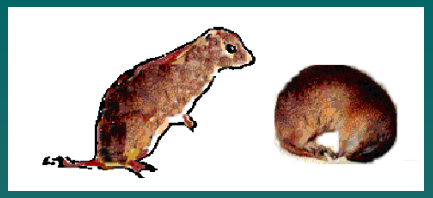

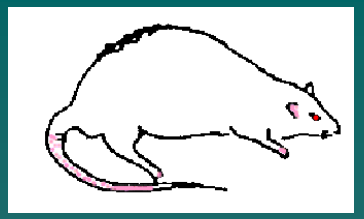

ZIMSKI SAN: tekunice, kosmonauti i Beogradska škola fiziologije

Institut za fiziologiju i biohemiju, Biološki fakultet,

Univerzitet u Beogradu

Beograd, 13. 03. 2017.

Can Humans Ever Harness the Power of Hibernation?

Scientists want to know if astronauts can hibernate during long spaceflights. First, they need to understand what hibernation is

Mozda bi Beogradska Skola Fiziologije trebalo da "posadi zastavicu" na teritoriju :-) – *Maja Đurišić (Stanford)*

…e doormouse hibernates to conserve resources in harsh conditions. Similarly, scientists envision humans hibernating to endure long-distance space travel. (Sasha Fox Walters / iStock)

By **Ben Panko**
SMITHSONIAN.COM
JANUARY 18, 2017

Newsweek,
jan 2017

HOĆU DA ŽIVIM, ZAMRZNI ME!

- Ovo je priča o srpskom akademiku Radoslavu Anđusu, koji je 1951. zamrzavao pacove
- Zamrzavanja ljudi radi života u budućnosti ne odriču se ni Rusi. I to će se desiti uskoro

Branka Mitrović

NIJE SLUČAJNO NASTALA izreka „pazi šta želiš". Svedok je boginja Eos, jedna od junakinja grčke mitologije. Od moćnog Zevsa tražila je da podari besmrtnost njenom ljubavniku Titonu. Ali uživajući u Titonovim tadašnjim „uslugama", zaboravila je na jedan važan detalj - večnu mladost. Ljubavnik je ostario, eno ga danas: oronuo, zatvoren, sam sebi mrmlja u bradu...

Pobediti smrt, starost ili bolest i ostati „u igri" i danas je želja mnogih. Čini se da je potraga za šansom da se živi što duže, ako je već besmrtnost pod znakom pitanja, intenzivnija nego ikad. Neki rešenje vide u zamrzavanju sopstvenog tela i novom životu posle smrti. Naravno, ako tehnologija uznapreduje... Da li je ideja da se probudite za nekih stotinak godina pusto zavaravanje?

Ništa od ovih pitanja nas ne bi mučilo da na njima nije poradio naše gore list. Srpski akademik Radoslav Anđus (1926-2003) bio je profesor fiziologije i biofizike na Univerzitetu u Beogradu. Objavio je više od 190 radova u domaćim i međunarodnim časopisima, analizirajući oblast termofiziologije. O hipotermiji (smanjivanju telesne temperature), hibernaciji (usporenom metabolizmu), biološkim ritmovima, temperaturnoj adaptaciji, aklimatizaciji, ali i o krionici, kojoj zaštiti tela od propadanja malo ko je znao kao on. Kratko rečeno: biofizičko modeliranje je držao u malom prstu!

Pošto je Narodna biblioteka bila uništena tokom Drugog svetskog rata, Radoslav Anđus nije imao gde da pročita da su naučnici do tog trenutka uspevali da spuste temperaturu miševa samo do 15 stepeni, pre nego što bi životinje izdahnule. Umesto toga, on je osmislio tehniku kojom je uspevao da oživi životinje čiju je telesnu temperaturu prethodno spustio na nula stepeni.

Njegova tehnika, koju je svetu predstavio 1951. godine, bila je zapravo veoma jednostavna. Prvo bi telesnu temperaturu pacova (u normalnom stanju ona iznosi 37 stepeni) spustio na oko 20 stepeni, tako što bi životinje stavio u teglu, koju bi onda odložio u frižider. Pacovi bi udisali vazduh koji su sami izbacili, koji je bio put ugljen-dioksida, od čega bi postali omamljeni - bila je to neka vrsta primitivne anestezije.

Prvi institut koji se bavi zamrzavanjem ljudi u Americi uspeo je da preživi 1984. godine zahvaljujući donaciji porodice Nikolić u iznosu od 5.359 dolara

Tako omamljene pacove stavljao je u led, gde bi im se telesna temperatura spustila na jedan stepen. U ledu bi proveli 40-50 minuta.

Anđus je u prvom momentu pokušavao da pacove vrati u život tako što ih je stavljao u toplu kupku, ali ovi pokušaji nisu bili uspešni. Tada je shvatio da bi, pre nego što celo telo bude zagrejano, prvo trebalo zagrejati deo oko srca. Stavljao bi im zagrejanu špatulu na grudi i u isto vreme davao veštačko disanje. U prvim eksperimentima uspeh je bio delimičan - samo 20 odsto pacova živelo je duže od 24 sata.

Kad je 1955. godine Anđus upoznao proslavljenog profesora Smita, pokušali su da odgovore na pitanje da li je velika smrtnost nastajala zbog lošeg procesa hlađenja ili zbog lošeg procesa reanimacije. Odlučili su da za zagrevanje koriste specijalne lampe, i rezultati su bili fantastični - čak 76 odsto pacova živelo je duže od 24 sata, a više od 68 odsto pacova živelo je i preko 66 dana. Bio je ovo veliki napredak u nauci. Ono što je bilo posebno zanimljivo je činjenica da kod životinja nisu primećene nikakve neurološke promene i da su im moždane funkcije bile na istom nivou kao i pre zamrzavanja.

U naučnim krugovima Anđus je, na planetarnom nivou, slavljen na svakom koraku. Naučna fantastika je polako, ali sigurno uz Anđusa počela da postaje stvarnost.

