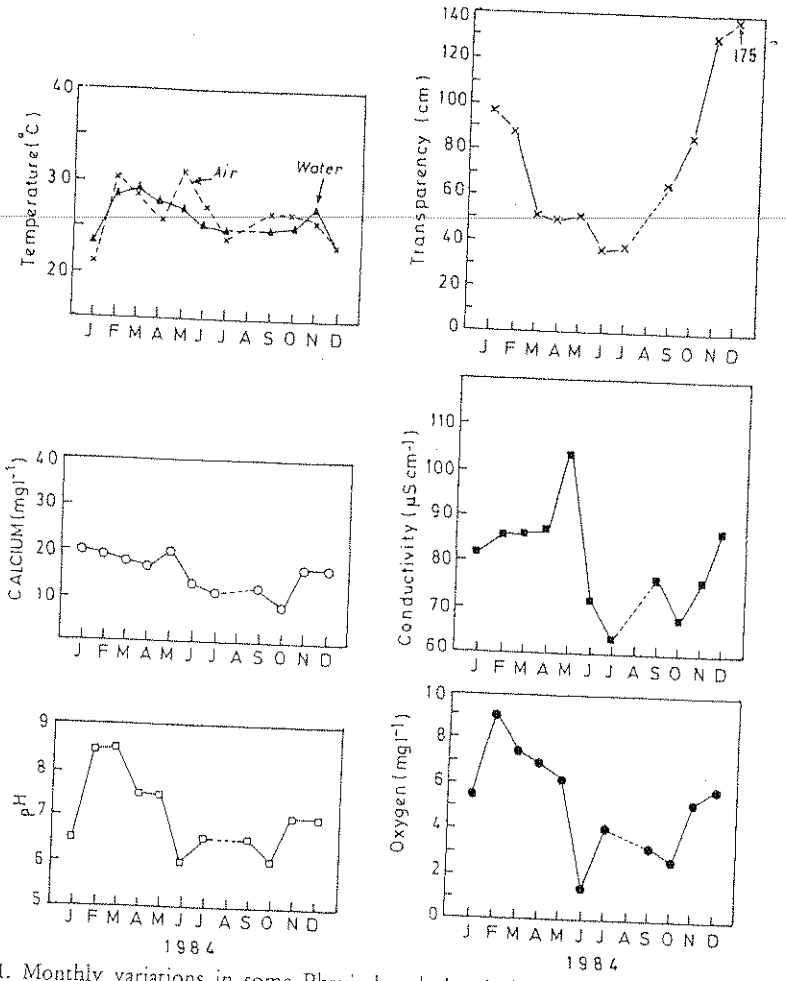

Fig. 1. Monthly variations in some Physical and chemical environmental factors in Oyun Reservoir.

perature was lowest in December—January (about 23 °C) but this increased to a peak (29.2 °C) in March, followed by a gradual decline to 25 °C in June. The temperature remained at about this level until October and was followed by an increase to a smaller peak in November (27 °C).

The transparency declined steadily from 95 cm in January to 36—51 cm in March—July, started increasing by October and reached a maximum of 175 cm in December.

Calcium hardness concentrations ranged from 8 to 20 mg/l during the year. Generally, higher values occurred from November until May, while relatively lower concentrations obtained in June—October.

High conductivities existed from December until May with values ranging from 82 to 104 μS/cm. Low values varying from 63 to 77 μS/cm were recorded in June—November. The latter observation may be due to a lowering of the concentration of the mineral content of the water by heavy rains.

An increase in the pH occurred from a value of 6.5 in January to a maximum of 8.5 in February—March, and was followed by a decline to 6.0—6.5 in June—October. This was succeeded by a slight increase to 7.0 in November—December.

Concentrations of oxygen ranging from 5.0 to 9.0 mg/l prevailed from November to May. A significant decrease in the oxygen content of the water occurred in June (1.3 mg/l), and thereafter concentrations fluctuated between 2.6 and 4.0 mg/l up to October.

