SEASONAL FLUCTUATIONS OF ADENYLIC COMPOUNDS IN FROG GASTROCNEMIUS

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T. A. Allik

Central Research Institute of Physical Training, (Dir. Prof. A. V. Korobkov), Moscow
Presented by Active Member AMN SSSR S. E. Severiny
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Adenylic system compounds were studied quantitatively in resting frog skeletal muscle in the different seasons of the year [1].

METHOD

The experiments were carried out in series lasting for from a few days to 3 months.

After dissection, the muscle was kept in Ringer's solution for 10-20 min, then frozen with liquid nitrogen and ground in a mortar with liquid nitrogen. It was then suspended in 3% trichloroacetic acid and, after precipitation of proteins, the extract was examined for ATP, ADP and AMP, which were separated chromatographically [3]. The quantities of ATP and ADP present (AMP was not found in these analyses) were calculated from the adenine concentration determined spectrophotometrically [8]. The results were processed statistically (small selection method) [5].

ATP and ADP Contents of Frog Gastrocnemius Muscle at Different Times of Year (mg/100 ml)

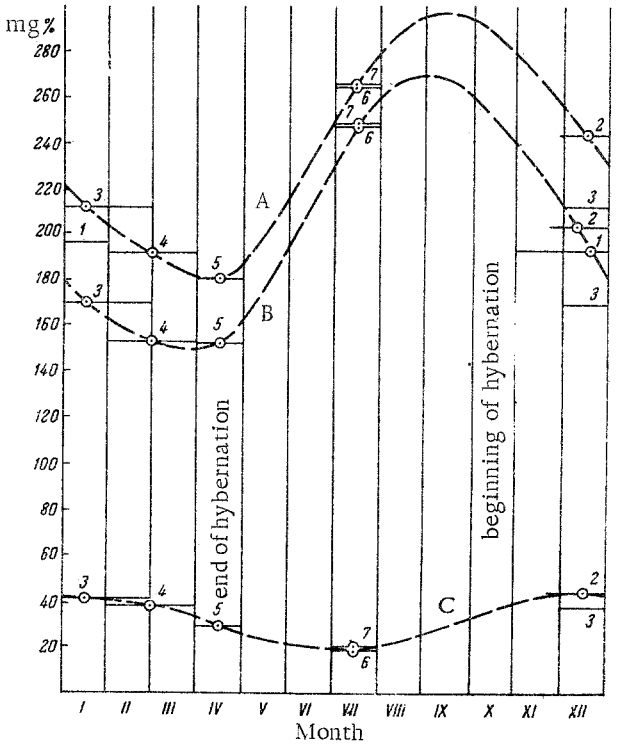
Period	No. of expts.	ATP	ADP	Total
October-January	16	195±7.9	–	–
End November-December	4	203±30.3	44±5.8	247±34.5
December-February	8	170±8.0	41±1.9	211±8.2
February-March	4	152±8.4	39±10.5	191±13.9
April	3	152	28.9	181
July	6	245±10.4	18.5±1.2	263±10.5
July	8	243±3.7	21±3.2	264±5.0
July	4	243±15.2	18±1.0	261±15

Note. No AMP was found in the muscles.

RESULTS

Certain gradual and regular changes were observed in the ATP and ADP contents of frog muscle in the course of the year (table and figure). ATP content, at its lowest in early spring (February to April), was 60% higher by July. The graphs (figure) suggest, however, that the ATP maximum is reached a little later - in the August-September period. It is, at any rate, obvious that ATP content is highest in summer and lowest in spring. There is a rapid increase of ATP in the frog gastrocnemius during May and June (an increase of 93 mg/100 ml in 2-3 months) and an almost equally rapid reduction (by 33 mg/100 ml in a month) in the winter months, December and January. No definite statement can be made as to changes in ATP content during the period August to October as data are not available, but the trend may be as shown in the figure, B.

The seasonal changes in ADP content differed sharply from these ATP changes: ADP was present in the muscle in greatest quantity in the winter months (December and January) and was at its lowest in summer (apparently in July).



Contents of adenylic system components in frog gastrocnemius at different times of year (values given in the table). A) Total adenylic content; B) ATP; C) ADP. No AMP was found. The numbers on the graphs denote position of entry in the table. Horizontal lines indicate level of content during period.

These changes are almost the exact opposite of the ATP changes described, but the ADP maximum lags considerably (about 3 months) behind the ATP maximum and coincides with the period of rapidly declining ATP content. It is difficult to gauge the relative position of the ADP minimum but it, too, would appear to anticipate the ATP maximum by 1 or 2 months. Although the changes in ADP content are much smaller in absolute value than the ATP changes (16 mg/100 ml as compared with 93 mg/100 ml), the relative magnitude of the ADP fluctuations is much greater. The ADP content increased by 90% of the July value from July to December, which means that it was nearly doubled. As no AMP was found in the muscles examined, the total adenylic content consisted of ATP and ADP. The changes in the system as a whole virtually reproduce the ATP changes but the amplitude of change is slightly less by virtue of the opposing trends of the ADP changes. The increment in the adenylic system as a whole amounted to 83 mg/100 ml, or 46% of the April value, from April to July.

These changes in ATP and ADP contents can be correlated with the annual activity cycle of Rana temporaria. In the Moscow area, after wintering, the frogs appear on land in April [6]. Their period of summer activity extends to the end of September of middle of October, when they finally go off to winter in water. There is a very active increase of ATP and of the adenylic system as a whole throughout this period and then decline in the wintering period. The extreme values in graphs A and B in the figure, correspond to the turning points in the cycle, the beginning and end of the wintering period.

Seasonal changes in the state of several organs of the frog have been noted by a number of investigators. Reduced resistance of skeletal muscle to the effect of high temperature and to the action of alcohol and increased absorption of vital red by muscle tissue in the spring period have been described [7]. Others have made similar observations [4]. Gradual reduction in protein and ribonucleic acid contents of frog liver cells during hibernation has also been described [2]. Our results point to the development of profound biochemical changes in the composition of muscle at the time of seasonal readjustments in the cold-blooded animal.

SUMMARY

As a result of 2 year observations a fact of seasonal fluctuations in the adenine system components was revealed in the gastrocnemius of Rana temporaria. The ATP content, minimal in February-April (about 150 mg%), increased in July by 60%. The ADP content in the muscles was the highest in December-January (over 40 mg%), and the lowest in July (about 20 mg%). No AMP was found to occur in the muscles. Changes in the total of the adenine system component were close to those in the ATP content.

The described variations correspond to the cycle of Rana temporaria activity. The minimal and the maximal ATP content and of the total of the adenine system components coincided with the turning points of the yearly cycle—the beginning and end of hybernation.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