Analizirajući radove akademika Anđusa nastavnik fizike Robert Etinger 1964. uvodi u upotrebu koncept krionike, da bi samo nekoliko godina kasnije, 1972, bila osnovana kompanija „Alkor", koja je prvu zvaničnu krioprezervaciju (zamrzavanje tela) obavila 1976.

ZNAČAJ PORODICE NIKOLIĆ

SRBIJA JE IMALA značajan doprinos u razvoju navedenog instituta. Kako se navodi u zvaničnom dokumentu iz novembra 1984. godine, „Alkor" bio je u velikim dugovima, da bi im se onda javila porodica Nikolić, koja ih je, kako se navodi, „spasla".

U dokumentu stoji: „Pokazujući svoju ljubav prema

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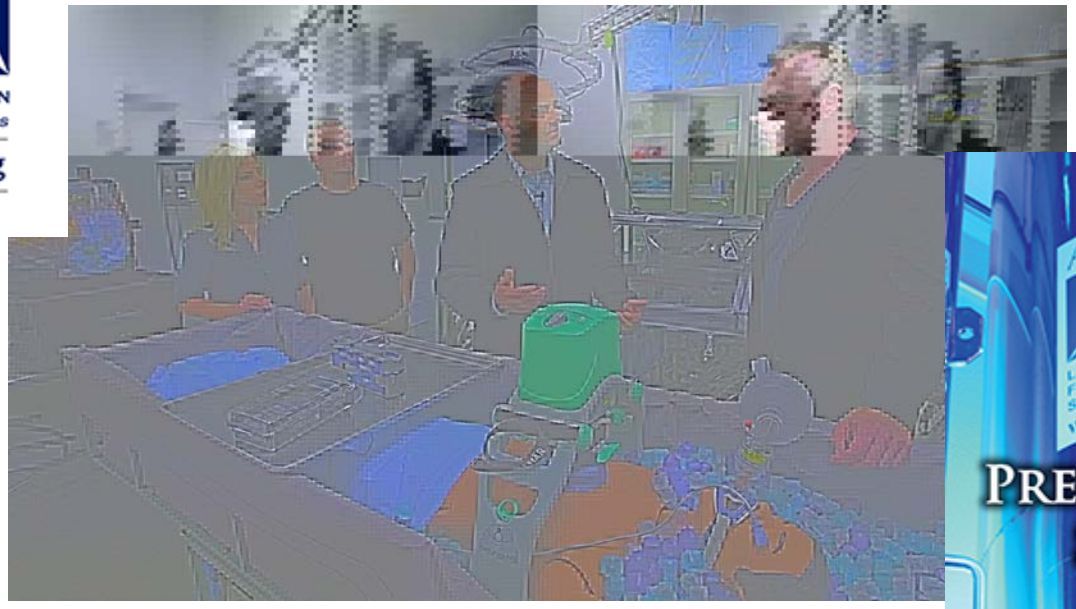
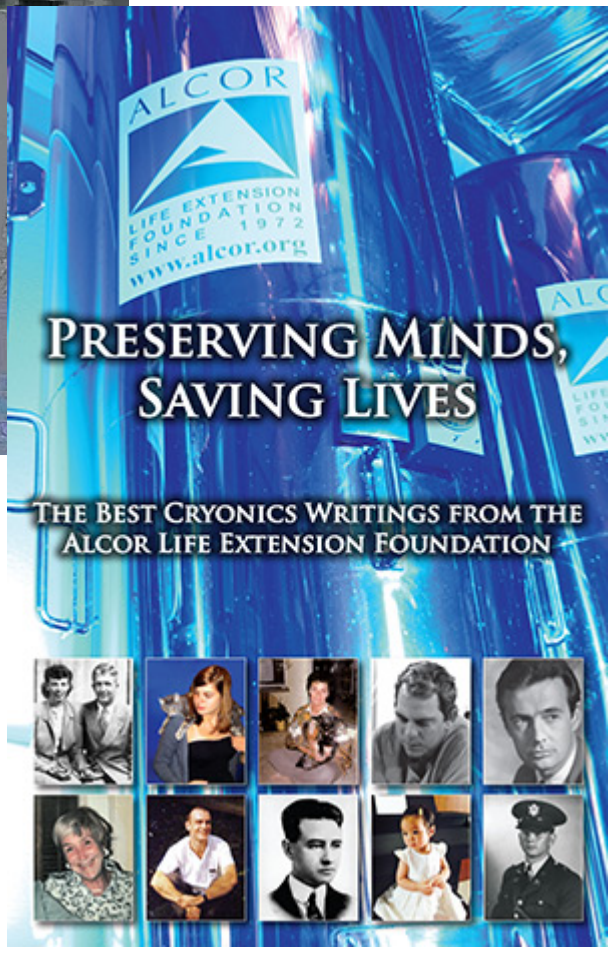




Ivan Djaja (Jean Giaja)

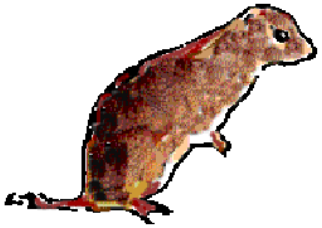
(1884-1957)

Osnivač Katedre za fiziologiju, 1910. godine

Beogradska škola fiziologije
1910 - danas

- Ivan Djaja
- Branimir Maleš
- Stefan Djelineo
- Vojin Popović
- Leposava Marković-Djaja
- Lazar Jovančić
- Radoslav Andjus
- Vojislav Pavlović
- Vojislav Petrović

U društvu sa prof. Djajom i dr Kurierom, sekretarom Francuske akademije nauka, na terasi Fiziološkog zavoda



