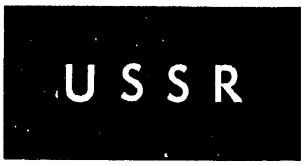
FOR OFFICIAL USE ONLY

JPRS L/8314

6 March 1979



TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY

BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 9/79)

U. S. JOINT PUBLICATIONS RESEARCH SERVICE

FOR OFFICIAL USE ONLY

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000100030017-9

BIBLIOGRAPHIC DATA SHEET	1. Report No. JPRS L/ 8314	2.	3. Recipient's Accession No.
4. Title and Subtitle TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY BIOMEDICAL AND BEHAVIORAL SCIENCES, (FOUO 9/79)			5. Report Date 6 March 1979 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Joint Publications Research Service 1000 North Glebe Road Arlington, Virginia 22201			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address As above			13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstracts

The report contains information on aerospace medicine, agrotechnology, bionics and bioacoustics, biochemistry, biophysics, environmental and ecological problems, food technology, microbiology, epidemiology and immunology, marine biology, military medicine, physiology, public health, toxicology, radiobiology, veterinary medicine, behavioral science, human engineering, psychology, psychiatry and related fields, and scientists and scientific organizations in biomedical fields.

17. Key Words and Document Analysis. 17a. Descriptors

USSR	Medicine
Aerospace Medicine	Microbiology
Agrotechnology	Physiology
Biology	Psychology/Psychiatry
Botany	Public Health
Epidemiology/Immunology	Radiobiology
Human Engineering	Toxicology
Marine Biology	Veterinary Medicine

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 2, 5E, 5J, 6, 8A

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
For Official Use Only. Limited Number of Copies Available From JPRS	UNCLASSIFIED	67
	20. Security Class (This Page) UNCLASSIFIED	22. Price

FORM NTIS-38 (10-70)

USCOMM-DC 40329-P71

JPRS L/8314

6 March 1979

TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY

BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 9/79)

CONTENTS PAGE

CONTENTS (Continued) PAGE

INDUSTRIAL MICROBIOLOGY

UDC: 634.0.863:[658.2+658.3]

THE PROGRESSIVE METHOD OF SHCHEKINO SHOULD BE USED IN THE HYDROLYSIS INDUSTRY

Moscow GIDROLIZNAYA I LESOKHIMICHESKAYA PROMYSHLENNOST' in Russian No 8, 1978 pp 1-2

[Article by I. P. Doshlygin, Glavmikrobioprom (Main Administration for the Microbiological Industry) under the USSR Council of Ministers: "One Should Work According to Shchekino Method"]

[Text] In accordance with the objectives set forth by the 25th CPSU Congress, workers in the hydrolysis industry should augment the productivity of labor by 41% in 1980, as compared to 1975, and increase production by 1.5 times. Such rapid development is implemented by opening new plants of production of feed yeast and furfurol, remodeling of existing shops at a number of enterprises and reaching the planned capabilities at the new plants. As for manning the construction projects, this is a problem that can be solved only by making available some of the workers at existing plants.

It would be inconceivable to perform this complex task without implementation of a set of management and technical measures to augment the productivity of labor at each enterprises and without upgrading management of all sectors of work.

One of the tested means of augmenting productivity of labor substantially is the Shchekino method of improving management thereof, material incentives and planning, enriched by the knowhow of the Polotsk Polimir Association and Bashkir petrochemists. At enterprises that work by the Shchekino method, the plans for production and growth of productivity of labor are being fulfilled and overfulfilled, there is actually no turnover of personnel or absenteeism, and salaries are higher than elsewhere.

How are such results achieved, and what is the substance of this progressive method? First of all, it involves creation of an atmosphere in which each worker is spiritually and materially concerned with finding and using the deep-lying reserves for growth of efficiency of production and labor based on cost accounting, as well as combining the personal and collective interests of workers in augmenting production with fewer personnel.

At the Bobruysk Hydrolysis Plant, for example, as a result of doubling up occupations and positions, increasing servicing regions and volume of work performed, mechanization of laborious operations, 47 people were released in 1977 from functional shops and departments. This made it possible to man newly opened production sectors. There was also an 8.6% increase in productivity of labor. The savings in the wage fund, constituting 34,000 rubles, were used for additional remuneration and bonuses for blue-collar workers and technical engineering personnel, who overfulfilled the plans for growth of productivity of labor. At this plant, the mean wages constitute 168 rubles per month per employee.

A reduction in personnel was also obtained at the following enterprises: Moldavgidrolizprom Association, Kansk biochemical, Arkhangel'sk and Khor hydrolysis plants, Shumerlino Chemical Plant and others. However, the Shchekino method has not yet obtained due support and dissemination at most enterprises.

Instead of heading work to introduce this progressive method, with the support of Party, trade-union, Komsomol, as well as creative public organizations, some enterprise administrators hold on to old management methods, they are governed by "the achieved level" and, let us confess, they are afraid of innovations. This can explain in part the great fluctuations in labor (labor input) per unit product at many plants. Thus, according to reported data for 1977, labor expended per ton feed yeast at plants of the hydrolysis industry was as follows (man-hours):

Zaporozh'ye [plant]	8.4	Volzhsk	9.1
Bel'tsy	12.4	Manturovo	11.7
Arkhangel'sk	8.9	Kirov	4.4
Volgograd	11.2	Bobruysk	7.9
Saratov	14.1	Gubakha	23.6
Lobva	12.0	Andizhan	9.3
Krasnoyarsk	13.7	Yangiyul'	13.4
Biryusinsk	7.7	Chimkent	18.9

Such a difference in labor input would not exist at the above plants, if all administrators would really be concerned with introduction of the Shchekino method.

It should be the first and foremost objective of plant teams and their supervisors to catch up to the best enterprises in the industry, with regard to production per worker.

Among enterprises under the Soyuzgidrolizprom VPO [expansion unknown], there are some that will not cope with the tasks referable to growth of productivity of labor (Onega, Lobva, Manturovo, Volzhsk plants). At the Tula, Chimkent, Saratov and Kedaynyay plants productivity of labor has declined, as compared to 1976. It is increasing slowly at the Volgograd, Zima, Rechitsa and a

few other plants. The hydrolysis industry as a whole is lagging in fulfillment of assignments referable to growth of productivity of labor.

Productivity of labor is one of the most important indices of efficiency of production. Comprehensive increase thereof is a first and foremost task, on the performance of which depends continued expansion of scale of production, starting up a large number of new plants and shops, as well as development of the servicing area.

One should immediately catch up with respect to adoption of the Shchekino method at all enterprises without exception. All of the resources must be put to the service of the Five-Year Plan, and there are quite a few such resources [reserves] at hydrolysis plants. For example, let us consider the number of workers per production sector. Quite often, even at progressive enterprises, there is excessiveness, with two operators needlessly assigned to one control console. Thus, in the yeast drying shop of the Kirovo Biochemical Plant, the established personnel specifications provide for 23 dryer operators, althoggh the diffusion dryers are automatically controlled from three consoles. A simple calculation shows that 14 people are enough to service this sector, and 5 more could be released when the control and inspection instruments for the dryers are switched to a single general console.

There are large resources for growth of productivity of labor in ancillary shops of enterprises, which presently employ more than 50% of all workers.

At many plants, the personnel involved with major and routine repair of the main technological equipment is still listed as part of the established staff of the main technological shops. It is known that centralization of such personnel in mechanical repair shops would not only increase the productivity of labor of repair personnel, but would improve the quality of their work.

The fear on the part of some enterprise administrators to convert to the Shchekino work method is not to their credit.

In a speechat the 18th Komsomol Congress, comrade L. I. Brezhnev stated that some management executives, who have a passive attitude toward adopting the Shchekino method, are apparently unable to abandon the established rules, to revise and alter some principles of management and forms of organization of production. L. I. Brezhnev further stated: "It is time, comrades, for us to learn to be businesslike in adopting progressive knowhow and following through with every useful matter."

It is imperative for us to derive some practical conclusions from the statements of comrade L. I. Brezhnev, general secretary of the CC CPSU. To work by the Shchekino method does not refer to a short campaign, but to a continuously practiced method of management, the effects of which are achieved on the basis of utilizing deep-lying resources, developing and

implementing a composite plan covering more than a year, at least the period to the end of 1980, and then the 11th Five-Year Plan.

At the first stage, the problem of releasing at least 10-12% of the personnel in existing shops and sectors must be resolved, and then 5-7% of the workers per year, in order to have the number thereof correspond to a scientifically substantiated norm.

Of course, it is not enough for administrators alone to work and implement such a plan, and the entire team of an enterprise must be involved in this work.

It would be wrong to believe that the Shchekino method consists merely of expanding servicing sectors, doubling up occupations and positions. It requires a composite approach, a combination of management and technical measures covering all aspects of production work, and consideration of the resources at each work place; for this reason it is wrong to consider that adoption of the method is a concern only for employees in labor and wage departments, although their role in this matter should not be underestimated.

All services without exception, the entire team of an enterprise, must be involved in preparaing for and implementing the change to the Shchekino method. The measures in the composite plan for upgrading organization of labor, material incentives and planning developed for 5-year periods must be confirmed annually, defining the target dates and individuals responsible for implementation, and organizing constant inspection [supervision].

The detected resources for augmenting production and increasing the efficiency of labor should be included at an early time, before the plan is approved, in a counterplan or state plan, so that it would be possible to take them into consideration and allocate the appropriate material resources to an enterprise for issuing additional production. It is only under such conditions that the expected effect can be obtained.

In preparing measures, special attention should be given to the following: improved use of work time by each worker, introduction of progressive work norms, expansion of servicing sectors, doubling up occupations and positions; mechanization of manual labor, particularly in raw material shops, packaging and stacking ready products, washing separators, loading and unloading, repair and other work; intensification of technological processes and operation of equipment; introduction of new, more productive strains of industrial microorganisms, engineering innovations that have justified themselves at other enterprises, concentration of inspection and control instruments on common consoles; centralization and reasonable organization of work pertaining to repair of equipment, power supply, laboratory and transport services; introduction of scientific organization of labor and improvement of working conditions; advancement of qualifications and skill of personnel, obtaining total interchangeability in a team or shift; upgrading the structure of management, elimination of duplication and multiple elements in the

control system; increased role of spiritual and material incentives in reaching high productivity of labor.

At the present time, there are nine production and one scientific-production associations in the hydrolysis industry. Use of the Shchekino method of working on the association level could yield a particular perceptible result.

In April 1978, a new procedure was approved for applying the Shchekino method at industrial enterprises: the decision to adopt this method is made by the management of the association and enterprise, along with the trade-union committee. Making this decision guarantees a stable plan to the enterprise; the higher organization is deprived of the right to alter it or to withdraw the wage fund savings formed as a result of reduction in personnel.

The new procedure for using the Shchekino method enables association and enterprise administrators to assign all the savings realized in the wage fund, as converted to percentage of plan fulfillment, for additional payments over and above the wage and salary rates for blue collar workers, engineering and technical personnel, white collar workers and junior service personnel, as well as disbursement of lump sum payments and prizes, for the purpose of providing incentives for employees who have achieved a higher productivity of labor, as compared to the norms and the plan. The additional payments may constitute up to 30% of the wage (salary) rate, and up to 50% for workers engaged in heavy and unattractive work, as well as junior service personnel.

In addition, lump sum payments [awards] can be made to blue collar workers, administrative and engineering-technical personnel for developing and implementing measures resulting in a reduction of personnel and increase in productivity of labor, as compared to the plan. In some cases, it is permissible to increase the prize to 60% of the piece-work earnings or scheduled wage rate to workers who have achieved high productivity of labor. The awards are increased to 25% for inventors and rationalizers who have offered suggestions for reducing the labor input for manufacturing the product. At enterprises that have converted to the Shchekino method, additional payments of 10% of the scheduled wage rate are established for workers engaged in equipment repair and up to 20% of the scheduled wage rate for those who repair particularly complex equipment.

The remainder of the wage fund that was not used for additional payments, awards and prizes is deposited to the material incentive fund.

Such favorable conditions make it possible to motivate intensively the contribution of each worker and the group as a whole to achieve a high efficiency of labor. They are a vivid manifestation of the concern of the Party and government for growth of productivity of labor and steady rise in the material standard of living of the working people.

10,657
CSO: 1870

INDUSTRIAL MICROBIOLOGY

UDC: [634.0.863.5.002:663.033:62-54]:
658.2(497.2)

AUTOMATIC REGULATION OF YEAST SUSPENSION LEVEL IN FERMENTERS

Moscow GIDROLIZNAYA I LESOKHIMICHESKAYA PROMYSHLENNOST' in Russian No 8, 1978 pp 28-29

[Article by K. Kundev, A. Tatarski and B. Damyanov, People's Republic of Bulgaria]

[Text] The rate of the process of cultivating feed yeast in fermenters depends on many factors. Maintaining a constant yeast suspension level in the unit should be considered one of them. It is known from the literature that a PI regulator is used to stabilize the level [1, 2]. However, there are considerable expenses involved for development and introduction of a system using such automatic regulators.

A constant yeast suspension level was maintained manually at the Razlogskiy Hydrolysis and Yeast Plant (NRB [People's Republic of Bulgaria]), and this required much labor. Moreover, accuracy was low.

In order to develop a suitable system of automatic control of suspension level, choose the type of regulator and adjustment of SAR [automatic control system], we investigated the dynamic characteristics of the fermenter in the wort delivery--yeast suspension level channel. The study was conducted by a known method [3]. The geometric volume of the fermenter is 600 m^3, it is 14 m in height and 74 m in diameter. The experiment was conducted in the following established mode: wort delivery $11.1 \cdot 10^{-3}$ m^3/s, air delivery $138.8 \cdot 10^{-4}$ $m^3/(m^3 \cdot s)$, pressure $4.51 \cdot 10^3$ Pa, pH of the culture medium 4.2 and culture medium temperature 309.65 K.

Turbulence [disturbance] at the input of the fermenter was determined according to change in wort flow (μ, m^3/s). We also recorded the change in volume (level) of yeast suspension in the unit (ϕ, m^3). During the experiment, the yeast suspension level was first stabilized manually by means of a variable pressure gradient flowmeter. The change in yeast suspension level was measured with piezometric and float level gages. We used the method of isolated, jump-type factors to study the object. The object was stabilized at the specified level of variables, then a disturbance was used at the input and the change in output value was recorded. We conducted six experi-experiments with disturbance of $\mu = 1.1 \cdot 10^{-3}$ m^3/s. We used data obtained

with optimum stabilization of all parameters for processing. Figures 1 and 2 illustrate the transient characteristics, which are close to exponential and transient functions of a first order aperiodic component. For this reason, the transient process can be approximated to a combination of two elementary components: the component of net lag and first order aperiodic component, i.e.:

$$T_0 \frac{d\varphi(t)}{dt} + \varphi(t) = K_0 \mu(t - \tau), \quad (1)$$

where T_0 is the object time constant, s; ϕ is the regulated parameter (volume), m^3; μ is the regulatory operation (disturbance), m^3/s; τ is the lag, s; K_0 is the transfer factor of the object, $m^3/(m^3 \cdot s)$ and t is time, s.

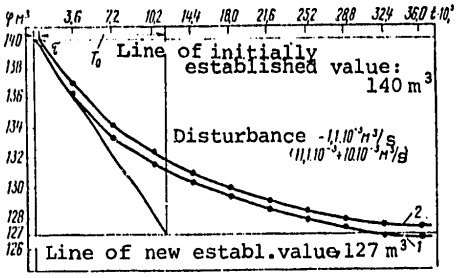


Figure 1.
Transient characteristics, with $\mu = -1.1 \cdot 10^{-3}$ m^3/s
1) experimental

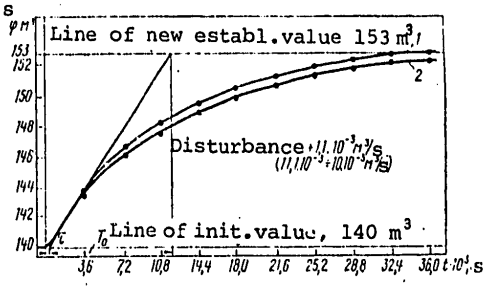


Figure 2.
Transient characteristics, with $\mu = +1.1 \cdot 10^{-3}$ m^3/s
2) estimated

The object's transfer factor was determined from the values of the coordinates of the experimental acceleration curve and magnitude of jump-type disturbance, using the following formula:

$$K_0 = \frac{\varphi_{(\infty)} - \varphi_{(0)}}{\mu_{(\infty)} - \mu_{(0)}} = \frac{\varphi}{\mu}, \quad (2)$$

where ϕ_∞ is the new established value of regulated parameter, m^3; $\phi_{(0)}$ is the regulated parameter at the time of addition of disturbance, m^3; $\mu_{(0)}$ is the value of regulation before addition of disturbance, m^3/s and μ_∞ is the same after addition of disturbance, m^3/s.