Changes in the condition index

The variations in the mean condition index of the bivalves are shown in Fig. 2. The index was high from January to May (128.27 ± 9.86—137.41 ± 10.04). This was followed by a drastic decrease in June (106.76 ± 10.05) after which it continued to decline at a reduced rate to a minimum in November (78.82 ± 8.35); the index increased significantly in December (121.77 ± 9.55). In general, the bivalves attained the best tissue condition from December til May while they were in a poor condition from June to November.

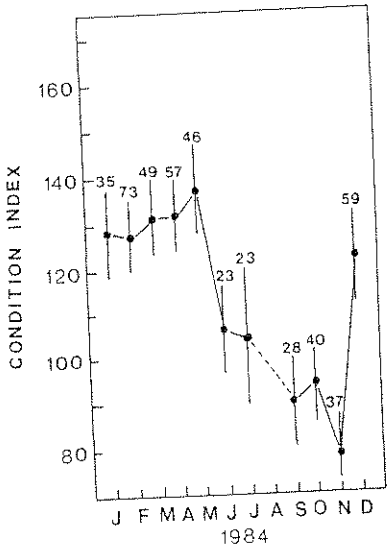

Fig. 2. Monthly changes in the mean cor
tion index of *A. sinuata* in Oyun Reserv
Vertical bars represent 2 standard err
Figures on top of bars indicate sample siz

Discussion

Correlations between the fluctuations of the meat condition and reproductive activity (i.e. gonadal proliferation and spawning) have been observed in subtropical and temperate marine and estuarine bivalves such as *Venus mercenaria* (ANSELL et al., 1964), *Cerastoderma edule* (HANCOCK & FRANKLIN, 1972; YANKSON, 1986), *Crassostrea virginica* (RUDDY et al., 1975) and *Crassostrea gigas* (HUGHES-GAMES, 1977). However, the relationship between the fluctuations in these two parameters in *Aspatharia sinuata* occurring in Oyun Reservoir was less clear. The bivalves maintained a consistently high gonadal activity throughout the year (BLAY, unpubl. observation) presumably because of the high temperature (23 °C—29 °C) prevailing in the lake. This would tend to favour uninterrupted gonadal development.

The results of this study indicate that the variations in the condition index of *A. sinuata* were rather closely linked to the changes in the environmental factors. From December to May when the condition index of the bivalves was high, there were correspondingly high water temperatures, high calcium and dissolved oxygen concentrations, high conductivities, and neutral and alkaline waters.

It is apparent that these relatively good conditions in the environment enabled the animals to maintain a high metabolic rate during the interval. In fact, the gradual decrease observed in the transparency from January to May was due primarily to phytoplankton production which therefore meant an increased food availability to the bivalves. This probably caused the attainment and sustenance of the high tissue quality in the animals during the period.

The low condition index of the bivalves from June to November, on the other hand, could be attributed to the slightly depressed water temperatures, low conductivities, low calcium and dissolved oxygen contents, and low pH which occurred in June—October. Although there was some improvement in the quality of the water in November, the tissue condition of the bivalves did not increase until December. Thus, the restoration of a better tissue quality lagged one month behind the commencement of improved environmental conditions in the reservoir. The reduced conductivity and calcium hardness over the period was a direct result of the diluting effect of rainwater, and would imply a lesser availability of nutrients in the water. The prevailing low pH and dissolved oxygen were likely due to the decomposition of inundated terrestrial vegetation, mainly grasses which sprouted in the exposed littoral zones during the period of draw-down. The petrified odour of the water during the period indicated the generation of hydrogen sulphide which could have far-reaching negative effects on the physiology and survival of the bivalves.

Furthermore, the low water transparency in June—July was due mainly to silty suspensions carried into the reservoir by the floods. This probably caused

a reduction in food production through photosynthesis by inhibiting light penetration. The presence of abundant silt may also have triggered the bivalves to close their shells and stop feeding, similar to KWEI's (1965) observation in the Volta clam, *Egeria radiata*. It has been observed that generally silt has a deleterious effect on bivalves because it tends to clog their ctenidia and reduce feeding efficiency, and growth (HEADLEE, 1906; ELLIS, 1936; PURCHON, 1968; BROOM, 1982).