Termofiziologija

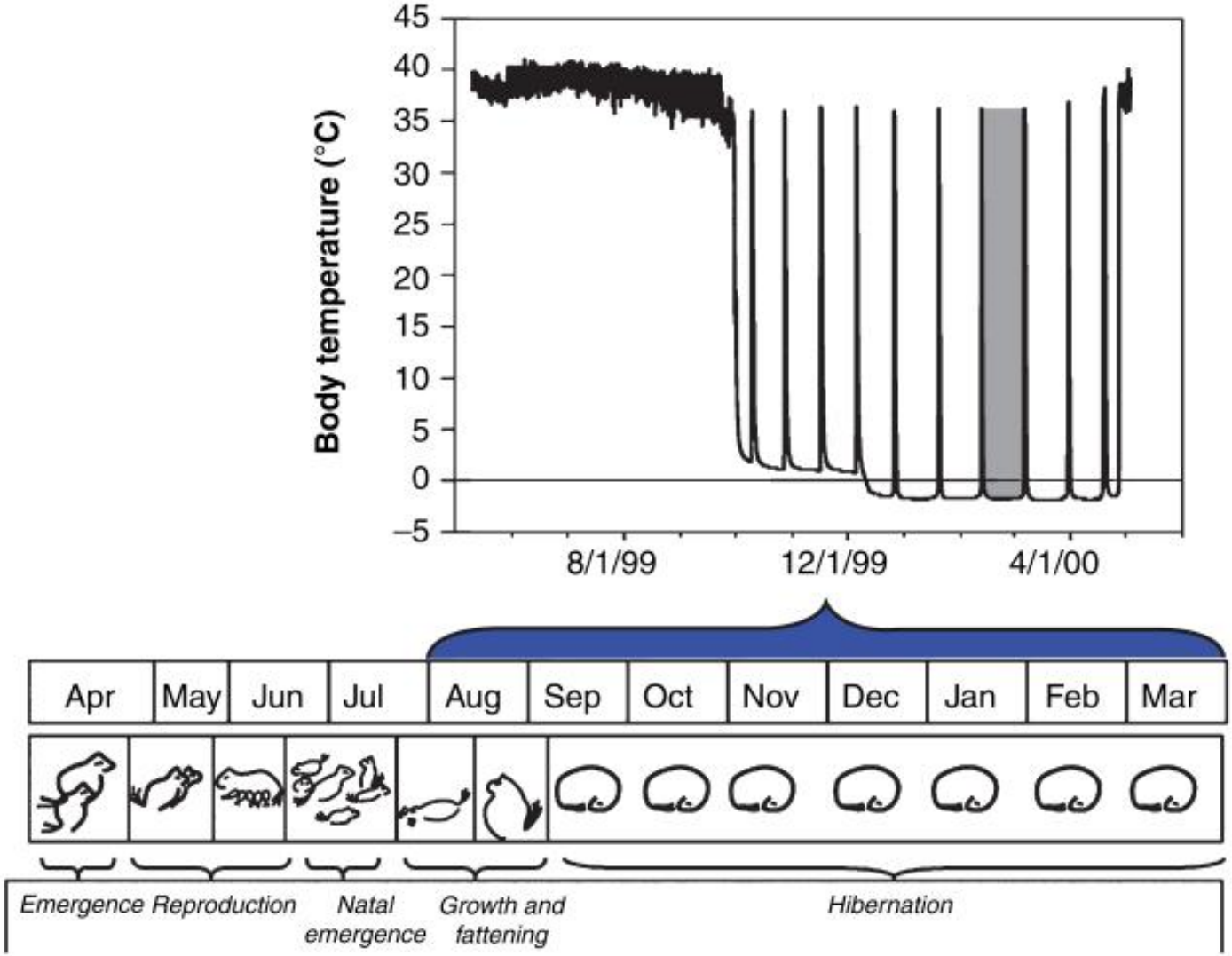
- Homeotermne životinje: nehibernatori i hibernatori

- Hibernacija predstavlja stanje smanjene telesne temperatrure, pri čemu te životinje zdržavaju sposobnost da vrate telesnu temperaturu na normalnu vrednost bez apsorbcije spoljašnje toplote (mrmot, hrčak, tekunica, bodljikavo prase, slepi miš…). Te životinje preživljavaju zimu smanjivanjem svoje telesne tempertaure na nekoliko stepeni iznad nule - „zimski san"

- Nehibernatori izloženi niskim temperaturama stvaraju toplotu drhtanjem i povećanjem metabolizma sve dok ne iscrpe termogenetske rezerve.

dr Stanko Stojilkovic, NIH (SAD)