In the specific case of ϕ = 13 m^3 and $\mu = \pm 1.1 \cdot 10^{-3}$ m^3/s, transfer factor $K_0 = 11.81 \cdot 10^3$ $m^3/(m^3 \cdot s)$. From the experimental acceleration curve, we determined $T_0 = 22.8 \cdot 10^2$ s and $\tau = 11.88 \cdot 10^3$ s. Substituting the obtained values of the coefficients in equation (1), we shall obtain a differential equation describing the transient process of change in volume (level) with jump-type change in delivery of wort to the fermenter:

$$11{,}88 \cdot 10^3 \frac{d\varphi(t)}{dt} + \varphi(t) = 11{,}81\,\mu(t-\tau). \qquad (3)$$

The general solution of this equation is:

$$\varphi(t) = \pm 11{,}81 \cdot 10^3 \mu \times \left(1 - e^{-\frac{t-22{,}8 \cdot 10^2}{11{,}88 \cdot 10^3}}\right) + \varphi_{(0)}. \qquad (4)$$

Coincidence of the experimental curve and exponent, representing the solution of the typical equation with constant coefficients taken from the experimental curve is proof of the accuracy of approximation of the transient characteristics to the standard differential equation.

The choice of regulator and estimation of the system for automatic regulation of yeast suspension level in the fermenter were performed in the following manner.

Since the ratio of lag to time constant of the object is low and the time constant of the object is high, one can use a two-position regulator in the SAR. In the presence of lag in the system and symmetrical static characteristic of the regulator with a zone of ambiguity, the fluctuations of the level will be:

$$\Delta H = 2\left(\delta + K_0 Q \frac{\tau}{T_0}\right), \qquad (5)$$

where δ = 1 cm, half the ambiguity zone, and Q is the regulatory action constituting 50% of the nominal value. From the structural dimensions of the fermenter, we find a ratio of level to volume of 2.35 cm/m^3. For this reason, $K_0 = 11.81 \cdot 10^3 : 2.35 = 27.75 \cdot 10^3$ cm $(m^3 \cdot s)$.

Thus, the level fluctuations constitute ΔH = 7.7 cm, i.e., 3.5 cm in relation to the nominal level. The fluctuation period is:

$$T_к = 4\left(\tau + \frac{\delta T_0}{K_0 Q}\right) = 1{,}21 \cdot 10^3 \text{ s}. \quad (6)$$

The frequency of switching the regulator per hour will be:

$$n = \frac{K_0 Q}{2(\delta T_0 + K_0 Q \tau)} = 5{,}9 \approx 6. \quad (7)$$

As a result of this investigation, a schematic diagram was proposed for automatic regulation of level of yeast suspension in a fermenter (Figure 3). The SAR consists of a sensor *1a*, instrument for level measurement *1б*, container with water *2*, type R9-Z40 regulator *1в* and regulator valve *1г*. The column of fluid in container *2* opens and closes access for air to the connecting pipe *3* going to regulator *в*. Connecting pipe *3* is installed in the container 2 cm from the preset level of the column of liquid in the container, corresponding to a normal level of yeast suspension in the fermenter. The regulator valve, 200 cm in diameter, is set to allow the yeast suspension to pass into the flotation device. There is an electric motor to the pump in the hydraulic regulator, which is triphasic and has a power of 0.13 kW; it drives the pump continuously. After establishment of the set level, air passes into connecting pipe *3* and the pump does not pump oil. When the level of the yeast suspension drops, the fluid level in *2* rises shutting off air, and the pump does not pump oil, as a result of which the regulator valve closes and the level of yeast suspension rises. This process of regulation continues until the level in *2* drops and air passes into pipe *3*. The process of level regulation is a fluctuating one.

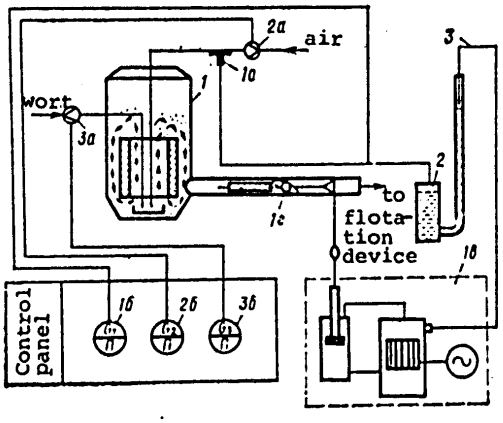


Figure 3.
Schematic diagram of system for automatic regulation of yeast suspension level

1) fermenter
1a) level sensor
1б) level measuring instrument
2) container with water
3) connecting pipe
1в) type R9-Z40 regulator
1г) regulating valve
2a,2б) suspension passage sensors
3a,3б) suspension use measuring instruments

Use of the system for automatic level regulation in industrial fermenters at the Razlogskiy Hydrolysis-Yeast Plant revealed that it works stably and with satisfactory precision. The mean and maximum deviations of level of the yeast suspension from the specified level constitute ±1-2 cm, respectively.

Conclusions

A study was made of dynamic characteristics of a fermenter as an object of automatic control. An approximation was made of the transient characteristics in the wort delivery--yeast suspension level channel in the apparatus. It was determined that it is purposeful to use a two-position regulator of level in industrial fermenters. The analysis made of the system of automatic control of suspension levels in industrial fermenters 600 m^3 in size can be used in designing analogous objects. The schematic diagram of SAR for yeast suspension level was described. the SAR operates stably, and this meets the technological specifications. The maximum deviation of yeast suspension level from the specified level is ±2 cm.

BIBLIOGRAPHY

1. Zvyagin, N.; Barashevich, V.; and Subbotin, B. "Automation of the Yeast-Cultivation Process," GIDROLIZNAYA I LESOKHIMICHESKAYA PROM-ST' [Hydrolysis and Wood Chemical Industry], No 7, 1971, pp 24-26.

2. Firkovich, V. "Automation of Hydrolysis Industry and Sulfite Alkali Processing," Moscow, Lesnaya prom-st', 1969, pp 209-215.

3. Balakirev, V.; Dudnikov, Ye.; and Tsirlin, A. "Experimental Determination of Dynamic Characteristics of Industrial Control Objects," Moscow, Energiya, 1967.

10,657
CSO: 1870

INSTRUMENTS AND EQUIPMENT

UDC: 615.47.002.237+615.47-65.011.46

MEANS OF IMPROVING EFFICIENCY AND QUALITY OF MEDICAL EQUIPMENT PRODUCTION

Moscow MEDITSINSKAYA TEKHNIKA in Russian No 5, 1978 pp 6-10

[Article by Yu. M. Tsentsiper, Medoborudovaniye Scientific Production Association, Moscow]

[Text] The most important task for enterprises that manufacture medical equipment, as well as for the entire industry of our country, is to further intensify production, increase its efficiency and quality of product, and ultimately meet in full the requirements of public health with respect to medical technology that meets modern specifications.

Intensification as a result of refinement of technology is one of the main forms of intensive development of existing production at the stage of refinement thereof, and this is the stage that is predominant in medical equipment plants.

The Medoborudovaniye [medical equipment] Scientific Production Association (NPO), some of the achievements of which are discussed in this article, is making a contribution to the solution of these problems.

There are a number of specific distinctions in the construction of medical equipment, aside from properties inherent in products of general machine-building: certain specifications for construction materials, higher specifications for reliability of construction, quality of finishing and others.

The use of progressive structural materials is one of the means of increasing the efficiency of production and quality of medical equipment.

In the next few years, rolled steel and aluminum alloys with higher purity of surface finish will be used on an increasing scale at enterprises that manufacture medical equipment. Thus, starting in 1978, cold-rolled curved sections will be used, instead of the hot-rolled angle sections used previously, will be used at the Dnepropetrovsk Medical Equipment Plant for the manufacture of medical tables. This will improve the quality of the tables and lead to a substantial reduction of laboriousness of manufacture thereof, as a result of total elimination of work dealing with cleaning surfaces before painting. At the Penza Chemical Disinfectant

Equipment Plant, tables for pathoanatomical examinations are being manufactured since 1976 with the use of highly polished stainless steel sheets. Expressly the use of such steel made it possible to manufacture these tables, since the purity requirements of their working surfaces are high and the design and configuration of the table are such that the use of ordinary methods of final polishing and trimming could not meet these requirements.

Modern polymers will also find increasing application in the construction of medical equipment in the very near future. In 1978, The Doschatoye Medical Equipment Plant will start running a highly mechanized line for the manufacture of support components (seat, back, arms of medical chairs and wheelchairs) made of integrated foam polyurethane. The outside surface of these parts will simulate leather. Enhancement of esthetic features of the products, substantial reduction of labor input and, finally, greater sophistication of production (the production line for these components constitutes one of the latest achievements in the technology of processing polymers) will be the result of introduction of new material and technology.

Of definite interest is the future replacement of medical table panels, presently manufactured of stainless steel, with panels made of ornamental paper laminated plastic material. The savings realized with regard to scarce stainless steel, the high hygienic qualities of such panels, modern appearance and progressive manufacturing technology leave no doubt as to the desirability of such a change.

In general, the most pressing problems are the ones dealing with the use of stainless steel. Its increasing shortage, the change to the use of nickel-free or low nickel content steel instead of traditional type 18-8 nickel-chrome steel, which has high technological qualities, puts difficult tasks to industry.

On the one hand, it is imperative to find methods that would permit cold stamping of nickel-free and low nickel content steel, welding and finishing thereof and, on the other hand, it is apparently necessary to make some structural alterations and replace stainless steel with bimetals and other materials. Much attention is given to solving these problems in the Medoborudovaniye NPO.

The increasing use of progressive methods of shaping parts stock is an important means of increasing efficiency of production.

For the last few years, the Medoborudovaniye NPO is working on introduction of casting from smelted patterns at medical equipment plants. In 1977, this technology was introduced at the Yelets Medical Equipment Plant for the manufacture of stock for components of operating tables, hoists, carts and other medical equipment. In 1977, this plant produced over 18 tons of castings, and this figure will increase by several times in the next few years.

In 1977, series production of components of anesthesia and respiration equipment by the method of casting from smelted patterns was begun at the Krasnogvardeyets Leningrad Production Association (LPO). Efforts to manufacture from parts of this equipment by other methods, in particular pressure-die casting, were unsuccessful.

The Medoborudovaniye NPO developed and handed over to the Krasnogvardeyets Association not only the technology for manufacturing the parts, but complex equipment, so that the enterprise was able to master series production in a shorter time.

In 1979, sections for casting from smelted patterns will be set up at the Doschatoye Medical Equipment Plant and Kazan' Medical Apparatus Plant. The projected economic effect of adopting this progressive technology will constitute over 20,000 rubles per year at the Doschatoye Plant. This method of casting from carbon and stainless steel will be used to manufacture stock for parts of gynecological tables, operating tables, medical beds and other equipment. Stainless steel is used extensively at this plant, so that the use of steel scrap to cast parts is an example of a reasonable solution of the problem of saving metal.

Pressure-die casting and chill [permanent mold] casting of parts made of aluminum alloys are practiced rather extensively at medical equipment plants. The obtained purity of surfaces and precision of dimensions, in spite of the complicated shapes of the parts, high productivity of the process--all these advantages of precision casting resulted in its occupying firmly the leading place in the production of stomatological and other medical equipment at the Bologda and Doschatoye medical equipment plants, Krasnogvardeyets LPO and other medical technology plants. The output of pressure-die casting increased by more than 1.5 times in 1977, as compared to 1971.

Manufacture of parts using thermoplast and thermosetting plastics is one of the other methods of progressive shaping that occupies a most important place in the manufacture of medical equipment. With each year, the output of plastic parts is increasing at the Volgograd, Doschatoye, Yelets and other medical equipment plants. The enterprises are essentially outfitted with modern technological equipment. There has been some growth, though not to the required extent, in instrument shops. The volume of production of plastic parts at medical equipment plants also increased by more than 1.5 times in 1976, as compared to 1971.

Processes of manufacturing permanent joints, welding and soldering, are important in the production of medical equipment. In the last 5-6 years, all medical equipment plants have changed to welding in an environment of shielding gases, including semiautomatic welding of low-carbon steel in an environment of carbon dioxide and argon-arc shot welding of stainless steel. There has also been a substantial improvement of the quality of welded seams, with decrease in volume of trimming and increase in productivity

of processes, as compared to manual electric-arc welding. In the years of the 9th Five-Year Plan, the level of mechanization of welding work in this branch of industry has risen from 47 to 54%.

However, soldering is becoming the prevalent tendency in the manufacture of medical equipment in the leading industrial countries of the world, and it yields smooth seams, without pores and pits.

High-temperature soldering will also be mastered in the next few years at Soviet medical equipment plants. Unlike the methods used by foreign firms, where soldering is generally performed manually with a gas-flame burner, highly productive conveyer furnaces will be used at our enterprises. This is related to the relatively high series production of items, and the need for utmost mechanization of labor and increase in sophistication of production.

Work has been done at the Medoborudovaniye NPO to develop optimum designs of soldered parts and experimental models have been manufactured. The Doschatoye Medical Equipment Plant, which will be remodeled in the next few years, will be the first plant, at which furnaces for high-temperature soldering will be installed. This knowhow will be transferred to other plants in the future.

Mechanical processing occupies a leading place, with regard to its volume, among other technological processes of manufacturing medical equipment. The change to increasing use of automatic and semiautomatic lathes, introduction of group processing methods, as well as gradual introduction of benches with digital program control will be the main tendencies in this direction. It is quite obvious that it is only through this route that it will be possible to achieve greater efficiency of production under conditions where the shortage of manpower and, particularly, machine [or lathe] operators is constantly increasing. One of the methods of cold plastic deformation, rolling hydraulic cylinders with a roller, is a highly effective process in the manufacture of hydraulic systems of medical equipment. This process, which is being introduced at the Yelets Medical Equipment Plant, along with the specialized section outfitted with precision metal-cutting equipment and test stands, will make it possible to improve significantly the quality and reliability of hydraulic systems, which do not meet the specifications for all parameters at the present time.

Heaters for resuscitation tables and those used to clean up neonates, developed at the Medoborudovaniye NPO are of great technical interest. These heaters consist of a Getinaks [plastic insulator] plate, with a vacuum-sprayed spiral-shaped resistance consisting of several layers of various materials. All the advantages of these heaters--uniform heating over the entire field of the heater, low energy consumption and considerably smaller size as compared to the known tubular heaters--warrant the belief that there is great promise to their use.

The medical equipment industry devotes special attention to electroplating, painting and varnishing processes. In the next few years, the vats in electroplating shops will be replaced by modern automatic electroplating units, the development and assembly of which are being performed by the Medoborudovaniye NPO, in accordance with the technical specifications of the All-Union Scientific Research Institute of Medical Instrument Making. Within 5-7 years, all medical equipment plants will be outfitted with this modern technological equipment.

In the pain shops, instead of chambers for traditional painting and varnishing, there will be complexly mechanized lines for spraying epoxide and other finishes in powder form, consistent with the modern worldwide tendency of development of finishing technology.

Already in 1978 the first such shop is to be started at the Dnepropetrovsk Medical Equipment Plant. The use of polymers in powder form will improve the appearance of the products, the finish will be long-lasting and the finishing process will be more efficient.

Considerable attention is devoted to mechanization of processes of assembling and testing products at the Medoborudovaniye NPO. In the last few years, conveyer lines have been developed for assembling and testing sterilizers at the Tyumen' Plant, for assembly of medical equipment at the Doschatoye and Yelets plants. The x-ray television unit installed at the Tyumen' Plant for inspection of welded seams is a graphic example of how the modern achievements of science and technology are applied in industry.

