

Distribution of Nucleic Acids in Different Tissues of Catfish *Clarias batrachus*

Saleem Mustafa and Naheed Shams

(Received May 7, 1981)

An attempt has been made to present data on the concentrations of RNA and DNA in different tissues, including those of the heart, kidney, liver and the skeletal muscles of *Clarias batrachus* (Linnaeus), an air-breathing catfish of considerable economic importance. Interpretation of differences in the relative amounts of the two nucleic acids in each of the tissues is also an important outcome of this study.

Materials and methods

Live specimens of *Clarias batrachus* captured from ponds at Aligarh (27°34'30"N, 78°4'26"E) were brought to the laboratory and reared in glass aquaria maintained at a temperature of $30 \pm 3^\circ\text{C}$. The supply of water was so adjusted as to maintain a dissolved oxygen concentration of 5 ± 1.5 ppm. Fish were allowed to rest for 24 hours, after which they were taken out, recorded for total length (as measured from tip of snout to the longest caudal fin ray) and body weight (determined on a sensitive electrical balance). Specimens were decapitated and samples of skeletal muscle, heart, kidney and liver were immediately taken out. White skeletal muscle was excised from the epaxial portion of the trunk below the place of the origin of dorsal fin. Known weights of the tissue were processed for the extraction of RNA and DNA. Techniques of Schneider (1957) were followed for the extraction of RNA from the tissues and determination of its concentration through the orcinol reaction. The values were read off against a standard curve prepared by relating the color intensity to different concentrations of purified yeast RNA. DNA was extracted according to the method described by Webb and Levy (1955) and its quantity estimated by the reaction of cystein-sulphuric acid reagent with deoxy sugars (Ashwell, 1957). Highly polymerised calf-thymus DNA was used for preparing the calibration curve. The color intensities were read on a Bausch and Lomb spectronic 20 spectrophotometer. Values of RNA and DNA

were expressed as $\mu\text{g}/100$ mg on fresh weight basis. Methods followed for the statistical evaluation of the data were the same as given by Goulden (1952).

Results and discussion

Concentrations of RNA and DNA in the skeletal muscle, heart, kidney and liver of *Clarias batrachus* are shown in Fig. 1. The application of Chi-square (X^2) test revealed marked heterogeneity in the distribution of nucleic acids in different tissues ($P < 0.001$). Highest concentration of RNA was recorded in the liver, followed by the kidney, heart, and lowest values were encountered in the flesh (skeletal muscle). Since the concentration of RNA in tissues is known to be an index of metabolic activity (Brachet, 1955; Leslie, 1955), the significantly higher value of RNA in liver, an important seat of metabolic functions, and relatively lower concentration of this nucleic acid in tissues like skeletal muscle and those of kidney and heart which are more active mechanically, are quite obvious.

The pattern of DNA distribution seemed to differ with that of RNA in that of all the tissues investigated its highest value occurred in kidney. The liver was the organ with DNA concentration second to the kidney; the values then declined in the order: heart, skeletal muscle. Although the variations in the actual amount of DNA in the individual cells of the different somatic tissues could not be ruled out, the difference in the DNA concentration can be attributed to other factors also, such as the number of cells/unit weight of tissue and ploidy. Tissues with larger number of cells in a given weight and with higher ploidy are known to yield greater concentration of DNA (Leslie, 1955; Mustafa, 1978). Mustafa (1976) expressed the view that because of narrower dimensions of hepatic cells in comparison with muscle fibers, larger number of cells contributing to the unit weight of liver can account for higher DNA concentration in this organ, but since the data on the exact cellular dimensions is not available, this point can be outlined only as a possibility and not a basis of specific interpretation vis-a-vis heterogeneity in DNA distribution in fish tissues. Vendrely (1955) documented

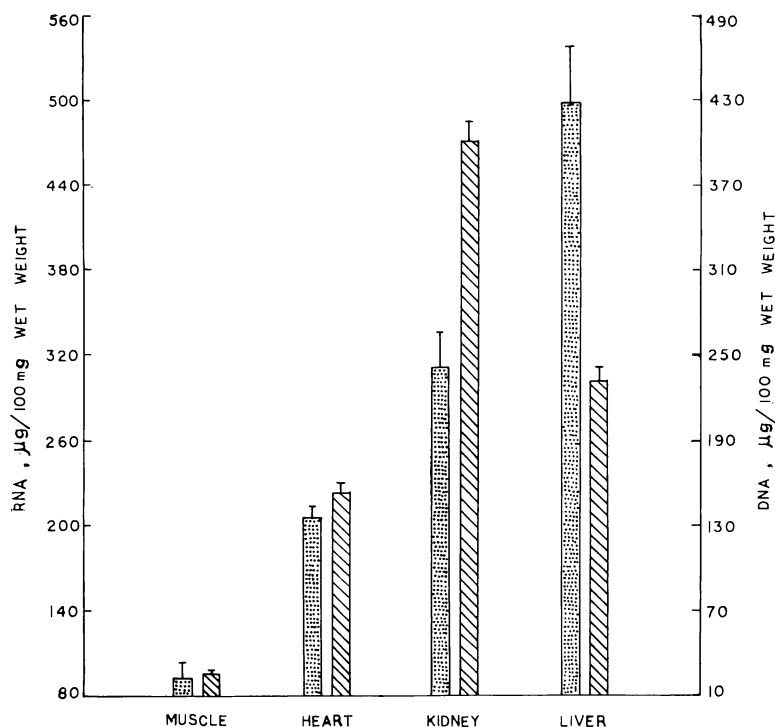


Fig. 1. Concentrations of RNA (dotted bars) and DNA (striped bars) in different tissues of *Clarias batrachus*. Vertical lines indicate standard error of mean of five observations.