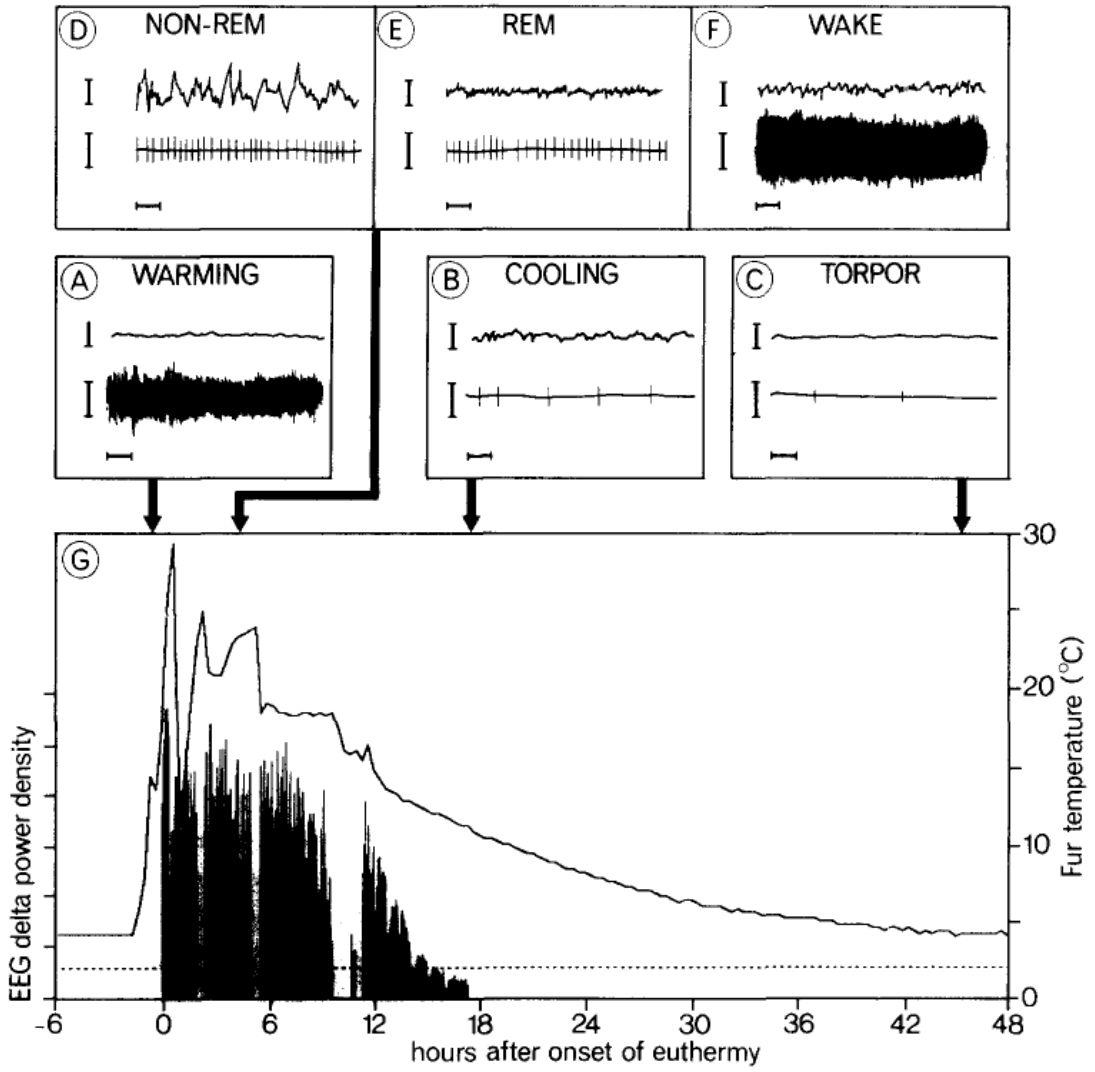
Godišnji ciklus prezimara



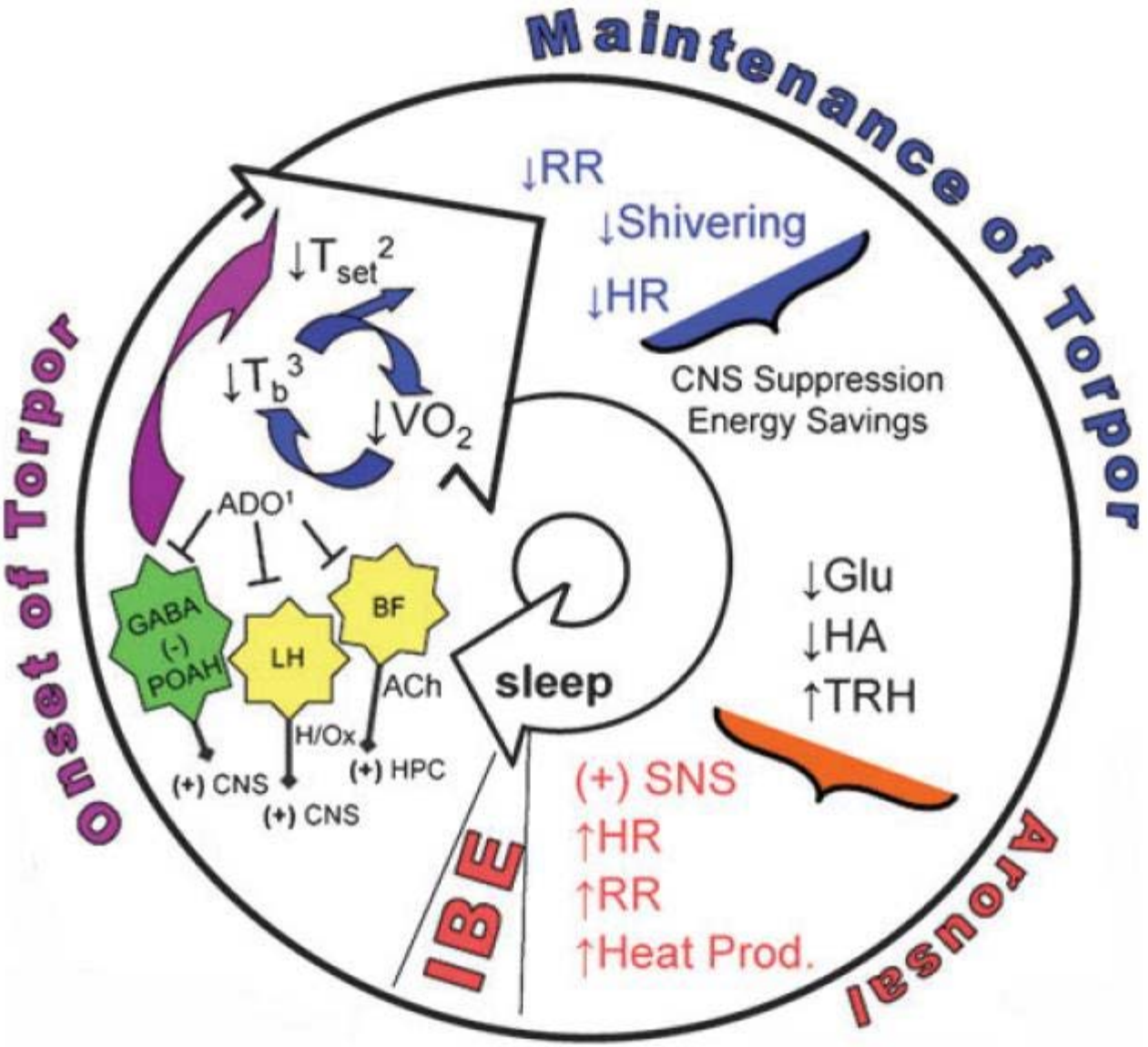
Zimski san

Zagrevanje radi spavanja – san tek pri izlasku iz hibernacije!