Work dealing to refinement of the technology of assembly and testing of products, and development of mechanized production plans will be included in the plans of Medoborudovaniye NPO in the next years as well.

At the present time, two-thirds of the work done by Medoborudovaniye NPO is directed toward technological preparation of production, refinement of technology, raising the level of mechanization and automation of main and ancillary processes. The main task is to move from the development of individual processes and individual types of technological equipment to composite solution of all problems pertaining to intensification of production of medical equipment. This includes specialization and organization of labor, as well as setting up highly mechanized sectors, shops and enterprises on the basis of modern technology. The solution to these problems is a guarantee that the objectives of the medical equipment industry will be reached.

10,657
CSO: 1870

NEUROSCIENCES

CONSCIOUSNESS AND EVOKED ELECTRICAL ACTIVITY IN THE CEREBRAL CORTEX

Moscow ZHURNAL VYSSHEY NERVNOY DEYATEL'NOSTI in Russian No 6, 1978 pp 1151-1159

[Report on the plenary session of the 25th Conference on Problems of Higher Neurologic Activity, Leningrad, September 1977 by E. A. Kostandov, Central Scientific Research Institute of Forensic Psychiatry imeni V. P. Serbskiy, Moscow]

[Text] The physiologists who studies higher neurologic activity in man is constantly and unavoidably confronted with the problem of consciousness. He studies the state of "clear consciousness" in man who not only perceives the signals presented to him but also arbitrarily decides on a chosen reaction based on his conscious evaluation of the subject. In addition to the physiologist's attempts to explain the functioning of the central nervous system for one or another psychic activity, he strives to dispense with the use of "subjective" concepts of consciousness. The role of consciousness in a neurophysiologic approach to the function of the more complex structures of the brain is frequently not considered. In these studies, consciousness is considered to be a subsidiary "subjective" phenomenon which does not effect the "objective" electrophysiologic and biochemical processes in more complex structures of the brain. It is indisputably recognized that consciousness is connected with the material physiologic processes which occur in more complex brain structures. However, we know little about them. Presently, we are studying the critical changes in cortical processes which are connected to perception of stimuli.

Information has been gathered on the specific sensory pathways in the related projectional zones of the neocortex. These data apply to both a conscious and unconscious state of the subject. Thus, evoked electrical potentials for auditory, visual, and somatosensory stimuli are registered in the related cortical

projectional regions in individuals in a shallow general narcosis, that is in a completely unconscious state (18, 20). During hysterical or suggested hypnotic anesthesia of the cerebral cortex, an evoked potential is developed for external signals which are completely unperceived by the subject (17, 24, 25). A conditioned communication can be produced using unperceived external signals (6, 9). All these facts indicate that perception of a signal does not just occur in the corresponding projectional and associative cortical zones. In all probability, an additional neurologic mechanism exists which enables perception of a signal. This mechanism must bring about integration of neuronal activity in various parts of the cerebral cortex and subcortical structures, and provides the most optimal conditions for perception of the significant external phenomena at a given moment. We know almost nothing about this neurologic mechanism which is a significant part of the physiologic basis of perception.

During experimental studies on the physiologic mechanisms of the "unconscious" we concluded that in order to solve this problem, it is necessary to explain the critical changes in the brain processes involved in perception of stimuli. Without a concept, all be it hypothetical, of the neurologic process which guarantees or accompanies perception of external stimuli, it is difficult to propose any kind of explanation for the physiologic basis of unconscious psychic phenomena.

The method of averaged evoked potentials was the instrument that made it possible for us, along with Yu. L. Arzumanov, to study the characteristics of the spatial-temporal configuration of the electrical activity of different regions or sections of the cerebral cortex. Subjects were exposed to visual stimuli which they were able to perceive and to stimuli which they did not perceive but which evoked autonomic and bioelectrical reactions. Recording of the average evoked potential (UVP) was conducted during the process of generating and strengthening temporary connections formed in the brain in response to unperceived and perceived visual stimuli.

The text subjects (20-40 years old) had in the past committed illegal acts, in the majority of cases out of jealousy, and during the period of our research were in a difficult life situation. UVP was recorded for visual stimuli combined with key words--"neutral" ones (arm chair, stairs, table, etc.) and "emotional" words (treason, wife, shame, etc.) which corresponded to conflict situations for the test subjects.

In one series of experiments, word stimuli were non-associative, that is easy for the test subject to perceive. In these cases, we observed in the occipital region clear cut divergence in the

amplitudinal temporal characteristics of the evoked response to neutral and emotional words. The late positive evoked potential (component P300) is developed with a significantly shorter latency period and is essentially greater in amplitude than the potential developed for neutral words. This difference is noted only for the component P300; the earlier waves of UVP did not change. Thus, the late negative wave N200 (latency period of approximately 200 milliseconds) for emotional stimuli essentially does not differ from responses to neutral words.

Significant differences in the amplitudinal and temporal parameters of an evoked potential to neutral and emotional words was noted in the vertex.

Consequently, activation of the cortical evoked response to a perceived, visual, emotional word stimulus occurs in the occipital region, not in the anterior regions of the cerebral cortex. In response to a perceptible stimulus for a given modality, activation of evoked potential is localized in scope. It is also limited in time because the late positive potential, with a latency period of only 300 milliseconds, is altered. In another series of experiments, certain neutral and emotional words were used as stimuli, but unlike the previous series of experiments, these words were not perceived by the subject. The test subjects could not read them because they were shown on the screen for a very short time. As expected, we noted that the test subjects saw the words "dimly", "weakly" in the flash of light on the screen.

In response to an unperceived word, a small but clear late evoked cortical response is registered. The response reflects the signalling significance of the word stimulus which corresponds to the emotional experiences of the test subject. This relationship is expressed in the amplitudinal differences between the potentials for neutral and emotional words. However, in contrast to the experiments with perceived words for a given circumstance, the size of the late positive evoked response to an emotional stimulus, in comparison to the potential for a neutral word, is greater in the occipital and vertex regions. Another difference is seen in the substantial differences in amplitude of the late negative wave N200 for neutral and emotional stimuli. For emotionally significant unperceived words, this component of UVP as well as the P300 wave is larger in amplitude in the occipital and vertex zones.

Thus, activation of an evoked cortical response, caused by an emotionally significant unperceived semantic stimulus, is diffuse. For a given stimulus, activation occurs in the perceiving cortical zone and in the anterior half of the cerebral cortex.

Unlike the response to a perceived stimulus, during unconscious perception of the word stimulus, activation is not limited to to the wave with a latency period of about 300 milliseconds, but also involves the earlier negative oscillation.

Analogous topographical differences in evoked cortical activity for perceived and unperceived stimuli must be considered in studying the development of associative, temporary connections in the visual sensory system. Test subjects were presented two stimuli in sequence with a pause between them of 1000 milliseconds: the first stimuli--a picture of an arrow pointed in a certain direction; the second stimuli--different neutral and emotional words shown on the same screen. The picture of the arrow pointed in one direction was combined with neutral words,and the same arrow pointed in another direction was combined with emotional words.

In one series of experiments, the difference in arrow direction was large and easy to recognize. It was also easy to perceive the semantic content of the second stimulus--the neutral or emotional word. Given the occurrence of a temporary connection between these perceived visual stimuli, changes in evoked potential for the first pair of stimuli were ambiguous and, to a certain extent, depended on the emotional significance of the second stimulus. The amplitude of the evoked potential for the first stimulus--the picture of the arrow--was clearly decreased in comparison to the potential for this same stimulus when shown in isolation. The decrease in the evoked cortical response for the first stimulus was observed both in tests where a neutral word was used as the second stimulus and in tests using an emotional word. Depression of the evoked response can be explained by concepts about the role of counter temporary connections in cerebral cortex activity (2, 4). With multiple consecutive combinations of two indifferent stimuli (in our experiments, the picture of an arrow combined with a neutral word), direct responses to them are suppressed and, in the opinion of I.S. Beritashvili (4), counter connections are developed which inhibit cortical reaction to the first pair of stimuli.

There is a substantial difference between evoked potentials obtained in tests using neutral and emotional stimuli: the late positive component P300, registered for the picture of the arrow combined with an emotional word, develops with a shorter latency period and is larger in size than the component registered for a picture of an arrow combined with a neutral word. By examining activation of the late cortical response to a stimulus combined with an emotionally significant word, we were able to explain the function of the mechanism for counter temporary connections. We will discuss this further in more detail. Presently, we are interested in another important characteristic of the above mentioned changes in evoked potential for the first stimulus paired

with perceived neutral and emotional words. These changes are relatively localized. They are observed in the visual region, that is in the zone to which both stimuli are directly addressed, and do not occur in the vertex, that is in the anterior parts of the cerebral cortex. Results of the second series of experiments indicated that the localized character of the changes in evoked activity in response to the emotional component of the second associative stimulus was observed only in those instances when its semantic content was perceived. In the second series of tests, a temporary connection between unperceived visual stimuli was uncovered. The stimuli and experimental conditions were identical to those in the first series with two exceptions: changes in the direction of the first stimulus (the arrow) were so minute that the test subjects did not perceive them, and the semantic content of the second stimulus was not perceived because it was displayed on the screen for a very short time. In these tests, the late evoked potential for the first pair of stimuli was clearly diminished when the word was emotionally significant. Changes in the evoked response were noted not only in the visual regions of the brain, as seen in tests with perceived stimuli, but also in the vertex. Both the amplitude of the component P300 and the negative wave which preceeded it were diminished.

Thus, we observed temporary connections between unperceived visual stimuli. Changes in evoked cortical activity, which occur as a result of the formation of these connections, are not limited to the visual cortex and are more diffuse than in instances when the combined stimuli were perceived. One would assume that the difference in cortical response to the first stimulus was determined by the fact that the subject did not perceive it. However, this assumption was disproved by the results of tests in which this stimulus was also not perceived, while the second semantic stimulus was well perceived. In these cases, the changes in the evoked potential for the first stimulus were analogous to those which occur in experiments with completely perceived stimuli (1).

Consequently, the nature of the evoked cortical activity, given formation of a sensory temporary connection, to a large extent depends on perception of the second associative stimulus. This indicates the validity of our concept regarding the changes in cortical activity which develop in response to the effect of the first combination of stimuli. These changes are determined by the effect of the counter temporary connections.

Changes in the evoked cortical responses to perceived and unperceived emotional words, evidently occurs as a result of additional "nonspecific" impulses from the structures in which neuro-

logic mechanisms for negative emotional reactions are integrated. These structures are incorporated in what is understood to be the "limbic system". In a series of studies on animals, scientists showed the influence of the functional state of the limbic system structures on the evoked potential, registered for sensory stimuli, in the neocortex. In experiments conducted by Sierra and Fuster (30) on electrical stimulation of the hippocampus and amygdala, the amplitude of prolonged latent visually evoked potentials of the cerebral cortex was increased. Depending on its intensity, stimulation of the posterior hypothalmus can cause both activation and inhibition of visual cortical electrical responses (3, 19). With stimulation of the septum, the amplitude of the evoked response of the visual cortex to light flashes is diminished (27).

We found that the anticholinergic substance, amizil, prevented local changes in the occipital region as seen in the amplitudinal-temporary parameters of the late positive wave P300, evoked in response to perceived emotional words. It did not alter the evoked potentials in the vertex. This confirmed our concept about the role of additional local activation of the limbic system structures in observed changes of potential. In animal experiments, it was shown that amizil inhibits cholinergic mechanisms in the limbic system for defensive reaction (7,8).

It is known that the activating (and inhibiting) influences of the limbic system on the neocortex are accomplished by the activating (and inhibiting) systems of the mesencephalonic and thalamic reticular formations, although it is not exclusively a direct influence (17,26).

In multiple studies, it has been established that the activating influence of the nonspecific reticular structures in the cerebral cortex has a dual nature--local and diffuse. The diffuse influence is accomplished by the mesencephalonic activating system, and the local, by the nonspecific structures of the thalamus. Recently, a great deal of attention has been directed at explaining the neurologic mechanisms for local activation of the neocortex and their physiologic role in the organization and performance of a behavioral reaction.

Long ago, clinical neurologists noted that consciousness is retained following resection or disease of any more or less restricted part of the cerebral cortex, but it inevitably disappears if, as a result of pathologic influences, the diencephalon is cut (28). Understanding the direct role of the reticular formation, in particular the nonspecific part of the thalamus, in the activation of the cerebral cortex allows researchers

to integrate these clinical facts by a physiologic approach. The direct dependency of consciousness on activation of the nonspecific system of the diencephalon--a structure which is connected with all parts of the cerebral cortex--led W. Penfield (28) to construct the theory of the central encephalonic system. This theory has been repeatedly subject to criticism because it denies the role of the diencephalonic structures in higher integrating mechanisms involved in the accomplishment of conscious activity. We consider the theory of the central encephalonic system to be untenable in relationship to the definite regulating role of the cerebral cortex in the organization of conscious experience. In addition, we can not ignore the rich clinical and physiologic factual material, accumulated during neurosurgical operations. Without doubt, these data attest to the key role of diencephalonic activating nonspecific structures in consciousness.

In higher vertebrate animals, especially in primates, electrographic expression of local activation can be seen in the delayed evoked currents of cortical potential. Skinner (31) recorded the delayed negative potential in the anterior regions of the cortex of cats by stimulation of the ventrolateral nucleus of the thalamus; a structure associated with the behavioral reaction of selective attention. Rebert (29) observed in monkeys the development of delayed negative potential in the premotor cortex, in the middle part of the thalamus, and in the caudate nucleus, during the pause between warning and triggering signals, that is, in conditions when the monkey should focus his attention on a forthcoming triggering stimulus. Fuster and Alexander (21) recorded in monkeys an evoked neuronal reaction in the granulous prefrontal cortex and in the dorsomedial nucleus of the thalamus during a delayed, instrumentally conditioned, feeding reaction. These authors concluded that the neuronal activity which they described was the basis for the development of the delayed negative potential and was connected with actively focused attention on information which must be retained in the memory for future utilization. The well known works of G. Uolter (16) and others describe conditioned delayed negative waves. In man, this wave develops in the neocortex in response to conditions which require active attention. According to the data of G. Uolter (15), one of the characteristics of this delayed potential, which is registered directly on the cerebral cortex in man, is its strictly expressed local character. The local character of a delayed negative potential was noted both in our work and in the studies of E. G. Briling. The evoked cortical electric activity involved in the process of speech activity was examined in these studies.

When a word is pronounced, a delayed negative wave develops in any part of the cortex of the left hemisphere. This wave can be compared to the potential for preparedness which is developed

in the motivating zone of the cortex during performance of an arbitrary motion.

Obvious and subtle indices of local activation can be seen in changes in amplitudinal and temporal parameters for the late positive wave, the component P300, of an evoked potential. This late potential develops in response to the effect of significant stimuli which illicit a tentative reaction or focus the attention of the individual. Given perception of significant visual stimuli when the test subject is not performing another arbitrary activity, changes in the P300 wave are noted mainly in the occipital cortical region (22,23,24). This was detected in our previously mentioned experiments using perceived emotional semantic stimuli.

We are faced with an extremely difficult but interesting question: given perception of an emotional semantic stimulus, in what manner and by which neurologic mechanism is the thalamic nonspecific system involved in local activation and likewise, given unconscious perception of these stimuli, how is the diffuse activated system of the mesencephalonic reticular system involved? We are not in a position to provide a sufficiently complete answer to this question, but we can present a physiologically based hypothesis to explain the corticofugal mechanism of the nonspecific systems involved in the process of unconscious and conscious perception.

According to our hypothesis, activation of temporary connections between the receiving elements of the cerebral cortex and the motor speech region, involved in perception of any external signal, has crucial significance. This concept has been confirmed by the multiple studies of R. Sperry and his colleagues (32, 33). Their data indicate that it is impossible for test subjects to verbalize and perceive stimuli if the visual information is received only by the right hemisphere without involvement of the motor speech region. Analysis and synthesis of semantic signals occurs in the gnostic speech zone of both hemispheres (mainly in the right hemisphere). These signals are not perceived if the nervous impulses from this zone are not transmitted to the motor speech region; that is, if activation of temporary connections between these cortical zones does not occur.