that frequency of polyploid cells and degree of polyploidy of individual cells in a tissue are related to metabolic activity. The same author reported that the liver contained a larger amount of three kinds of nuclei-diploid, tetra-ploid and octaploid, and that the kidney had only diploid nuclei. Despite this, however, a lower concentration of DNA in liver than the kidney only indicates that factors other than polyploidy can potentially exert an overriding influence in determining the DNA concentration. Creelman and Tomlinson (1959) also published results of the nucleic acid analyses on sockeye salmon which are consistent with the present data but avoided any comment on possible basis of the differences in the DNA concentration between liver and kidney.

In all the nucleic acid investigations at the tissue level, one cannot lose sight of the effect of differences in the relative amounts of both extracellular and intracellular materials (other than nucleic acids), since they contribute to the unit weight of the samples used for analyses.

Any increase in these substances, especially water, on a fresh weight basis, will invariably amount to a so-called 'dilution effect' on the nucleic acid concentrations (amount/unit weight) rather than their contents in individual cells.

The highest RNA/DNA ratio was found in skeletal muscle (3.556). Although this tissue was poorest in RNA as well as DNA, the amount of DNA relative to RNA was much lower and hence the high RNA/DNA ratio. The ratio for the liver was 2.142, implying that RNA was a little more than twice as much concentrated as DNA. The proportion of RNA to DNA in the heart was even less than that in the liver; the ratio being only 1.329. The lowest ratio was encountered in the kidney (0.774) where the DNA concentration even exceeded that of RNA.

Acknowledgments

We are thankful to Head of the Department of Zoology, Aligarh Muslim University, for providing research facilities.

Literature cited

- Ashwell, G. 1957. Colorimetric analysis of sugars: cysteine reaction of DNA. In Colowick, S. P. and N. O. Kaplan, eds.: Methods in enzymology. Vol. 3. Academic Press, New York, 1154 pp.
- Brachet, J. 1955. The biological role of the pentose nucleic acids. In Chargaff, E. and J. N. Davidson, eds.: The nucleic acids, chemistry and biology. Vol. 2. Academic Press, New York, 576 pp.
- Creelman, V. M. and N. Tomlinson. 1959. Biochemical studies on sockeye salmon during spawning migration. VI. Ribonucleic and deoxyribonucleic acids. J. Fish. Res. Bd. Can., 16: 421~428.
- Goulden, C. H. 1952. Methods of statistical analysis. Asia Publ. House, New York, London, Bombay, Calcutta, Madras, New Delhi, 467 pp.
- Leslie, I. 1955. The nucleic acid content of tissues and cells. In Chargaff, E. and J. N. Davidson, eds.: The nucleic acids, chemistry and biology. Vol. 2. Academic Press, New York, 576 pp.
- Mustafa, S. 1976. Some aspects of the anatomy and chemistry of fish muscle. Ph. D. Thesis, Aligarh Muslim University, Aligarh, India, 139 pp.
- Mustafa, S. 1978. Deoxyribose nucleic acid in the musculature of freshwater catfish *Heteropneustes fossilis* (Bloch). Broteria Ciencias Naturais, 48: 83~92.
- Schneider, W. C. 1957. Determination of nucleic acids in tissues by pentose analysis. In Colowick, S. P. and N. O. Kaplan, eds.: Methods in enzymology. Vol. 3. Academic Press, New York, 1154 pp.
- Vendrelly, R. 1955. The deoxyribose nucleic acid content of the nucleus. In Chargaff, E. and J. N. Davidson, eds.: The nucleic acids, chemistry and biology. Vol. 2. Academic Press, New York, 576 pp.
- Webb, J. M. and H. B. Levy. 1955. A sensitive method for the determination of deoxyribonucleic acid in tissues and microorganisms. J. Biol. Chem., 213: 107~117.
- (Division of Ichthyology and Fisheries, Department of Zoology, Aligarh Muslim University, Aligarh-202 001, India)

Clarias batrachus の諸組織の核酸の分布

Saleem Mustafa • Naheed Shams

ヒレナマズ *Clarias batrachus* の骨格筋, 心臓, 腎および肝の RNA と DNA 量を調べた。核酸の分布は極めて不均一であり, この現象について詳細に論じた。調べた諸組織の RNA/DNA 比から諸組織中の両核酸の相対的割合の相違を明らかにした。