Daan et al, 1991

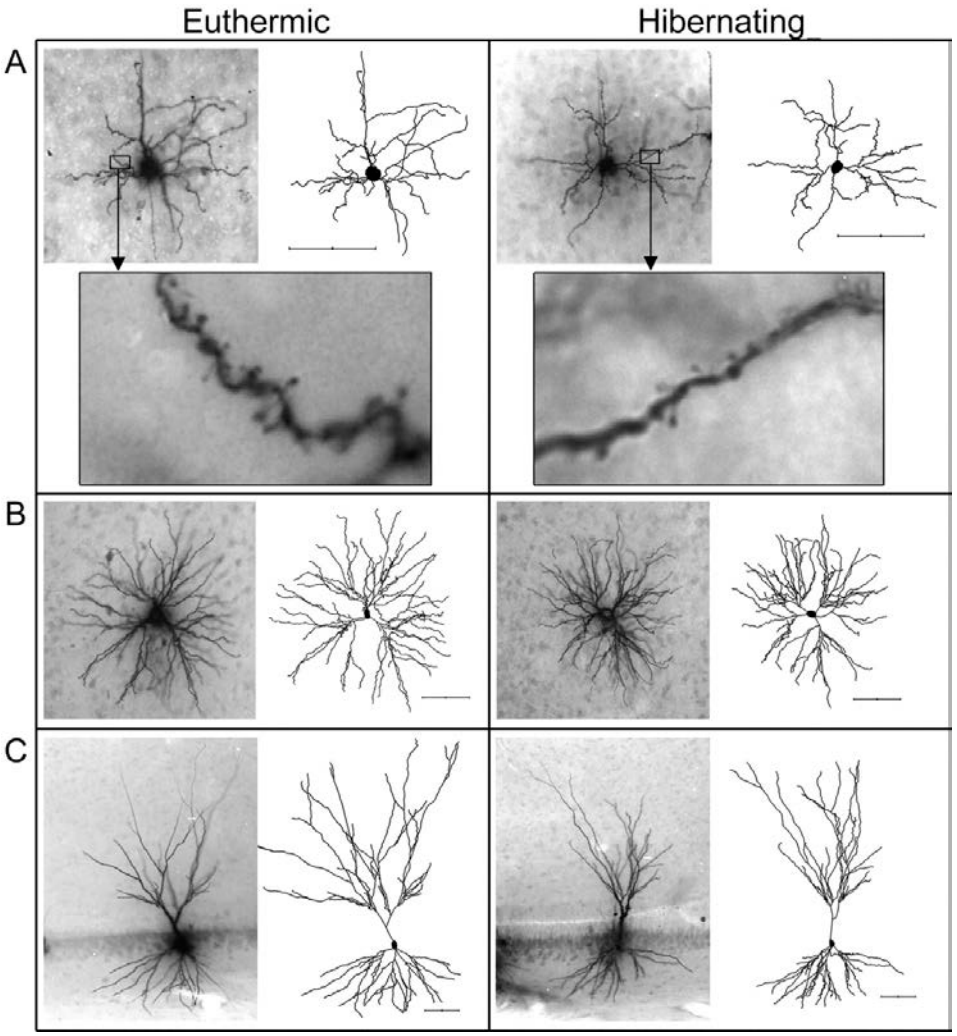


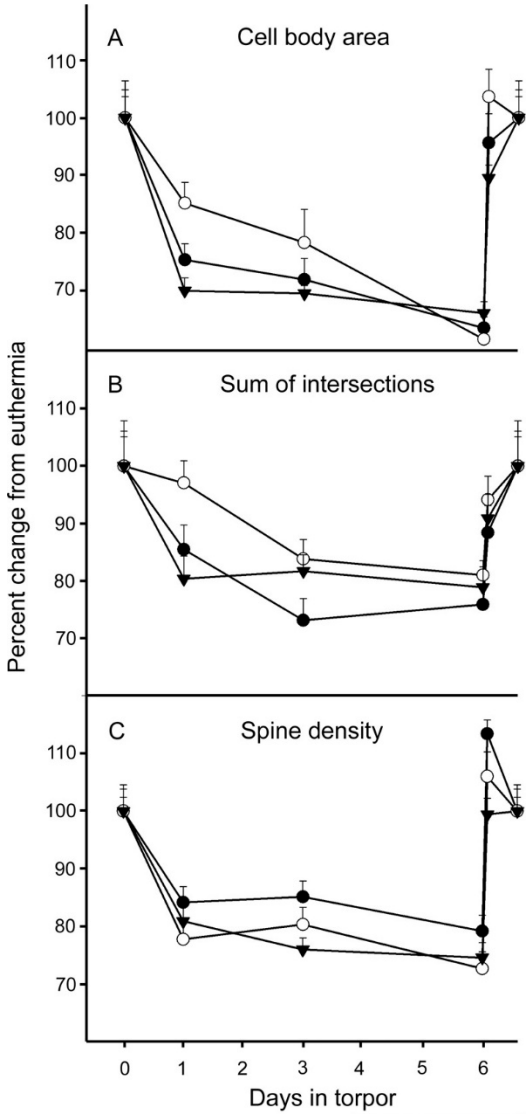
MEHANIZAM CIKLUSA HIBERNACIJE



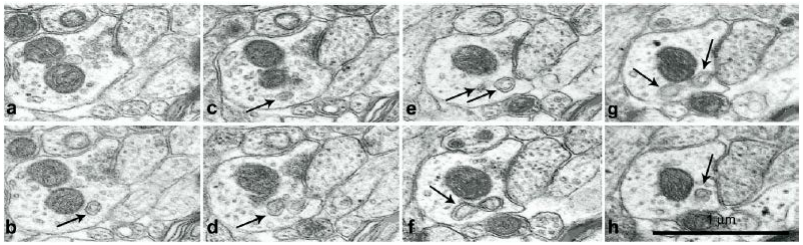
Drew et al., 2007

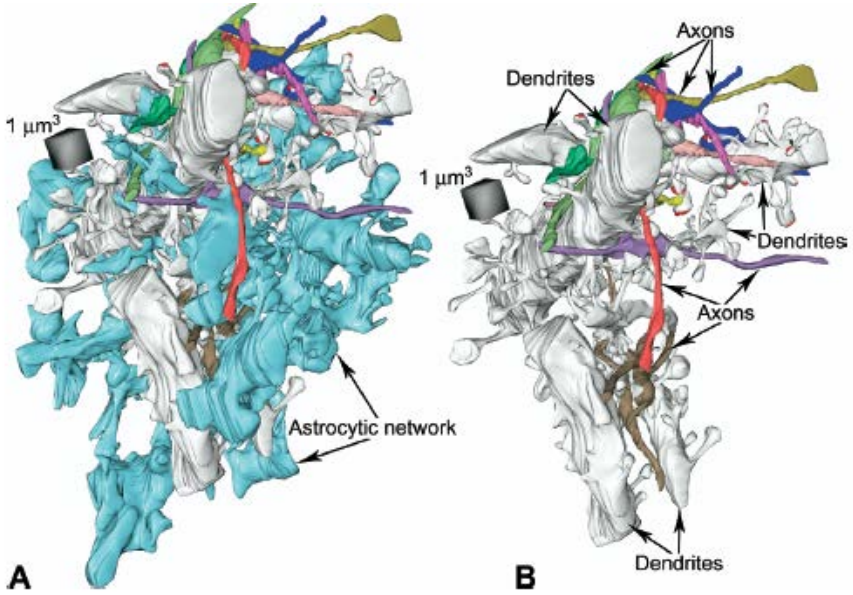
NEURONI I SINAPSE TOKOM HIBERNACIJE