The difference,noted in our experiments, in the evoked activity for perceived and unperceived semantic stimuli clearly attests to the involvement of the corticofugal mechanisms in the nonspecific impulsation of cortical reaction. Only after preliminary analysis of the impact on the cortex of the semantic properties of the visual stimuli used in our experiments were we able to discern the non specific influence of emotionally

significant stimuli on the cerebral cortex and judge the "perceptibility" of a word stimulus. Undoubtedly, the nature of the nonspecific influence on the thalamic and brain stem structures is determined by corticofugal impulses. The difference between these influences is a result of the semantic content of the stimuli. In the cerebral cortex, there are structural-functional elements which, in all probability, are the source of similar corticofugal influences.

A series of experimental results, obtained in animal studies, points to the presence in the cerebral cortex of structural mechanisms involved in performance of a directed reflex (5, 14). The activating mechanisms for a directed reaction are located in the secondary cortical zones, adjacent to associational fields. With electrical stimulation of these points on the cortex, integrated directed reactions occur which are similar to those seen in natural stimulation of receptors. This electrical stimulation reinforces the activating influences of the reticular system in the cortex. Previously learned cortical activating mechanisms are triggered during the formation of a temporary connection when the cerebral cortex is stimulated by irradiation. In cases when stimuli are perceived, that is, when the structures of the motor speech center are temporarily connected, triggering of the cortical activating mechanisms for focused attention occurs, as well as activation of these mechanisms located in other regions of the brain. Evoked corticofugal impulses stimulate thalamic mechanisms for focused attention, which in turn leads to the development of local "nonspecific" activating influences. These influences selectively raise, for a given moment, the level of "creative" excitability of parts of the cerebral cortex. We think that with the aid of this cortico-thalamo-cortical mechanism for a counter connection, involved in the structure of a temporary connection, the cerebral cortex creates the optimal conditions for both conscious recognition of a significant signal stimulus and performance of an adequate arbitrary reaction.

Our data on evoked potentials indicate that the above mentioned mechanism for local activation is not involved in the formation of a temporary connection for an unperceived external stimuli. In all probability, the temporary connection between motor speech cortical structures is not activated or formed. Evidently, these mechanisms, located in the secondary cortical zones of analyzing structures, for activation of a directed reflex are involved in the system for temporary connections. As shown in animal experiments, evoked corticofugal impulses stimulate the nonspecific structures of the mesencephalonic system, as a result of which the diffuse "nonspecific" influences of the mesencephalon on the cerebral cortex are strengthened. We observed this effect in the form of diffuse changes in amplitude of the late cortical

evoked potential in response to unperceived emotionally significant word stimuli. This scheme, based on modern neurophysiologic concepts, allows scientists to visualize the neurologic mechanisms involved in the cortical dynamics of "nonspecific" activation of the cerebral cortex. In some cases, activation is local and in others, diffuse, depending on the perceptibility of the signalling stimulus.

The concept that local activation of the cerebral cortex is determined by the signaling significance of the perceived stimulus which dominates psychic activity at a given moment was confirmed by studies on cortically evoked electric activity in healthy mature individuals during performance of a chosen voluntary motor reaction (11). Recording of average evoked potentials was conducted during tests using physically similar visual stimuli with differing signaling significance: in one variant, the stimulus was only a warning, but the choice of reaction was determined by the character of the activating signal; in another variant, the warning stimulus determined the choice of reaction.

Analysis of the late positive wave P300 indicated that a warning stimulus, which determines the choice of a reaction, evokes an electrical response which, in the anterior regions of the cerebral cortex, has a larger potential responsiveness to stimuli of analogous physical force. However, this cortical region does participate in the process of choosing a reaction. A similar difference in size of evoked response was not observed in the occipital region.

Evidently, the size of the component P300 in anterior regions of the cerebral cortex determines local activation of the cerebral cortex. This local activation of the cortex at a given instance is probably the essential component in the neurologic mechanism needed to prepare and organize "the commands" signalled by the environment, for performance of a motor act. This explains the changes in an evoked response observed in the anterior regions of the cerebral cortex in which, according to data from neuropsychologic studies on patients with organic disorders of the frontal lobe, a goal oriented motor activity is organized (12).

Results of the two previously mentioned experiments, using perceived stimuli, clearly show that the cortical topographic phenomenon for activation or inhibition of late evoked responses is determined by the signal significance of stimuli which dominate cortical activity at a given moment. When it is necessary to select a reaction, in reponse to visual stimuli, activation of the cortex occurs in the anterior regions. If a perceiving function dominates, then local activation is observed mainly in the related perceiving cortical zone, to which the given stimulus is addressed. Thus, during performance of conscious

activity, the resulting local activation of the cerebral cortex has a dynamic character, determined by the signal significance of the stimuli and by the predominant arbitrary activity.

By no means do we consider the described cortico-thalamo-cortical mechanism for focused attention to be the substructure of consciousness, as is assumed in the central encephalonic theory of W. Penfield. Rather, we view it as the element in the complex brain system which guarantees conscious experience in man.

It appears to us that the quoted experimental results indicate that modern psychophysiologic and electrophysiologic methods of research provide a physiologic approach with which to study the most complex processes of higher neurologic activity in man. However, we acknowledge that our understanding of all the intricacies of the physiologic mechanisms for conscious and unconscious experience in the human mind remains incomplete. However, these experimental findings indicate that I.P. Pavlov's ideas on the physiology of consciousness were indeed prophetic. Clearly understanding that consciousness is a function of the entire cerebral cortex, I.P. Pavlov stressed the dynamic character of local changes in brain response. He wrote: "If it would be possible to see through the skull and if the sites in the cerebral cortex of optimal excitability were illuminated during stimulation, we would catch sight of the thinking conscious individual and would observe the constantly changing contours of the light spot, surrounded by the shadowed expanse of the rest of the cerebral cortex" (13).

BIBLIOGRAPHY

1. Arzumanov, Yu. L. Journal of higher neurologic activity, 1974 volume 24, No 5, page 917.

2. Asratyan, E.A. Journal of higher neurologic activity, 1969, volume 19, No 2, page 195.

3. Baklavadzhyan, O.G. Autonomic regulation of electrical activity in the brain. Leningrad, "Science", 1967.

4. Beritashvili, I.S. In the book: Works of the Institute of Physiology imeni I.S. Beritashvili. Tbilisi, Publication of the Georgian SSR Academy of Sciences, 1956, volume 10, page 3.

5. Beritashvili, I.S. In the book: Gagrskiye [word unknown] discussions. Tbilisi, "Metsniyereba" [expansion unknown], 1963, volume 4, page 111.

6. Gershuni, G.V. Physiology journal. USSR, 1946, volume 32, No. 1, page 43.

7. Il'yuchenok, R. Yu. and Chaplygina, S. R. Journal of higher neurologic activity, 1970, volume 20, No 1, page 176.

8. Il'yuchenok, R. Yu. and Yeliseyeva, A.G. Journal of higher neurologic activity, 1967, volume 17, No 2, page 330.

9. Kostandov, E.A. and Arzumanov, Yu. L. Journal of higher neurologic activity, 1974, volume 24, No 3, page 465.

10. Kostandov, E.A. and Briling, E.G. Journal of higher neurologic activity, 1973, volume 23, No 5, page 938.

11. Kostandov, E.A. and Vazhnova, T.N. Journal of higher neurologic activity, 1976, volume 26, No 6, page 1123.

12. Luriya, A.R. Higher cortical function in man. Moscow, Publication of MGU [Moscow State University], 1962.

13. Pavlov, I.P. Completed collected works, 1951, volume 3, book 1, page 121.

14. Sokolov, E.N. In the book: Gagrskiye [word unknown] discussions. Tbilisi, "Metsniyereba" [expansion unknown], 1963, volume 4, page 183.

15. Uolter, G.U. In the book: Problems of the dynamic localization of the brain. Moscow, 1968, page 194.

16. Uolter, G.U. The living brain. Moscow, "World", 1966.

17. Beck, E.C., Dustman, R.E. and Beier, E.C. EEG a. Clin. Neurophysiol., 1966, v. 20, No. 4, p. 397.

18. Celesia, G.G. a. Puletti, G. EEG. a. Clin. Neurophysiol., 1971, v. 31, No. 6, p. 603.

19. Chi, C.C. a. Flynn, J.P. EEG a. Clin. Neurophysiol., 1968, v. 24, No. 4, p. 343.

20. Domino, E.F. Anesthesiology, 1967, v. 28, p. 184.

21. Fuster, J.M. a. Alexander, G.E. Science, 1971, v. 173, p. 652.

22. Garcia-Austi, E., Bogacz, J. a. Vanzulli, A. EEG a. Clin. Neurophysiol., 1964, v. 17, No. 2, p. 136.

23. Goff, W.R. In: Attention in Neurophysiology. Ed. C.R. Evans and T.B. Mulholland, London, 1969, p. 169.

24. Halliday, A.M. a. Mason, A.A. EEG a. Clin. Neurophysiol., 1964, v. 16, No. 3, p. 314.

25. Levy, R. a. Behram, J. EEG a. Clin. Neurophysiol., 1970, v. 29, No. 4, p. 400.

26. Llamas, A., Avendano, C. a. Reinoso-Suares, F. Science, 1977, v. 195, No. 4280, p. 794.

27. Lorens, S.A. a. Brown, Th. S. Expt1 Neurol., 1967, v. 17, No. 1, p. 86.

28. Penfield, W. Princeton University Press, Princeton, New Jersey, 1975, p. 123.

29. Rebert, Ch. S. EEG. a. Clin. Neurophysiol., 1972, v. 33, No. 4, p. 389.

30. Sierra, G. a. Fuster, J. M. EEG a. Clin. Neurophysiol., 1968, v. 25, No. 3, p. 274.

31. Skinner, J.E. EEG a. Clin. Neurophysiol., 1971, v. 31, No. 3, p. 197.

32. Sperry, R.W. In: Brain and conscious experience. Berlin--Heidelberg--New York, 1966, p. 298.

33. Sperry. R.W. a. Gazzaniga M. In : Brain Mechanisms underlying speech and language. Ed. C.H. Millikan a. F.L. Darley, New York and London, 1967, p. 108.

34. Spong, P., Haider, M. a. Lindsley, D.B. Science, 1965, v. 148, No. 3668, p. 395.

9139
CSO: 1870

NEUROSCIENCES

THE STATE OF PROSPECTS FOR THE LONG TERM SCIENTIFIC PROJECT 'BRAIN' TO STUDY THE MECHANISMS OF HIGHER NEUROLOGIC ACTIVITY

Moscow ZHURNAL VYSSHEY NERVNOY DEYATEL'NOSTI in Russian No 6, 1978 pp 1143-1150

[Report on the 23rd Session of the Scientific Council, 17 April 1978, Leningrad by E. A. Asratyan and P. V. Simonov, Institute of Higher Neurologic Activity and Neurophysiology, USSR Academy of Sciences, materials presented by M. G. Ayrapetyants, U. G. Gasanov, N. G. Lopatina, V. V. Ponomarenko, N. F. Suvorov, K. V. Sudakov, and M. M. Khananashvili are used in the report]

[Text] The long term scientific project "Brain", undertaken to study the mechanisms of higher neurologic activity, represents one of the creative developments stemming from the work of I.P. Pavlov. The latest achievements in general neurophysiology and modern experimental techniques applied to this study are based on his fundamental work. The indepth elaboration of fundamental scientific questions in the field of higher neurologic activity is relevant for education, psychoneurologic clinics, rational organization of labor, the practice of animal husbandry, and a whole series of other fields, which have major applied significance for our country.

In this report, we do not intend to give an exhaustive summary of all the most significant results, obtained by soviet researchers in this scientific field. Rather, we will focus on the results which illustrate the basic directions of the scientific project "Brain" and which reveal the current state of research and its future prospects.

Mechanisms for learning, activating, and inhibiting conditioned reflexes. In studies on mechanisms for conditioned reflexes, researchers have concentrated on analysis of systematic neuronal activity and on the identification of synapses which can modify

and functionally unite different neurons (IVND [Institute of Higher Neurologic Activity and Neurophysiology, USSR Academy of Sciences; Brain Institute, USSR Academy of Medical Sciences; IF [Institute of Philosophy], Ykrainian SSR Academy of Sciences; Institute of Psychology, USSR Academy of Sciences; IEM [Institute of Epidemiology and Microbiology], USSR Academy of Medical Sciences; MGU [Moscow State University]; and LGU [Leningrad State University]). Investigators established the specific forms of organization of neuronal microsystems in the cortical projection zones of the brain during performance of conditioned reflex reactions by functionally differentiated cells, initiation of associative changes in the population of cortical cells, and functional union of neurologic elements from different areas of the cortex. Data were obtained on the selective pliability of synaptic pathways of cortical neurons using mathematical analysis of synaptic activity in overall responses. Studies on individual neuronal projection zones of the cortex demonstrated the specificity of sequential conditioned reflex response. This specificity controls the reorganization of neuronal activity in response to various stimuli.

The operation of bilateral (direct and reverse) conditional signals in the activation of a conditioned reflex was demonstrated by recording neuronal activity in cortical responses to signal and reinforcement stimuli. The further elaboration of the "polarization" and "neuroglial" hypotheses for how temporary nervous signals are completed is of interest. New experimental evidence has been obtained which indicates the usefulness of these hypotheses, originally proposed by soviet scholars.

A series of studies on neuronal mechanisms for conditioned reflexes was used to analyze neuromediatoral activity (IVND and NF, USSR Academy of Sciences; Brain Institute, USSR Academy of Medical Sciences; and MGU). Reorganization of cortical neuron activity for a conditioned reflex occured when remote signals were combined with local application of norepinephrine and acetelcholine, causing the conditioned reaction of the neurons to oppose the usual response to applied pharmacologic "reinforcement". It was shown that the choline sensitivity of cortical neurons depends on the signaling (positive or inhibiting) significance of the conditional stimulus. Associative changes in neuronal activity can also occur when the action of two mediators are combined with diametrically opposed effects. By studying the neurochemical bases for training, scientists discovered informational exchanges of membraneous proteins, the appearance of new antigenic characteristics in them, and changes in the activity of the protein networks in the synaptoplasm. Additional data were obtained on the involvement of catecholaminergic mechanisms of the brain in the performance of a conditioned reflex

and the role of serotonergic mechanisms in reinforcing the response. The protein content of the neurons of the motivating cortex and the hippocampus is altered by these processes.

Recently, scientists studying the macrostructural bases for conditioned reflex activity have focused a great deal of attention on training the limbic system (IVND and NF, USSR Academy of Sciences; Brain Institute, USSR Academy of Medical Sciences). Study of the spatial organization of the neurologic processes involved in the performance of a conditioned reflex revealed the regulating influence of the limbic structures on the functional relationship of different parts of the cerebral cortex. It was demonstrated that the select functional connections of the hippocampus and caudate nucleus with the projection and associative regions of the neocortex are determined by the stage of conditioned reflex reinforcement. With reinforcement, the frequency of the theta rhythm is altered, as evidenced by a high degree of coherence in EEG recordings.

Study of the generalization of conditioned reflexes, illicited by direct electrical stimulation of limbic structures was very fruitful for analysis of the functional interrelationship between these structures. Studies showed that combining direct electrical stimulation with feeding or defensive reinforcement for limbic training completely alters this reaction, which was caused previously by stimulation of certain limbic structures.

Simultaneous stimulation of rhythmic and permanent currents at two hippocampal sites, from which the phenomenon of self stimulation can be illicited, allowed scientists to differentiate between the "motivational" and "reinforcing" components of an experimentally induced self stimulation reflex.

One can hope that further studies of the mechanisms for activation of conditioned reflexes, on the macro- and micro-structural levels, and the utilization of cellular analogs for temporary signals and conditioned reflexes in invertebrates will lead to understanding those membraneous-synaptic and intracellular exchanges which are the bases for training.

Neurophysiologic bases for integrated behavior. The study of the neurophysiologic bases for goal-oriented behavior is one of the most important creative developments stemming from the work of I.P. Pavlov, for whom the terms "higher neurologic activity" and "behavior" were synonymous. Pavlov repeatedly asserted that higher neurologic activity is a result of interaction of the most complex unconditioned reflexes (instincts), conditioned reflexes, and their diverse systematized forms (for example, dynamic stereotypes). In man, this process is seen in the complex functional

training for mechanisms of speech and thought processes.