Another possible reason for the "poor" condition of the bivalves in June—November is that submerged samples at the time included some individuals that had aestivated for varying lengths of time between February and May as a consequence of the draw-down of water levels. The condition index of aestivating *A. sinuata* has been observed to decline with time (BLAY & YOLOYE, in press), and it would take some time for such individuals to regain their lost tissue condition following their inundation by water.

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References

AGIUS, C., JACCARINI, V. & RITZ, D. A. (1978): Growth trials of *Crassostrea gigas* and *Ostrea edulis* in inshore waters of Malta (Central Mediterranean). — Aquaculture 15: 195—218.

ANSELL, A. D., LOOSMORE, F. A. & LANDER, K. F. (1964): Studies on the hard-shell clam, *Venus mercenaria* in British Waters. II. Seasonal cycle in condition and biochemical composition. — J. Appl. Ecol. 1: 83—95.

BLAY, J., Jr. (in press): Morphometry, length-weight relationships and length distributions of five populations of the freshwater bivalve *Aspatharia sinuata* (Unionacea, Mutelidae) in Nigeria. — Malacologia 30 (1).

BLAY, J., Jr. & YOLOYE, V. (1987): Observations on the growth of some populations of the freshwater bivalve *Aspatharia sinuata* (Unionacea, Mutelidae) in Nigeria. — Korean J. Zool. 30: 140—153.

— — (in press): Changes in the weight, condition index and biochemical composition of the freshwater aestivating bivalve *Aspatharia sinuata* (Unionacea, Mutelidae). — Proceedings of the Joint 15th Ghana Science Association/13th West African Science Association Biennial Conference. 24—28 August, 1987. University of Ghana, Ghana.

BROOM, M. J. (1982): Analysis of the growth of *Anadara granosa* (Bivalvia: Arcidae) in natural, artifically seeded and experimental populations. — Mar. Ecol. Progr. Ser. 9: 69—79.

Ellis, M. M. (1936): Erosion silt as a factor in aquatic environments. — Ecology 17: 29—42.

Flaschka, H. A. (1964): EDTA titrations; an introduction to theory and practice, 2nd ed. — Pergamon Press, Oxford, 144 pp.

Hancock, D. A. & Franklin, A. (1972): Seasonal changes in the condition of the edible cockle (*Cardium edule* L.). — J. Appl. Ecol. 9: 567—579.

Headlee, T. J. (1906): Ecological notes on the mussels of Winona, Pike and Center Lakes of Koscuisko County, Indiana. — Biol. Bull. 11: 305—318.

Hughes-Games, W. L. (1977): Growing the Japanese oyster (*Crassostrea gigas*) in subtropical seawater fish ponds. I. Growth rate, survival and quality index. — Aquaculture 11: 217—229.

Kwei, E. A. (1965): The spawning and growth of the Volta oyster *Egeria radiata* (Lam.). — Ghana J. Sci. 5: 150—159.

Purchon, R. D. (1968): The biology of the mollusca. — Pergamon Press, Oxford, 560 pp.

Ruddy, G. M., Feng, S. Y. & Campbell, G. S. (1975): The effect of prolonged exposure to elevated temperatures on the biochemical constituents, gonadal development, and shell deposition of the American oyster, *Crassostrea virginica*. — Comp. Biochem. Physiol. 51 B: 157—164.

Walne, R. P. & Millican, P. F. (1979): The condition index and organic content of small oyster spat. — J. Cons. perm. internat. explorat. Mer. 38: 230—233.

Yankson, K. (1986): Reproductive cycles of *Cerastoderma glaucum* (Bruguiere) and *C. edule* (L) with special reference to the effects of the 1981—82 severe winter. — J. Molluscan Stud. 52: 6—14.