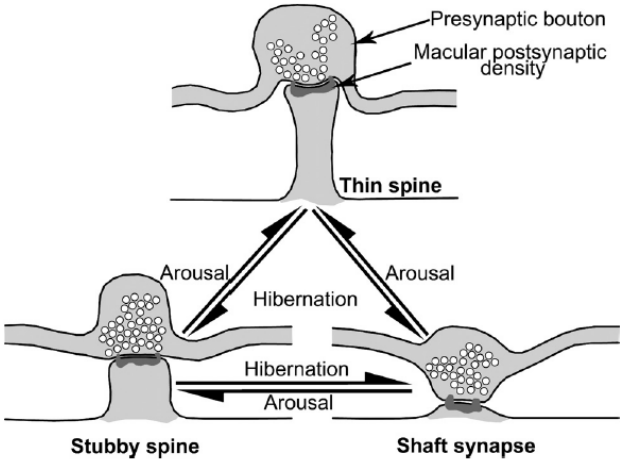




Christina G. von der Ohe et al. J. Neurosci. 2006;26:10591-10598





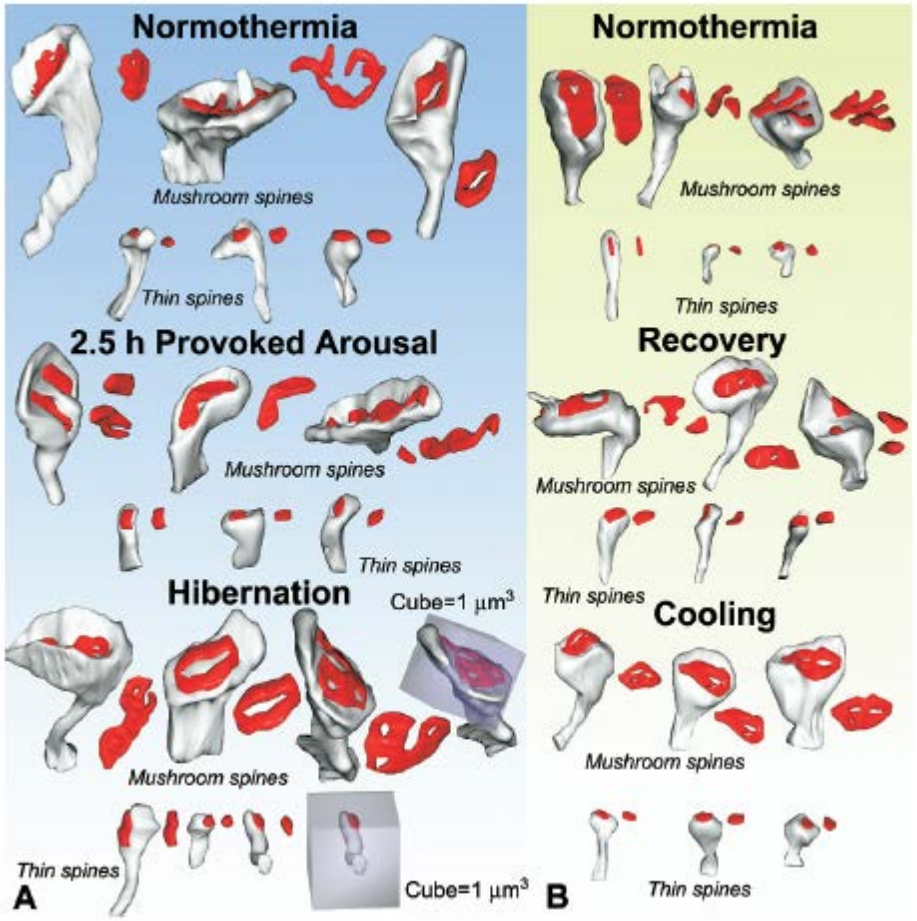


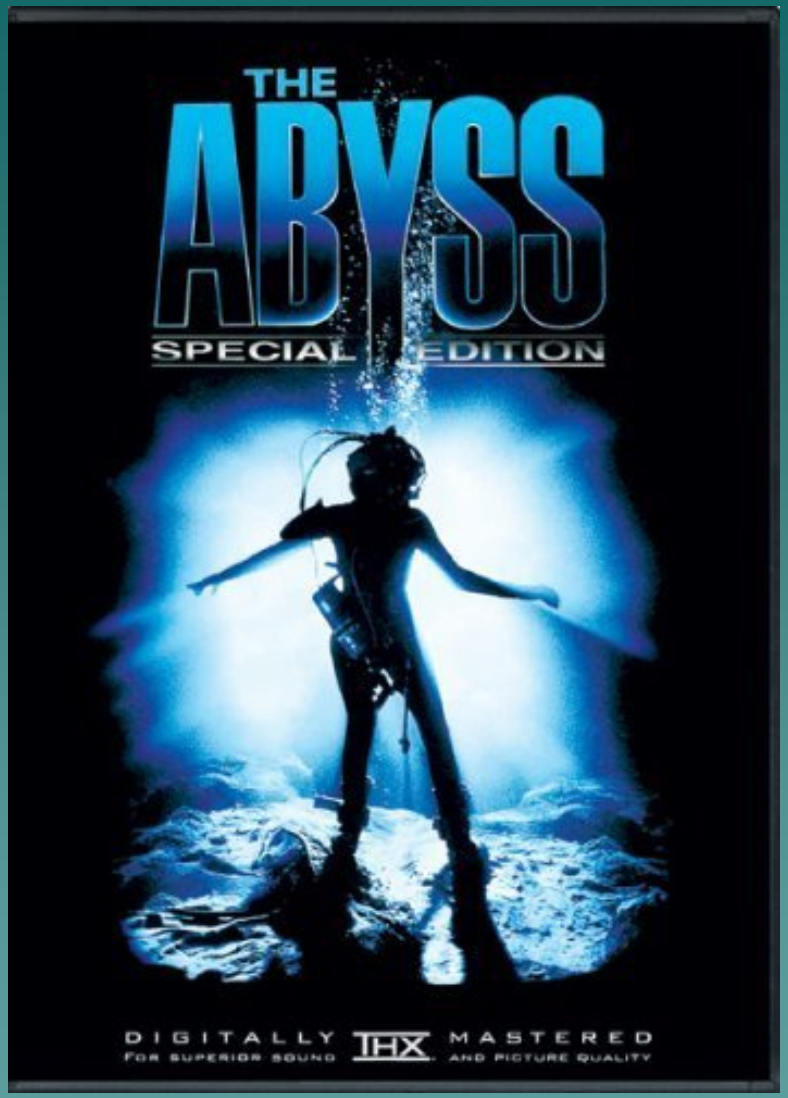
Neuroscience 149 (2007) 549–560

REVERSIBLE REDUCTION IN DENDRITIC SPINES IN CA1 OF