Building on these fundamental theoretical assumptions of I.P. Pavlov, scientists at the IVND and NF, USSR Academy of Sciences obtained new experimental data which reinforced concepts of how the physiologic mechanisms for motivated behavior are a result of a complex interaction between vital unconditioned reflexes and various kinds of conditioned stimuli (direct and counter-conditional signals). Investigators paid particular attention to counter-conditional signals, that is the influence of the unconditioned reflex on the functional state of the brain structures which receive the conditional signals, related to the given unconditioned reaction: the signals for food, water, and avoidance of painful stimulation. They also studied the motor apparatus involved in behavioral acts. It was shown that these counter-conditioned signals can have a tonic character, guaranteeing strict selective responses by the animal to multiple external stimuli. As a result, the behavior of the animal becomes active and goal-oriented. The whole pattern of behavior, illicited in response to a given set of factors, allows scientists to measure the non-regulated opposition to motivated behavior caused by the reflex principle of brain activity. This line of research builds on the works of I.M. Sechenov and I.P. Pavlov.

Experimental data were compiled at the IVND and NF, USSR Academy of Sciences on the fundamental role of four brain structures (frontal section of the neocortex, hippocampus, amygdala, and hypothalmus) in the genesis of emotional reactions and in the organization of behavior. These four structures form two subsystems, one of which (hypothalmus and amygdala) selects the predominant needs by evaluating the subdominant competetive motivations, and the second (the frontal cortex and hippocampus) evaluates the probability of satisfying these needs for a given situation at a given moment. It was shown that the frontal cortex orients behavior to signals with a high probability for reinforcement. The hippocampus is responsible for reaction to the signals for improbable events. Experimental need informational schemes for integrated brain activity allows scientists to systematize in theoretical terms an enormous amount of factual material, related to the function of the limbic system and to propose conceptual schemes for the organization of behavior, naturally superimposed on the anatomical structures of the brain.

Using models for feeding and defensive behavior of nestlings and homing behavior of cats, evidence was obtained regarding the most significant natural stimuli which determine the innate forms of behavior and their subsequent dynamics related to training processes. Informational and energetic parameters of the apparent stimuli and their connection with the visually specific sensi-

tivity of animals were determined. The role of impulse activity of neurons in the somatosensory cortex and the reticular formation of the brain stem in the process of kitten development was studied. On the basis of the data, the characteristics of acoustical activity of these cells were defined, typical forms of their electrical discharge were classified, and the evolution of potential for action was traced. An original method was devised to evaluate the geometry of a developing neuron.

The ontogenic approach to the study of brain function in children allowed researchers to explain the gradation and heterochronism of involvement of various parts of the brain in the processes of perception and attention and the role of the cortical lobes, which mature later, in the organization of adequate reaction to external action (Institute of Child and Adolescent Physiology, APN USSR [USSR Academy of Pedagogical Sciences].

Studies on the neurophysiologic bases for goal-oriented behavior being conducted by a number of scientific groups are based on P. K. Anokhin's theory of the functional system. Some of these studies are being conducted at the following institutions: Institute of Normal Physiology, USSR Academy of Medical Sciences; individual laboratories at the Institute of Pediatrics, USSR Academy of Medical Sciences; First LMI [Leningrad Medical Institute]. The sequence for storing and remembering results of actions which precede stimuli to reinforce feeding behavior was demonstrated experimentally. An hypothesis was formulated on the structure of the "receiver" which interprets the consequences of an action. At the basis of this theory is an assumption that the traces of the reinforcement stimulation remain fixed in those neurons which are selectively involved in motivational stimulation.

By examining human activity during working conditions, scientists found ways to coordinate the physiological rhythms of man with work rhythms. They also derived a series of indices to characterize the degree of resistance of the functional state to the process of instilling working habits. Study of EEG rhythms in conditions of social isolation during simulation of prolonged space flight and in polar workers in the Antarctic, allowed scientists to trace the dynamics of the functional state in a cycle of adaptation and readaptation. For a study of the system of man-machine, groups of people were selected according to their predominant mechanisms for coping with disturbances and distractions. By this selection process, operators were classified according to type of coping mechanisms.

Experimental pathology and therapy for higher neurologic activity. Until recently, this scientific field, based on the work of I.P. Pavlov and his colleagues, was clearly under-developed,

although the advances in modern neurophysiology were extremely advantageous for its further development. The theoretical and practical significance of this scientific field can be seen in the project "Brain". At the present time, data are available which conclusively point to the fact that given differences in the quality and degree of complexity of the factors which lead to pathology in higher neurologic activity of man and animals, the resulting pathophysiologic stresses in man and animal are very similar. For example, contents of norepinephrine and serotonin can be altered in brain tissues given a depressive state in humans and monkeys subject to social isolation. It also has been shown that man and higher animals, given a similar pathologic state, respond similarly to the therapeutic influences of the same drug.

Recently, it has become especially apparent that the success and practical value of studying experimental pathology of higher neurologic activity, to a large extent, depends on selecting models in which to adequately examine the etiology and pathogenesis of neurologic disturbances in man. Analysis of clinical data points to two critical factors in the genesis of neurosis in man: motivational conflicts arising within the sphere of interpersonal relationships, and the chronic need to make decisions without sufficient time to digest all the information required to take a course of action. This stuation is sometimes referred to as "informational overload". In fact, such an "overload" indicates a lack of available means required to solve the given problem, that is to satisfy the need.

Intensive studies are being conducted at IF, Georgian SSR Academy of Sciences; IVND and NF, USSR Academy of Sciences; IEM, USSR Academy of Medical Sciences; Institute of Normal Physiology, USSR Academy of Medical Sciences; and IEP and T [Institute of Experimental Pathology and Therapy], USSR Academy of Medical Sciences (Sukhumi) to find an animal model in which to study experimental pathology of higher neurologic activity, the principle causes for which are seen in neurotic diseases in man.

It has been found that dogs, raised without litter mates during early stages of their ontogenesis, are characterized by a significant degree of aberration both in mechanisms for regulation of emotion and in function of short term memory. In these animals, it is easy to produce prolonged experimental neurosis. It is also difficult to reinforce training in these animals. Increasingly, other methods are being used to disrupt the normal social relationships. These include creating group stress by a threat of painful stimulation, providing signals for aggressive and defensive stimulation in other animals of the same species and so forth.

Overstress of the functional abilities of the nervous system is achieved by such experimental methods as gradually increasing the burdens on the function of short term memory, testing delayed reactions, employing probability reinforcement, evaluating ability to work out complicated dynamic stereotypes, using conditioned reflex reinforcement on dissimilar reflexes, and so forth.

A multifaceted analysis of different functions and systems in an organism is a very productive way to study experimental neurosis: disturbances in sleep structures, brain vasculature, the relationship between neuromediators in brain tissues and peripheral blood supply, and the micromorphological displacements in various sections of the cerebrum. Simultaneous analysis of changes in many functions during the process of development of experimental neurosis has important practical significance for elaboration of methods for early diagnosis and for monitoring the effectiveness of therapeutic measures.

Having clinically established the role of debilitating influences which enable the development of neurotic diseases, scientists are now studying the effects of exposure to ionizing radiation, chronic noise and prolonged hypokinesis on behavior. Experimental data have been obtained on the role of genetic factors which determine predisposition and resistance to emotional stresses.

Study of the dynamics of cardiovascular function in different genetic strains of rats exposed to experimental stress, enabled scientists to establish precise prognostic criteria for disturbances in cardiovascular function. It has been shown that Wiaster rats, resistant to cardiovascular disturbances, have a predisposition to disturbances in the adrenalizing ennervation of the stomach. Stimulation of the medial anterior brain bundle (the system for "rewards") in rats substantially weakens the reactions of fear and agression, increases experimentally induced activity, and in situations of conflict, facilitates the choice of the correct reaction. One mechanism for inhibiting emotional reaction to pain involves strengthening the resistant influence of the central gray matter of the brain.

In clinical conditions, it is apparent that there is a relationship between the state of psychogenic childhood and the psychogenic and actual course of hypertonic and ulcer diseases. It has been shown that increasing the arterial pressure in patients with hypertonic diseases correlates with characteristic changes in the structure of evening sleep and interhemispheric interaction.

With the development of research in the field of experimental pathology and therapy for higher neurologic activity, it has

become possible to conduct a series of scientifically organized meetings such as the joint meetings of the Bureau of the Department of Physiology, USSR Academy of Sciences and the Medical Biologic Division, USSR Academy of Medical Sciences, and a meeting to critically analyze neo-freudianism.

In light of the evident revitalization of interest in the problems of experimental pathology in higher neurologic activity which, thanks to the multifaceted collaborative project "Interbrain", has been observed among neurophysiologists and clinicians in socialist countries, we consider the general level of work in this field to be still inadequate. The level of development does not correspond to the practical importance of the problem. We hope that the mutual interest in this problem by two academies-- USSR Academy of Sciences and Academy of Medical Sciences-- will enable further progress in the development of this field, including more widespread use of monkeys as the most effective model in which to simulate human pathology.

The genetics of higher neurologic activity and innate forms of behavior. Studies on the genetics of behavior have been conducted at six scientific research institutions in our country: Institute of Physiology imeni I.P. Pavlov, USSR Academy of Sciences; Institute of Cytology and Genetics SO [Siberian division], USSR Academy of Sciences; Department of Biology, MGU; the Department of Biology, LGU; Institute of Breeding and Genetics of Agricultural Animals; Institute of General and Pedagogical Psychology, USSR APN [Academy of Pedagogical Sciences].

The characteristic feature of soviet research on the genetics of behavior is the elaboration of questions on the mechanisms which influence genes for behavior and their relation to activity of the nervous system and the endocrine glands. Research is also focused on the role of the nervous system and neurohormonal factors in the realization of the mutation process and in microevolutionary transformations.

Studies on the genetics of the human nervous system by utilizing "twin" methods indicated the dependency of certain EEG components of different sections of the brain on genotypes. A dependency on genotypes was established for particular extrapolated reflexes in mice and rats.

Data on the genetic dependency of reactivity to stress in the process of domestication of wild animals enlarged upon research in this area. Specially bred populations of mice and rats, obtained by double crossbreeding according to reactivity to stress, were studied. Examination of the influence of genetic polymorphism on stress sensitivity during pregnancy for differential breeding of

females indicated that reaction to stress can lead to elimination of certain genotypes which are more susceptible to stress. This reaction to stress serves as a factor which influences the genetic structure of the following generation and participates in the process of microevolution.

Selection studies on the threshold of neuromuscular excitability in rats have been completed. Differences between strains with high and low excitability appeared in the second generation and were retained to the same degree in the sixth generation. It was shown that this divergence between strains is not accompanied by a divergence in a number of morphologic indices (for example, weight of the animal) related to nutritional conditions during ontogenesis which could have an effect on the general tonicity of the nervous system. Development of a strain of rats, characterized by threshold of excitability of its effector section, is required for further genetic and neurophysiologic and behavioral analysis. Such a strain could be used to simulate different pathologic states of the nervous system and can serve as test objects for the study of the effects of pharmacologic preparations. The study of characteristic behavior and physiologic indices in interspecies crossbreeding of sturgeon showed that the character of motor activity and adaptation to salinity of the water was inherited through the maternal strain. Elaboration of this concept, in addition to its theoretical significance--explanation of the role of the nucleus and cytoplasm of the oocyte--also has practical significance. These data are needed to create scientifically based conditions for industrial and reservoir breeding of sturgeon.

Current experimental work on the project "Brain" must be combined with continual upgrading of the theoretical and methodologic level of research in progress. Recently, a series of reports appeared which, without grounds, criticized the science of higher neurologic activity by contradicting the achievements made in psychology. Current advances in understanding the physiology of higher neurologic activity are often seen by authors of such articles as being too simple and fascile. For example, E. Il'enkov, in reviewing the current "widely disseminated concept" of higher neurologic activity in man wrote the following: " This concept can be applied to anything, such as to training which is used on circus animals: working with innate ("unconditioned") reflexes, building on them to produce new kinds of "conditioned" reflexes. Trainers begin with the "first" set of reflexes (innate) and then build a "second signal system" upon them by using spoken commands. In the end, a man is obtained" (Communist, 1977, No 2, page 72). Unfortunately, E. Il'enkov not once provides a reference for such statements as "widely disseminated concepts", "mythical hunt oriented reflexes", "scientifically based preju-

dices, decorated by terminology of the genetics and physiology of higher nervous activity"(we quote the vocabulary of the authors, E.A., P.S.). For the non-specialist reader in this field, perusal of such articles gives an entirely unfavorable impression of the theoretical level of research on higher neurologic activity.

This scientific topic is subject to question. In the opinion of V.P. Zinchenko and M.K. Mamardashvili "mental events, in fact, occur not in the head as neurophysiologic events, but grow and unfold in extracerebral and transindividual reality and in quasi-scientific fathoming of existence" (Questions of Philosophy, 1977, No 7, page 118). According to V.P. Zinchenko and M.K. Mamardashvili, a neurologic representation of the nature of mental activity "creates the banal idea that this unique reality, that is psychic reality, is located in the scope of the brain as it was previously thought to be in the scope of the heart, liver, etc. Well then, it is easier to ascribe the property of objectivity in everyday consciousness to the neuronal mechanisms of the brain, to find in them the informational containing relationships, and to assert the objective nature of brain activity, than to admit the reality of the subjective, psychologic character of mental activity and moreover, to recognize the dependency of mental activity on space and time" (Questions of Philosophy, 1977, No 7, page 110). Again, with the exception of a single reference to the controversial article by M.M. Kol'tsova, we can not locate in the cited literature concrete statements by those authors with whom V.P. Zinchenko and M.K. Mamardashvili are in dispute.

It is clear that unsupported references to "disseminated concepts", "everday consciousness", "mechanical thought" by these anonymous opponents deprive our discussions of the productivity which is possible only when clear and precise formulations of the theoretical positions of both the supporting and opposing viewpoints are given.

We are approaching the 150 year anniversary of the birth of I.M. Sechenov who, in the opinion of I.P. Pavlov, was the first scientist to suggest a new approach to this field. His work provided a place for this important field of physiologic research in the study of the living organism. Scientific study of a higher neurologic activity is one of the most promising developments to come out of the scientific-technical revolution both in its philosophical and applied implications. By understanding these answerable but extremely difficult problems, we will be able to continue our research.

9139
CSO: 1870

PHYSIOLOGY

A MORPHOLOGIC STUDY OF ADRENAL GLANDS OF RATS AFTER FLIGHT ON THE BIOSATELLITES 'COSMOS-605' AND 'COSMOS-782'

Leningrad ARKHIV ANATOMII, GISTOLOGII I EMBRIOLOGII No 9, 1978 pp 30-36

[Article by Ye. A. Savina, Institute of Biomedical Problems, USSR Ministry of Health]

[Text] Study of the adrenal glands of rats, placed on biosatellites, is interesting because these glands are sensitive indicators of the effect of the stress factors of flight and the adaptive capacities of an organism. The first morphologic study of adrenal glands of mammals (mice and porpoises) after short term exposure to weightlessness was conducted by V.G. Petrukhin (1962). In animals sacrificed 2-3 days after flight on a satellite, scientists observed acute plethora of the adrenal glands, depletion of the cortical lipids, mild hemorrhaging in the medullary matter. Thirty days after landing, the adrenals had a normal structure. No structural changes were observed in the adrenal glands of mice placed on board the space ship "Apollo-17"(Ordy, J.M., Brizzee, K.R., and Samorajski, T. 1975).

Data are presented in this report to correlate morphologic manifestations of the adrenal gland reaction observed in animals during the first 9-11 hours and those observed two days after prolonged residence in conditions of weightlessness.

Materials and methods of investigation. The basic experimental conditions on the biosatellite are outlined in the article by Ye. A. Il'ina and co-authors (1976).

Studies were conducted on adrenal glands from animals sacrificed 9-11 hours, 48 hours (29 rats), and 25-27 days (17 rats) after completion of space flights of 19.5 days duration ("Cosmos-782") and 22.5 days duration ("Cosmos-605"). Controls for each of the

above mentioned groups were provided by sacrificing an equal number of animals from related land experiments which simulated the conditions of flight, and by using rats retained in vivarium. Wistar line rats were used for the experiments on the biosatellite "Cosmos-605" and SPF Wistar line rats were used for the biosatellite "Cosmos-782".

Adrenal glands were dissected from fat cells, weighed, and fixed in Bouins solution and calcium formol. Lipids were stained by Berg's method, fat red O and sudan black B stains. Cholestrol was examined by Shul'ts' method and viewed in polarized light. Adrenal glands of animals from the "Cosmos-605" satellite were studied in more details. Catecholamines and the medullary matter of the adrenals were examined by Khillarp-Khekfel't reaction. The islet cells which secrete noradrenaline were studied by Erenko's method. The activity of the Krebs cycle enzymes (dehydrogenases: succinate, malate, isocitrate) and the pentose shunt (dehydrogenases: glucose-6-phosphate and 6-phosphogluconate) were measured in cryostated sections of unfixed tissue. Activity of the 3(β)-sterol-dehydrogenases was determined by Wattenberg's method which was modified by Allen (1960). Karyometry was conducted on cells from the fasicular and glomerular zones and from the medullary matter. Using the tracing apparatus RA-6, outlines of the cell nuclei were traced (100 cell nuclei from each zone were enlarged 2,000 times), their long and short diameters were measured, and nuclear sizes were calculated according to standard methods (Khecin, Ya. Ye., 1967).

Experimental results and discussion. A definite increase in adrenal weight was observed in rats sacrificed 9-11 hours after flight on the 'Cosmos-782" in comparison with animals from the land experiments and controls retained in vivarium. The adrenal gland weight was not altered in animals from land experiments.

According to general histologic structures of the cortex and individual related zones, the adrenal glands of rats from the flight group did not differ substantially from the glands of rats retained in vivarium. The glomerular zone was well defined for its whole perimeter and was composed of cells from vacuolized, almost colorless, cytoplasm. The subglomerular layer, composed of cells from the eosinophilic granular cytoplasm, was examined in all animals. Sections from the fasicular zone had a radial alignment and the cortex had a generally uniform structure. The external zones were composed of cells from vacuolized cytoplasm, whereas the middle and internal parts of the section were composed of cells principally from eosinophilic cytoplasm and even individual vacuoles. The reticular zone was narrow and plethoric; its cells contained individual vacuoles. In the capillary lumens of the cortex, segmented nuclear leukocytes were often observed.

Таблица 1

1. Масса надпочечников крыс из полетных и наземных экспериментов

2. «Космос-782»	3. Число крыс*	4. Масса надпочечников (мг/100 г массы тела) (M ± m)	5. «Космос-605»	6. Число крыс*	7. Масса надпочечников (мг/100 г массы тела) (M ± m)
8. 5—11 ч после полета	12	16,4±0,6** $P_1 < 0,001$ $P_2 < 0,001$	14. 1—2 сут после полета	15	18,3±0,5** $P_1 < 0,001$ $P_2 < 0,001$
9. 5—11 ч после окончания наземного опыта	12	13,2±0,4	15. 1—2 сут после окончания наземного опыта	15	12,0±0,5
10. Виварный контроль	12	13,1±0,5	Виварный контроль 16.	15	13,0±0,4
11. 25 сут после полета	11	14,6±0,6	26—27 сут после полета 17.	12	12,6±0,4
12. 25 сут после окончания наземного опыта	11	13,4±0,3	26—27 сут после окончания наземного опыта 18.	12	12,1±0,6
13. Виварный контроль	11	12,6±0,4	Виварный контроль 19	12	12,6±0,3

20. Примечание: ** — достоверные различия; P_1 — достоверность различий между полетными группами и виварным контролем; P_2 — достоверность различий между полетными и наземными экспериментами.

21. * В таблице приведена масса надпочечников всех животных, находившихся эксперименте.

Table 1

Key:
1. Weight of adrenal glands of rats from flight and land tests
2. "Cosmos-782"
3. Number of rats
4. Weight of adrenals (mg/100g body weight) (M±m)
5. "Cosmos-605"
6. Number of rats
7. Weight of adrenals (mg/100g body weight) (M±m)
8. 5-11 hours after flight
9. 5-11 hours after completion of land test
10. Controls retained in vivarium
11. 25 days after flight
12. 25 days after completion of land experiment
13. Controls retained in vivarium
14. 1-2 days after flight
15. 1-2 days after completion of land test
16. Controls retained in vivarium
17. 26-27 days after flight
18. 26-27 days after completion of land test
19. Controls retained in vivarium
20. Note: **significant differences. P_1--significance of difference between flight groups and controls retained in vivarium; P_2--significance of differences between flight and land tests.
21. *The weight of adrenals from all animals, subject to the experiment, are presented.

Karyometry of cells from the glomerular and fasicular zones showed a significant increase in the size of nuclei from the

external fasicular layers in rats from the flight group in comparison with control animals from land experiments and those retained in vivarium (Table 2).

Таблица 2

1. Объем ядер клеток пучковой зоны коры надпочечников крыс из полетных и наземных экспериментов *

2. «Космос-782»	3. Число крыс	4. Объем ядер в мкм³ (M ± м)	5. «Космос-605»	6. Число крыс	7. Объем ядер в мкм³ (M ± м)
8. 9—11 ч после полета	5	130,5±4,1** $P_1 < 0,001$ $P_2 < 0,001$	14. 2 сут после полета . .	6	143,0±4,7** $P_1 < 0,05$ $P_2 < 0,05$
9. 9—11 ч после окончания наземного опыта	5	92,1±3,93	15. 2 сут после окончания наземного опыта . .	6	124,0±4,71
10. Виварный контроль	5	84,5±2,65	Виварный контроль	16. 10	128,0±3,4
11. 25 сут после полета	5	100,0±3,67	27 сут после полета	17. 6	129,7±7,0
12. 25 сут после окончания наземного полета	5	84,3±2,96	27 сут после окончания наземного опыта . 18. . . .	6	113,5±4,15
13. Виварный контроль	5	101,7±2,42	Виварный контроль . . 19.	10	119,9±2,3

20. Примечание. ** — достоверные различия; P_1 — достоверность различий между полетными группами и виварным контролем; P_2 — достоверность различий между полетными и наземными экспериментами.

21. * Объемы ядер клеток клубочковой зоны и мозгового вещества не приводятся в связи с отсутствием достоверных различий между экспериментальными группами и виварным контролем.

Table 2

Key:
1. Size of cell nuclei from the fasicular zone of the adrenal cortex in rats from flight and land experiments
2. "Cosmos-782"
3. Number of rats 3
4. Size of the nucleus in μ (M±m)
5. "Cosmos-605"
6. Number of rats 3
7. Size of the nucleus in μ (M±m)
8. 9-11 hours after flight
9. 9-11 hours after completion of land test
10. Controls retained in vivarium
11. 25 days after flight
12. 25 days after completion of land flight
13. Controls retained in vivarium
14. 2 days after flight
15. 2 days after completion of land test
16. Controls retained in vivarium
17. 27 days after flight
18. 27 days after completion of land test
19. Controls retained in vivarium
20. Note:**significant differences; P_1--significance of differences between flight groups and controls retained in vivarium; P_2--significance of differences between flight and land experiments.

21. Sizes of cell nuclei from the glomerular zone and the medullary matter were not calculated on the basis of absence of significant differences between experimental groups and controls retained in viviarium.

Examination of lipids revealed marked differences between the adrenal glands of rats from the flight group and those from animals retained in vivarium. In the first 9-11 hours after flight, a significant decrease in lipid content was noted, particularly in the internal layers of the cortex. The glomerular zone was separated from the rest of the cortex by a large number of brightly luminescent large droplets. The subglomerular layer was devoid of lipids. In all animals, delipoidization of the fasicular zone (middle and particularly the internal layers) and the reticular zone was observed (Figure 1).

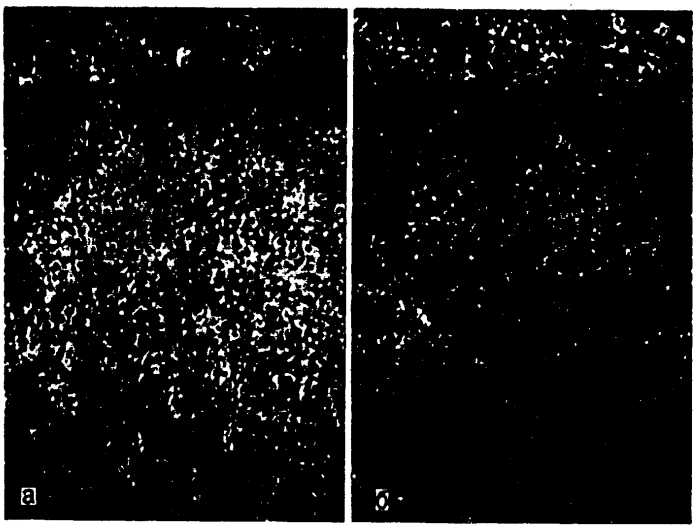


Figure 1. Lipid content in the cells of the fasicular zone of the adrenal glands of rats in normal conditions and after flight on the biosatellite. a. Control. Cells of the glomerular and fasicular zones in the adrenal cortex contain a large amount of large, brightly luminescent lipid droplets. b. Experiment. 9 hours

(Figure 1 continued) after flight. A marked decrease in lipid content of the fasicular zone of the adrenal cortex. Berg's method. ML-2, ob. 20.

The extent and range of delipoidization varied in different animals. In some rats, a moderate amount of finely dispersed lipid droplets was located only in the external layers of the fasicular zone, whereas in the rest of the fasicular and reticular zones the lipid inclusion was almost absent. In other rats, the external layers of the fasicular zone were more replete with lipids. Delipoidization was present mainly in the internal and particularly the middle layers of this section.

In animals, sacrificed 9-11 hours after completion of a synchronized experiment, the general structural design, the relationship of individual cortical layers of the adrenal glands, and the size of cell nuclei in the glomerular and fasicular zones did not differ from the controls retained in vivarium (see Table 2). Delipoidization was localized and was significantly less marked than in the flight group.

In rats, examined on the second day after flight on the "Cosmos-605" satellite, the weight of the adrenal glands remained significantly increased (see Table 1), whereas the histologic structure of the cortex, in comparison with animals from the "Cosmos-782" satellite, underwent definite changes. The interzonal borders had a ragged appearance, and the fasicular zone was widened causing narrowing of the glomerular and reticular zones. The subglomerular layer was not examined. Increase in the size of the cell nuclei from the fasicular zone was retained, however differences, in comparison with controls retained in vivarium, were less significant (see Table 2). Delipoidization, noted in the first hours after landing, alternated with an accumulation of a large quantity of finely dispersed lipid droplets throughout the entire thickness of the cortex. The sudanphobic zone was not evaluated (Figure 2).

Correlation of enzyme activity (Krebs cycle, pentose shunt, 3(β)-sterol-dehydrogenase) did not show any differences in the adrenal glands of experimental animals in comparison with the controls.

Two days after flight, the size of the cell nuclei from the medullary matter, the luminescent intensity of islet cells which secrete noradrenalin, and total content of catecholamines (evaluated by the Khillarp-Khekfel't reaction) were not different from the controls retained in vivarium.

Two days after completion of the land experiment changes in the histologic structures, the histochemical properties, and the

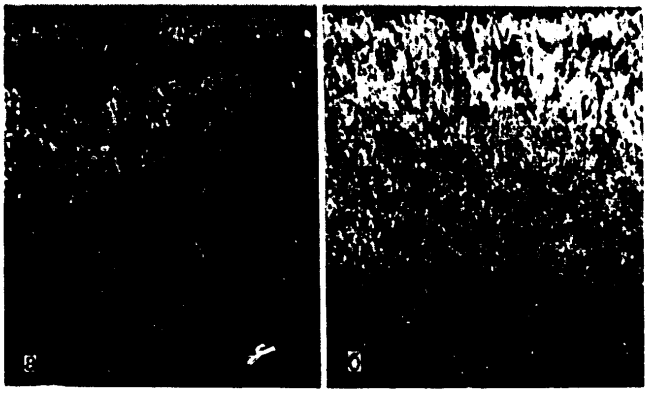


Figure 2. Subglomerular layer of the rat adrenal cortex after flight of different durations on board the biosatellite. a. Experiment. 9 hours after flight. The subglomerular cortical layer, deprived of lipids, has distinct contours; delipoidization of the fasicular zone. b. Experiment. 2 days after flight. Absence of subglomerular layer of the cortex; accumulation of finely dispersed lipid droplets throughout the entire thickness of the adrenal cortex. Berg's method. ML-2. ob. 10.

weight of the adrenals were not observed.

Morphological displacements, noted in rat adrenals in the first two days after landing, were transitory and after 25-27 days were normalized in animals from all the experimental groups ("Cosmos-605" and "Cosmos-782").

Morphologic signs of hypertrophy and hyper-function of the adrenal cortex were detected in rats during the first 9-11 hours after biosatellite landing: increase weight of the adrenals, significant increase in the size of the cell nuclei from the fasicular zone, and delipoidization of internal cortical layers. Results of biochemical studies, conducted during this experiment, showed an increase in the content of corticosteroids in adrenal gland tissue and in blood plasm (Kvetnyanski, R. et al., 1976; Tigranyan, R.A., et al., 1976). In other words, during the

first hours after landing morphologic and biochemical displacements, characteristic of a stress reaction, were observed in the adrenal glands. Two days after flight, the intensity of morphologic indications of increased functional activity was lowered significantly. Thus, if in the first hours after flight, the size of the cell nuclei from the fasicular zone was increased by 54 percent, than two days latter, it exceeded the control only by 11 percent. The content of corticosteroids in blood plasm of these animals was lower than in the control animals (Tigranyan, R.A. et al., 1975).

According to these data, it is possible to determine whether the observed displacements in the animals are caused by exposure to weightlessness or if they develop acutely upon return to earth.

In order to evaluate the acute stress reaction caused by the effects of a complex of factors present at the time of descent and after landing of the biosatellite, we correlated the possible relationship of increased size of cell nuclei from the fasicular zone with delipoidization of the adrenal cortex. These changes could develop 11 hours after satellite landing, based on the increase in the size of cell nuclei from the fasicular zone observed two hours after a single dose intake of ACTH. After eight hours, the increase reached its maximum--59 percent more than the control (Kracht, T., 1954). In analogous conditions (intake of ACTH) the maximum lowering of lipid content in the adrenal cortex also developed in the first 6-12 hours (Skelton, F.R., 1961). The development of an acute stress reaction was evidenced by the absence of signs of structural rebuilding in the cortex. Such rebuilding was not detected in the first 9-11 hours, but was clearly apparent two days after flight.

The marked changes seen in rats from the flight group, as compared with those observed in animals from synchronized experiments, may be caused both by changes in the reactivity of the animals after prolonged residence in weightlessness and by the more complex group of factors which effect flight animals (in particular, return to earth's gravity). Apparently, the dynamic factors of simulated re-entry and landing to which animals from the synchronized experiment were subjected had a lesser impact.

Evaluation of the morphologic manifestations of an acute stress reaction was complicated, to a significant degree, by the retrospective analysis of the state of adrenal glands in conditions of space flight. Thus, for example, an unresolved question remained: does the increase in adrenal weight occur in the process of flight or after landing? The relatively moderate increase in adrenal gland weight could have developed in the course of the first 11 hours of the animals' residence on earth. How-

ever, the absence of disruption in blood circulation and histologic signs of acute structural reorganization of the cortex suggested that changes in adrenal gland weight did not occur in a short period. The possibility of hypertrophy and increase in the functional activity of the cortex during the time of flight (at least during individual stages of flight) was evidenced by data from studies on the lymphoid organs, in which not all the observed changes fit into a picture of acute stress (1). Reduction in the body weight of rats from the flight group, in comparison with animals from the land experiments and controls retained in vivarium (given practically identical food consumption) was another indication that a stress reaction occurred during the time of flight (Durnova, G.N., Kaplanskiy, A.S., and Portugalov, V.V., 1977).