RAT AND GROUND SQUIRREL SUBJECTED TO HYPOTHERMIA–NORMOTHERMIA *IN VIVO*: A THREE-DIMENSIONAL ELECTRON MICROSCOPE STUDY

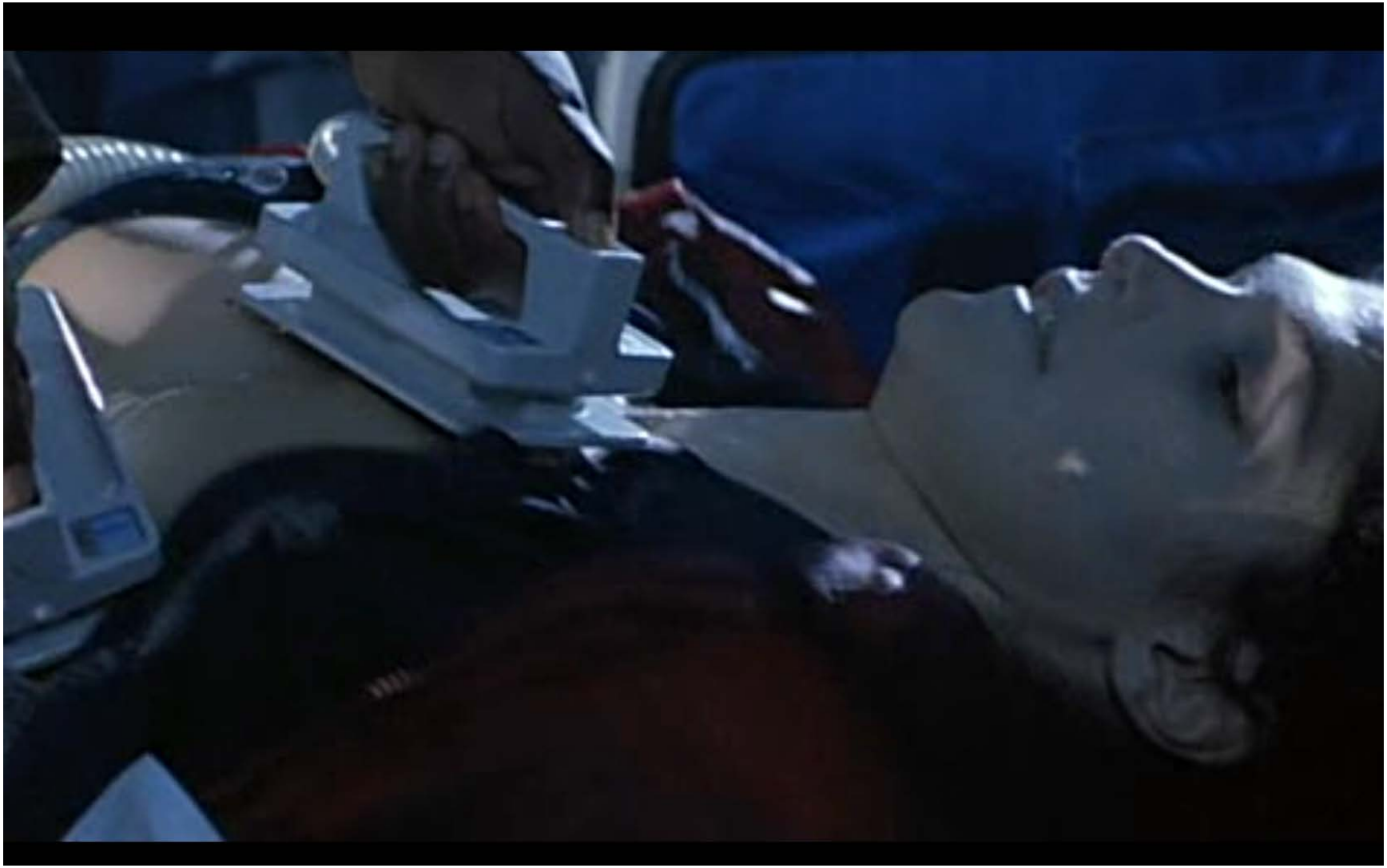
V. I. POPOV,[a,b] N. I. MEDVEDEV,[a] I. V. PATRUSHEV,[b] D. A. IGNAT'EV,[b] E. D. MORENKOV[c] AND M. G. STEWART[a]*