Despite the stated difficulties, study of animals in the first hours after flight allowed scientists to establish that the phenomena of acute stress reaction developed despite normal cortical architecture. The emergence of the subglomerular layer--distinctness of its borders and those of the corresponding individual zones--attested to the significant degree of normalization of cortical structures at the end of the flight. According to data presented in the literature, the condition of the subglomerular zone is one of the morphologic criteria by which the functional activity of the whole adrenal cortex can be judged (Greep R.O. and Jones, I., 1950). Disappearance of the subglomerular layer is observed in conditions of stress influences and corresponds to increased cortical function. Reduction of the layer's dimensions is a good index of adrenal gland "recovery" after stress reactions because it is often related to normalization of the cortical structures and its histochemical properties (Glasser, S.R. and Leathem, J.H., 1956). Reduction of the subglomerular zone in animals, subjected to a recurrent influence, is an indication of adaptation by the organism to a given factor, whereby increased adrenal function is no longer exhibited (Mitro, A. and Mikulaj, L., 1965).

Based on this criterion, it is likely that prior to re-entry to earth, the function of the adrenal cortex was not increased and that the animals had fully adapted to flight conditions.

The effect of the complex of factors, present during re-entry and landing of the biosatellite, permits, to a certain degree, evaluation of the "stability margin" of the adaptational systems of an organism. Absence of indices for "exhaustion" of adrenal cortical function, based on morphologic and biochemical data (Tigranyan, R.A. et al., 1976), attests to the preservation of the adaptational capacity of an animal organism after prolonged residence in weightlessness.

Thus, morphologic manifestations of functional displacements in the adrenal glands were detected in rats after flight on the biosatellites "Cosmos-605" and "Cosmos-782". These displacements reflect the adaptational reaction of the organism to conditions of weightlessness and to the effects of return to earth's gravity.

BIBLIOGRAPHY

Durnova, G.N., Kaplanskiy, P.S., and Portugalov, V.V. The influence of 22 days of space flight on the lymphoid organs of rats. Space Biology and Aerospace Medicine, 1977, No 2, p. 53-57.

Il'in, Ye., A., Serova, L.V., and Noskin, A.D. Experiments with mice exposed to 22 days of flight on the biosatellite "Cosmos-605" (Problems and methods of study). Space Biology and Medicine, 1976, No 3, p. 9-13.

Kvetnyanski, R., Tigranyan, R.A. et al. The influence of prolonged residence in space on the activity of the sympathetic-adrenal system of rats. Proceedings of the IX Symposium on Space Biology and Medicine, Budapest, 1976, p. 100-107.

Petrukhin, V.G. Pathomorphologic changes in internal organs of animals subject to flight on space satellites. In: Problems of Space Biology, 1962. Volume 2, p. 128-139.

Serova, L.V. The question of organism resistance during weightlessness. Aerospace Medicine. Proceedings of the V All-Union Conference, Kaluga, 1975. Volume 1, p. 36-38.

Tigranyan, R.A., Gayevskaya, M.S., et al. The nature of metabolism in rats subject to weightlessness. VIII Symposium on Space Biology and Medicine. Reports. Varna, 1975, p. 104-105.

Tigranyan, R.A. Popova, I.A. et al. Changes in biological indices of blood from rats after flight on "Cosmos-782" biosatellite. Proceedings of the IX Symposium on Space Biology and Medicine, Budapest, 1976, p. 83.

Khesin, Ya. Ye. Dimensions of the nuclei and the functional state of cells. Moscow, "Medicine", 1967, p. 421.

Allen, J.M. A histochemical study of 3 (β)-sterol-dehydrogenase in the adrenal cortex of the developing mouse. Anatomical Record, 1960, v. 137, N 1, p. 57-62.

Glasser, S.R. and Leathem, J.H. The influence of diet on the recovery of the rat adrenal from stilbestrol induced stress. Endocrinology, 1956, v. 56, N 4, p. 420-425.

Greep, R.O. and Jones, I. Ch. Steroid control of the pituitary function. Recent Progress in Hormone Research, 1950, v. 5, p. 197-254.

Kracht, T. Zur Dauer der Nebennierenrindenactivierung nach ACTH und ACTH-depot. Arch. experim. Pathologie und Pharmakologie, 1954, Bd. 223, p. 355-361.

Mitro, A. and Mikulaj, L. Uber die Verteilung Fetten in Nebenniere von Ratten im Laufe wiederholter Stresseinwirkung. Endokrinologie, 1965, Bd. 49, N 1-2, S. 18-21.

Ordy, J.M., Brizzee, K.R., and Samorajski, T. Condition of flight animals on recovery; food intake; observation on the hypothalamus, pituitary and adrenal cortex. Aviation, Space and Environmental Medicine, 1975, v. 46, N 4, p. 627-633.

Skelton, F.R. Response of the adrenal cortex in disease. In: The Adrenal Cortex, ed. Moon, H.D. New York, 1961, p. 176-200.

9139
CSO: 1870

PHYSIOLOGY

ANOTHER DISCUSSION ON THE MECHANISMS FOR HISTOLOGICAL AND CYTOCHEMICAL CHANGES IN MAMMALS (RATS) DURING ORBITAL FLIGHTS

Leningrad ARKHIV ANATOMII, GISTOLOGII I EMBRIOLOGII No 9, 1978 pp 23-29

[Article by V.V. Portugalov, Institute of Biomedical Problems, USSR Ministry of Health]

[Text] Flights of the biosatellites of the "Cosmos" series have enriched the field of space biology with a multitude of new data which reveal how weightlessness effects various mammalian organisms including man. Data collected during the biosatellite series "Cosmos-605", "690", "782", and "936" indicate that factors of space flight influence, to varying degrees, the structure and chemical organization of various functional systems in living organisms (Portugalov, V.V., 1976, 1977).

V.S. Yagodovskiy et al. (1976, 1977) in studying a series of satellites beginning with "Cosmos-605", and somewhat latter, the American investigators C.W. Asling, D.J. Baylink, and E.M. Holton, also using data from Soviet biosatellites, noted that osteoporosis of the spongy segments of long tubular skeletal bones developed in rats during prolonged orbital flight. Reduction of the spongious of metaphyses and epiphyses was associated with a decrease in mass of the primary spongious near the epiphyseal cartilaginous layer. Thinning of the cortical layer occurred in the metaphyseal region. The dimensions of the osteocytic lacunae in the diaphysis increased to a statistically significant degree. This increase indicates the development of periosteocytic osteolysis during flight.

Similar phenomena were observed in rats, subject for a prolonged period to hypokinetic conditions and to experimental land tests in which all the conditions of flight were simulated except weightlessness. However, in the later tests, these changes, according to the data of Yagodovskiy, were less obvious than

those seen in flight animals.

Thus, we have accumulated facts which indicate that removal of the static burden from the skeleton leads to changes in mineral metabolism, manifested by the development of osteoporosis of the spongy segments of long tubular skeletal bones and periosteocytic osteolysis of them.

Studies of skeletal muscles (Il'ina-Kakuyeva, E.I. et al., 1976, 1977 a,b) indicated that different muscles have dissimilar functional responses to the effects of space flight. Thus, in muscles of the posterior extremities, the maximum loss in mass was noted in the soleus muscles; to a lesser extent this was seen in the gastrocnemius muscle; and in the quadricep muscles of the femur only a tendency towards decreased mass was detected. The muscle mass in the anterior extremities, for example the biceps of the shoulder, was not altered. In all muscles of the posterior extremities, signs of the development of muscle fiber atrophy were observed microscopically. In functionally different muscles, these signs were manifested in different degrees. In contrast to the composite muscles, in the red soleus muscle edema associated with proliferation of connective tissue cells occurred in addition to atrophic processes. In the edematous zone, segments of the muscle fiber underwent death and breakdown. Correlation of the results from studies on the soleus muscles in rats after flight, with data on these same muscles subjected to hypokinesis, suggested to us that changes in the muscle occur at the end of flight.

We consider the prevalence of atrophic changes in the skeletal muscles to be related to reduction or even complete removal of the static burden from the muscle, experienced during weightlessness. Data from multiple experiments on the effects of restricted mobility during hypokinesis indicated the correctness of this conclusion (Portugalov, V.V. et al., 1968, 1971, 1975), as well as those drawn from the previously mentioned experimental land tests.

Other associated mechanisms take part in the genesis and development of changes in the orientation-motor apparatus of an organism. At the present time, it is difficult to establish a direct connection between the level of afferent information transmitted to muscles from the central nervous system and the nature of muscle metabolism. A deficiency in proprio- and interoceptive impulses creates a "stimulation deficit" in the nerve centers and alters both the nerves and tissues innervated by them during trophic processes (Chernigovskiy, V.N., 1960; Mogendovich, M.R., 1970, and others). It appears that the deprivation (complete or partial) of motor function, which occurs during space flight and

during certain earth conditions, leads to a deficit in the function of related brain structures and to subsequent disturbances in the nutrition of the skeletal musculature and bones. Reference should also be made to the fact that along with reduction in proprioceptive impulsation (quantitative and qualitative), distortion of angioreception with possible redistribution of blood in the organism of the rat occurs during flight. In fact, most recently it has been demonstrated in studies of the gastrocnemius muscle that during flight a significant decrease in the number of functioning capillaries occurs (Kaplanskiy, A.S., 1978). We disagree with Kaplanskiy's understanding of the genesis of these displacements. He relates these observed changes to a decrease in the kinetic burden on the muscles while we attach cardinal significance to removal of the static burden.

Observations conducted during the early period after completion of space flight (4-11 hours) revealed a definite decrease in the protein content of the cytoplasm of motor neurons in the spinal cord at the level of the lumbar region, a decrease in the protein content and RNA in the major sensory nerve cells in the spinal cord ganglia located at this level, and a decrease in the content of water-soluble proteins in the structures of the gray and white matter of the spinal cord and intervertebral ganglia. These changes can be interpreted as cytochemical manifestations of a deficit in intero- and proprioceptive impulsation during the time of flight (Gorbunova, A.V. et al., 1976, 1977, 1978). Thus, the changes detected in the early period after flight (4-11 hours) in protein and RNA metabolism in nerve structures involved in the signal reflex arc must be viewed as the response to removal of the static burden from the orientation-motor apparatus, which enables the organism to adapt to conditions of weightlessness. Similar displacements in the gray matter of the cortex in the sensory motor zones of the cerebral cortex were not detected concurrently. The later indicates that adaptation to weightlessness occurs mainly at the level of the signal reflex arc.

We mentioned previously that residence in weightlessness inevitably leads to development of atrophic and particularly dystrophic changes in skeletal muscles. It is clear that with disturbance of the structural organization of muscle tissues, normal muscle metabolism becomes impossible. Indeed, in the early period after flight (4-48 hours), the spectra of the isoenzyme LDH in the soleus muscle migrate from "cardiac type" to "intermediate" (Petrova, N.V. et al., 1976, 1977). The nature of these changes in spectra of the isoenzyme LDH indicates that an increase in the glycolytic processes of the soleus muscle occurs during space flight. Until recently, it was difficult to prove

that the function and structural organization of tissues is under the strict control of the nervous system. In multiple experiments on the trophic influence of the nervous system on muscle, described in studies published by V.S. Il'in (Il'in, V.S., 1964; Il'in, V.S. et al., 1967, 1972, 1975), it was demonstrated that any type of damage to nerve ganglia leads to disturbances in muscle nutrition. We observed changes in the nature of muscle metabolism in rats subject to flight conditions. During weightlessness, in addition to changes in the structure of signal reflex arcs, alteration of the trophic inter-relationship between the nerve and muscle occurs, producing modification of the metabolism in the later.

The results of experiments, conducted on the biosatellite "Cosmos-936" by V.M. Shvetz to study ectopic osteogenesis, reinforced these concepts of the nature of neurotrophic changes which develop in skeletal bones during weightlessness. These studies showed that residence in weightlessness did not significantly influence the processes of remodelling and new formation of ectopic bone. Based on these data, we consider that changes which occur during weightlessness in the morphologic parameters of skeletal bones, such as their mineral metabolism, are determined mainly by disturbances caused by the deficit in motor function.

What other important changes occur in an organism during flight? Observations have been accumulated in the literature which state that a decrease in hematopoiesis occurs in conditions of weightlessness. J.T. Ellis and coauthors (1975), working with mice sent on the spaceship "Apollo", relate this decrease to hypoxia. Results of our investigations, obtained from biosatellites from the "Cosmos" series where atmospheric conditions were identical to the earth's, allowed us to establish a causal relationship between the observed changes--depression of erythropoiesis--and decrease in the size of the functional load on the orientation-motor apparatus (V.N. Shvetz and Portugalov, V.V., 1976, 1977).

In animals during the early period after orbital flight, a complex of structural changes appeared in the hypothalamus-pituitary-adrenal cortex system which determines development of the protective, adaptive, and compensatory reactions (Savina, Ye.A., 1977; Savina, Ye. A. and coauthors, 1977). Neurosecretory cells in the supraoptic nuclei of the hypothalamus became increasingly active, their nuclei increased in dimensions, and the perinuclear zone of the majority of the cells was expanded. The content of neurosecretory granules in the cells was lowered in comparison with control animals. In the pituitary gland, the number of Herring bodies and the density of neurosecretory granules were diminished. Based on these data, we consider that all the enumerated changes are caused by factors which are

activated at the time of satellite landing and return to earth's gravity. The adrenal glands increased in weight in comparison with the controls. There was a high content of lipids in the glomerular zones of the adrenal cortex and significantly less in the internal layers of the cortex--indications of localized delipoidization in the sheaf and reticular zones. The degree of manifestation and distribution of this process varied in different animals. The absence of a sudanphobic zone and the presence of hypertrophic cells in the fasicular and reticular zones was also noted. In other words, in flight rats, two types of changes were noted in the adrenal glands: acute changes which possibly develop during re-entry to earth, and changes resulting from prolonged residence in flight conditions (Savina, Ye.A., 1977).

Examination of the lymphoid organs of rats 2-24 hours after flight revealed a decrease in the weight of the spleen and the thymus glad and a tendency toward decrease weight of the inguinal lymphatic nodes. Microscopic analysis of the spleen showed diffuse neutrophilic infiltration, hyperplasia of the white and red pulps, a decrease in the number and dimensions of the lymphoid follicles and their light centers, and a decrease in the number of erythroid hemogenesis sites. In the early period after landing massive breakdown of lymphocytes and accumulation of nuclear debris occurred in the cortical material of the thymus gland. Twenty-four hours after flight, the cortical substance of the thymus, for all practical purposes, contained no lymphoid elements. The distinction between the cortical and medullary matter in the gland tissue was preserved. The lymphatic nodes, as well as the spleen and thymus, underwent involution (Durnova, G.N. and co-authors, 1976, 1977). Both Soviet and American scientists (L. Kraft) comment on the acute depletion of lymphocytic elements in the inguinal lymphatic nodes.

Thus, in the lymphoid organs,as well as in the hypothalamus-pituitary-adrenal system, displacements of two types were noted: the first type has an "acute character",such as the breakdown of lymphocytes in the cortical matter of the thymus and neutrophilic infiltration of the spleen; the second type is characterized by atrophy of lymphoid follicles and their light centers in the spleen and lymphatic nodes, reduction of the cortical matter in the thymus and inguinal lymphatic nodes, etc. The first type of change represents morphologic manifestations of acute stress and frequently develops in a period of 6-24 hours after cessation of the factors which cause it. In studying the effects of space flight, scientists should consider the complex of reactions which accompany biosatellite landing and passage from weightlessness to earth's gravity. Hypoplasia of lymphoid tissue, which causes decreased weight of lymphoid organs, develops early and is evidence of the influence in the early

stages of space flight of those factors which cause stress (Durnova, G.N. and co-authors, 1976, 1977).

Signs of stress reactions in other functional systems of an organism have been observed. In the stomach, these signs appear in the form of decreased content of neutral mucopolysaccharides in the goblet cells in the neck of the fundic gland, and reduced population of lymphocytic elements in the Peyer's patches of the small intestines (Shubich, M.G. and co-authors, 1977). In the liver, fatty infiltrates, caused by mobilization of lipids, occurs. (Yakovleva, V.I., 1977). In the myocardium, increased activity of phosphorylase A and B occurs as a result of an increase in adrenaline content (Kaplanskiy, A.S. and co-authors, 1977). Accumulation of neutrophilic leucocytes are seen in lung capillaries (V. I. Yakovleva).

Ya. A. Vinnikov and co-authors (1978) noted changes in the inner ear structures responsible for balance. The authors relate these changes on the one hand to disturbances, produced by weightlessness, in calcium metabolism within the system of the otolith-otolithic membrane, and on the other hand to local disturbances in circulation and drainage of endo- and perilymph. The otolithic membrane, which had a granular structure in the control rats, acquired a gelatinous character after flight and adjoined the surface of the receptor epithelium of the utriculus. Immobilization of the otolithic membrane resulted from the effect of the G-force during landing. Otoconia, often characterized by the presence of multi-sided crystals with alternating light and dark granular substances, had an oval-spherical shape. A component of this otoconia was vacuolization. Stasis of the capillaries and edema of the connective tissue developed. In the membraneous labyrinth, the most obvious changes were seen in the receptor cells arranged within acutely vacuolized cup-shape nerve endings. Thus, changes in the vestibular apparatus in animals is determined by the effect of flight factors such as weightlessness and G-forces.

Studies on the retina of the eye, conducted by the American investigators D.E. Philpott, R.Corbett, and others, indicated that a contribution to the total effect of space flight on an organism is made by the flow of the more heavily charaged particles of the solid propellant Z equally 6-28. In the early period after flight, necrobiotic and necrotic changes of the nuclei occurred in the external and internal nuclear layers of the retina. In the area where external segments of the rods contact with cells of the pigmented epithelium, channels of up to 26-28μ in length were observed.

Additional research data indicate that the fundamental histo-

logic and cytochemical changes, which occur during orbital flights of 18.5-22.5 days duration, are determined on the one hand by deprivation of motor function, and on the other hand by the development of non-specific reactions to stresses which intensify during individual parts of the trajectories of space flight (during lift-off and re-entry). The results of the biosatellite flight of "Cosmos-936" attest to the correctness of our interpretations of the available data. For this flight, animals were placed in a centrifuge which created a constant operating speed of about 1 g.

Preliminary data from studies on long tubular bones, conducted by E.M. Holton, suggest on the basis of indirect indices, the preservation of normal or close to normal mineral metabolism in rats placed in a centrifuge.

The results of cytochemical, biometric, and histologic studies on muscles of the anterior andposterior extremities in rats placed in a centrifuge, suggest that the use of artifical gravity during conditions of weightlessness impedes the development of the atrophic processes and metabolic disturbances observed in animals exposed to weightlessness during orbital flight (Ye.I. Il'ina-Kakuyeva). Use of artifical gravity impedes, but does not completely prevent these disturbances. Possibly during experiments on "Cosmos-936", such conditions were not created and the influence of precess and coriolis force accelerations did not permit complete dilution of the undesirable effects of weightlessness. Using cytochemical methods, scientists established that residence of animals in conditions of "artifical weight" significantly stabilized muscle metabolism. Thus, the spectra of the isoenzyme LDH in the soleus muscle of rats placed in a centrifuge retained the characteristics of "cardiac type", disregarding a change of activity of two fractions (N.V. Petrova). In other words, fundamental shifts in the trophic relationships of nerve to muscle do not occur in conditions of artifical gravity.

In the gastrocnemius muscle of rats placed in a centrifuge, the number of functioning capillaries decreased to the same extent as rats exposed to conditions of weightlessness (Kaplanskiy, A. S., 1978).

Shifts in the content of water-soluble proteins in the gray matter of the spinal cord, the structures of the intervertebral ganglia, and the gray matter of the cerebral cortex were not observed in rats placed in a centrifuge. Subsequent observations have provided us with additional data to support the existence of a direct relationship between decreased content of water-soluble proteins and the effects of weightlessness on an

organism. We have discussed the genesis of these displacements previously. We attribute the decreased quantity of water-soluble proteins in the white matter of the spinal cord of rats placed on a centrifuge during the flight of the biosatellite "Cosmos-936", to possible slowing of metabolic transport in the orientation systems of these animals (A.V. Gorbunova and co-authors, 1978).

Histologic study of the adrenal glands (Ye. A. Savina) and lymphoid organs (G.N. Durnova) in rats exposed to conditions of artifical gravity, did not show changes characteristic of acute stress. These observations again emphasize, as previously stated, that the leading factor in the development of acute stress after flight is transition from weightlessness to the earth's gravity.

These data reinforce our opinion that in mammals (rats), the most significant changes resulting from exposure to weightlessness, can be related to the development of motor function deprivation. These data allow us to look at the complex of changes, which occurs in a mammalian organism during space flight, as a nuerotrophic phenomenon. The significant displacements observed in these animals are caused by the stress effects of space flight. These stresses, in turn, can be displayed, to varying degrees, during different parts of the flight trajectory.

In this report, we did not discuss the role of disturbances in blood supply and intra-organ circulation in the genesis of certain changes produced by weightlessness. We attach considerable significance to this question; however, at this time, there are no related experimental data available.

BIBLIOGRAPHY

Vinnikov, Ya.A., Gazenko, O.G., Titova, L.K. et al. Structural and functional organization of the vestibular apparatus in rats placed in conditions of weightlessness for 19.5 days on the satellite "Cosmos-782". Archives of Anatomy, 1978, v. 74, N 1, p. 22-28.

Gorbunova, A.V. and Portugalov, V.V. Cytochemical investigation on protein and RNA in spinal motor neurons and neurons of the spinal ganglia of the rat after space flight. Aviation, Space and Environmental Medicine, 1976, v. 47, N 7, p. 708-710.

Gorbunova, A.V. and Portugalov, V.V. The influence of space flight on the composition of water-soluble proteins in the spinal cord and intervertebral ganglia. Bulletin of Experimental Biology and Medicine, 1977, v. 84, N 8, p. 168-171.

Gorbunova, A.V. and Portugalov, V.V. The influence of artificial gravity in space flight on the content of water-soluble proteins in the structures of nerve tissue. Bulletin of Experimental Biology and Medicine, 1978, v. 85, N 8.

Durnova, G.N., Kaplanskiy, A.S. and Portugalov, V.V. Effect of 22 day space flight on lymphoid organs of rats. Aviation, Space and Environmental Medicine, 1976, v. 47, N 6, p. 588-591.

Durnova, G.N., Kaplanskiy, A.S. and Portugalov, V.V. Changes in lymphoid organs of rats during space flight. Archives of Anatomy, 1977, v. 72, N 5, p. 14-20.

Il'in, V.S. Central regulation and adaptation of cell metabolism in higher organisms. In: Molecular Biology. Problems and Perspectives. Moscow, 1964, p. 323-332.

Il'in, V.S. Pleskov, V.M. and Razumovskaya, N.I. Hexokinase in soluble fractions and in mitochondria of embryonic skeletal muscles,and intact and denervated muscles in an adult rabbit. Biochemistry, 1967, v. 32, N 4, p. 807-811.

Il'in, V.S. Yemel'yantsev, A.M., Pleskov, V.M. et al. The biochemical bases of nerve trophic processes. Pathologic Physiology and Experimental Therapy, 1972, N.3, p. 3-12.

Il'in, V.S., Razumovskaya, N.I., and Usatenko, M.S. Influence of nerve impulse on the enzyme sysnthesis in skeletal muscles. Advances in Enzyme Regulation, 1975, v. 13, p. 219-234.

Il'ina-Kakuyeva, Ye.I., Portugalov, V.V. and Krivenkova, N.P. Space flight effects on the skeletal muscles of rats. Aviation, Space and Environmental Medicine, 1976, v. 47, N 7, p. 700-703.

Il'ina-Kakuyeva, Ye. I., Portugalov, V.V. and Krivenkova, N.P. Influence of space flight factors on skeletal musculature. Space Biology and Aerospace Medicine, 1977 a, N 1, p. 20-25.

Il'ina-Kakuyeva, Ye.I. and Portugalov, V.V. Combined effect of space flight and radiation on skeletal muscles of rats. Aviation, Space and Environmental Medicine, 1977 b, v. 48, N 2, p. 115-119.

Kaplanskiy, A.S.,Durnova, G.N. and Portugalov, V.V. Morphologic studies of the heart in rats placed on board biosatellites. Bulletin of Experimental Biology and Medicine, 1977, v.83, N 4, p. 485-486.

Mogendovich, M.R. Reflex trophic process and proprioreception. In: Nerve Trophis in Physiology and Pathology. Moscow, 1970, p. 48-54.

Petrova, N.V. and Portugalov, V.V. Isoenzyme LDH in skeletal muscles after space flight and hypokinesis. Space Biology and Aerospace Medicine, 1977, N 5, p. 66-72.

Petrova, N.V. and Portugalov, V.V. Effect of penetrating radiation on skeletal muscles of rats in weightlessness. Aviation, Space and Environmental Medicine, 1976, v. 47, N 10, p. 1080-1082.

Portugalov, V.V. Preliminary results of morphologic and cytochemical studies on animals exposed to 22 days of space flight on board ISZ [earthbound artifical satellite) "Cosmos-605". Publication of the USSR Academy of Sciences. Biological series, 1976, N 3, p. 418-429.

Portugalov, V.V. Morphologic and cytochemical studies on the biosatellite "Cosmos-782". Archives of Anatomy, 1977, v. 72, N 7, p. 5-20.

Portugalov, V.V., Gazenko, O.G., Il'ina-Kakuyeva, Ye. I. et al. Cytophysical and cytochemical aspects of hypokinesis. Proceedings of the XVIII Congress MAF [International Astronautical Federation]. Belgrade, 1967, Varshava, 1968, p. 133-144.

Portugalov, V.V., Il'ina-Kakuyeva, Ye.I., Starostin, V.I. et al. Structural and cytochemical changes in muscles of rats given restriction of mobility. Archives of Anatomy, 1971, v. 61, N 11, p. 82-91.

Portugalov, V.V., Rokhlenko, K.D., and Savik, Z.F. Changes in the red soleus muscles with reduced function. Archives of Anatomy, 1975, v. 68, N 2, p. 11-18.

Savina, Ye.A. Comparative evaluation of changes in the hypothalamus-pituitary-adrenal system in rats from the biosatellites "Cosmos-605" and "Cosmos-782". X Symposium on Space Biology and Medicine. Sukhumi, 1977, p. 58-59.

Savina, Ye. A., Pankova, A.S., and Alekseyev, Ye.I. Morphologic manifestations of functional displacements in the hypothalamus-pituitary-neurosecretory system and kidneys of rats exposed to the effects of space flight. Space Biology and Aerospace Medicine, 1977, N 5, p. 72-76.

Chernigovskiy, V.I. Interoreceptors. Moscow, 1960.

Shvetz, V.N. and Portugalov, V.V. Space flight effects in hematopoietic function of bone marrow of rats. Aviation, Space and Environmental Medicine, 1976, v. 57, N 7, p. 746-749.

Shvetz, V.N. and Portugalov, V.V. Influence of space flight factors on erythropoiesis. Bulletin of Experimental Biology and Medicine, 1977, v. 83, N 2, p. 238-240.

Shubich, M.G., Goryacheva, L.L., Dudetskiy, et al. Histochemical study of digestive organs in rats after flight on "Cosmos-605". Space Biology and Aerospace Medicine, 1977, N 3, p. 40-44.

Yagodovski, V.S., Triftanidi, L.A., and Gorochova, G.P. Space flight effects on skeletal bones of rats (light and electron microscopic examinations). Aviation, Space and Environmental Medicine, 1976, v. 47, N 7, p. 734-738.

Yagodovski, V.S., Triftanidi, L.A., and Gorochova, G.P. The influence of space flight on skeletal bones in rats. Space Biology and Aerospace Medicine, 1977, N 1, p. 14-20.

Yakovleva, V.I. The dynamics of lipid content in the liver of rats placed on the biosatellites "Cosmos-605" and "Cosmos-782". Archives of Anatomy, 1977, v. 73, N 10, p. 39-43.

Ellis, J.T., Kraft, L.M., Lushbaugh, C.C., Humansen, G.L. et al. Evaluation of viscera and other tissues. Appendix III. Aviation, Space and Environmental Medicine, 1975, v. 46, p. 641-642.

9139
CSO: 1870

PUBLICATIONS

UDC: 628.147.22

BIOLOGICAL DAMAGE TO MATERIALS AND PREVENTION THEREOF

Moscow BIOPOVREZHDENIYA MATERIALOV I ZASHCHITA OT NIKH (Biological Damage to Materials and Prevention Thereof) in Russian 1978 signed to press 28 Mar 78, pp 2, 304, 218-220

[Annotation, foreword by Ye. M. Lebedev, scientific secretary of the scientific council for biological injuries, USSR Academy of Sciences, and table of contents from book edited by Prof I. V. Starostin, doctor of biological sciences, published by the Scientific Council for Biological Injuries of the USSR Academy of Science, 560 copies, 232 pages]

[Text] Annotation

This is a collection of papers dealing with species composition, ecology and morphology of microorganisms, fungi, marine invertebrates, insects and rodents which are the sources of biological injuries and interference, and which cause significant detriment to the national economy of our country. Much attention is given to classifying biological damage, methods of detecting it quickly, methods of evaluating resistance to biological organisms, means of protecting raw material, fabrics, engineering devices from biological damage.

The authors of this collection include scientists from Academy and sectorial institutes who are working actively in the area of biological injuries, as well as practitioners with extensive industrial experience in the control of biological damage.

This collection is intended for a wide range of scientific workers, engineers and technicians dealing with problems of biological injuries.

Foreword

At the present time, problems of intensification of practical use of the results of scientific research have acquired exceptional importance. One of the main objectives of the 10th Five-Year Plan is to improve the quality, reliability and durability of the national product. Among these problems, a prominent place is held by problems of increasing the resistance of

materials, goods and installations from biological organisms and being overgrown by them, problems of protection against functional interference, fouling, damage, obstruction and corrosion resulting from the presence and vital functions of organisms.

In the 3 billion years of evolution of life on earth, organisms have acquired the capacity to affect most natural substances, directly or indirectly. People have encountered the results of such effects, deleterious to industrious activity, since antiquity. Even in the days of natural farming, some means of protection were found in processing raw material, storing and using products. Development of trade and navigation [seafaring] aided in selection of the most reliable measures. Some of the ancient discoveries, for example, the use of copper compounds as protection against fungi, marine borers and fouling organisms, have not lost their value to this day. Some fell by the wayside in the Middle Ages, when shop specialization of industry occurred. But even in our times, the distance between the producer and consumer does not always permit the former to evaluate the true durability and resistance to organisms of his products. Not infrequently, the visual evaluation of bioresistance of materials on the basis of growth on their surface of a mixture of molds, which is practiced abroad, does not guarantee fitness of the product under real natural and operating conditions.

Many organisms (microorganisms, fungi, algae, marine invertebrates, insects, rodents and birds) can damage raw material, products and installations; they can cause corrosion or create functional interference. The problem of protection against biological damage and fouling became more acute with the intensive development of rivers, soil, uninhabited territories and exploration of space, minerals of land and sea. People often cause the spread and manifestation of detrimental effects unintentionally. Pollution of the environment by excessive heat, organic substances and fertilizers is also a contributing factor. Most "synthetic" and fuel-lubrication materials do not have sufficient biostability. Many complex modern instruments and installations have elements that are vulnerable to organisms.

Problems of biostability, imperviousness to fouling and reliable protection against biointerference are particularly important to communication equipment, transport, industrial, power plants and housing, household and stored objects and to the preservation of priceless cultural monuments.

According to foreign estimates, the loss referable to direct biological damage alone exceeded 3% of industrial production in the early 1970's. These estimates did not include the following: biological damage erroneously attributed to wear, aging and corrosion; 2) functional interference due to fouling of functional parts of equipments and ships, obstruction and fouling of pipes, etc.; 3) losses due to collisions between aircraft, rockets and birds; 4) damage to so ed goods, household products, as well as cultural monuments. For this reason, the true losses are even greater.

Almost all organisms, those that are destructive and fouling organisms, are present in nature on a mass sclae. They play a useful part in productivity of the biosphere and self-purification of water, air and soil, which is needed by mankind.

For this reason, to protect the environment one should only implement selective, local measures. Development thereof, use in operating and overhauling equipment require the mandatory involvement of biologists specializing in ecology of biological damage and fouling organisms.

A number of publications of the Scientific Council for Biological Damage, published in 1972-1976, as well as books dealing with biology of fouling organisms and biostability of cellulose and polymer materials disseminate such information: books, documents, textile, wood-pulp and museum material, published by academic and sectorial institutions.

The papers in this collection were written on the basis of scientific reports delivered by the authors at sessions of the Council in 1973-1977.

Contents

10,657
CSO: 1870

END