Berger, 1998; Karkar et al., 2002; Colbourne et al., 2003; De Georgia et al., 2004), a topic considered earlier by Andjus and Smith (1955), and Andjus et al. (1955). Rela-




THE
ABYSS
SPECIAL EDITION
DIGITALLY THX MASTERED
FOR SUPERIOR SOUND AND PICTURE QUALITY

„This water....is only a couple degrees above freezing! I go into deep hypothermia, my blood'll go like ice water, right? My body systems will slow down, they won't stop... „



By CBSNews.com staff CBSNews.com staff CBS February 3, 2000, 2:06 PM

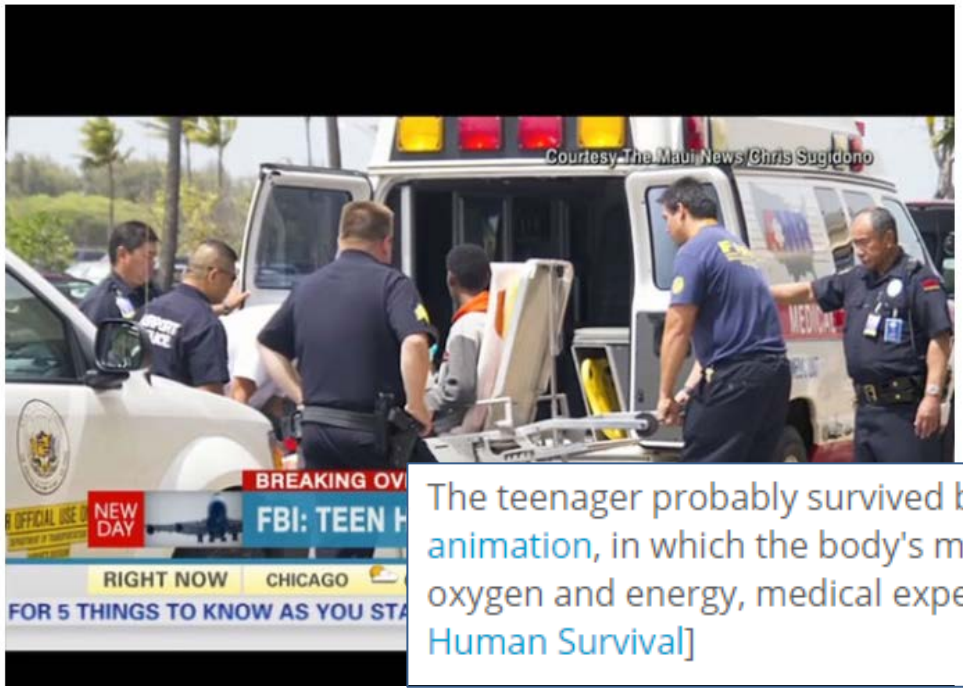
Frozen Woman: A 'Walking Miracle'

Live Science > Strange News

Airplane Stowaway May Have Survived in 'Suspended Animation'

By Tanya Lewis, Staff Writer | April 21, 2014 03:01pm ET

135 11 1 3 1740 MORE



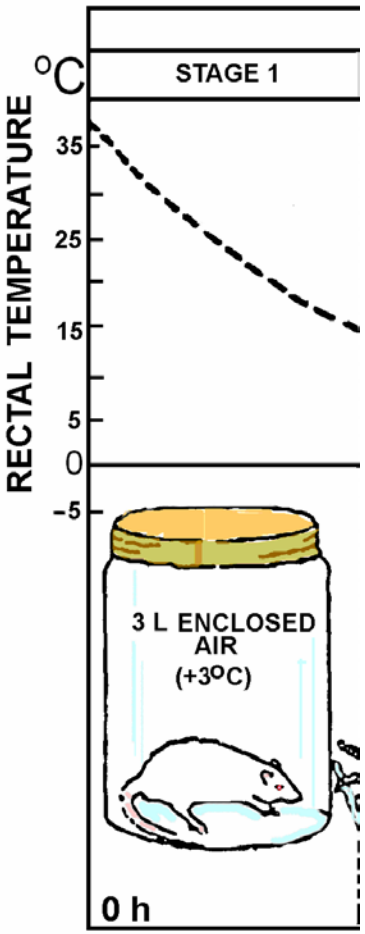
The teenager probably survived by entering a state of suspended animation, in which the body's metabolism slows down and requires less oxygen and energy, medical experts say. [Infographic: The Limits of Human Survival]

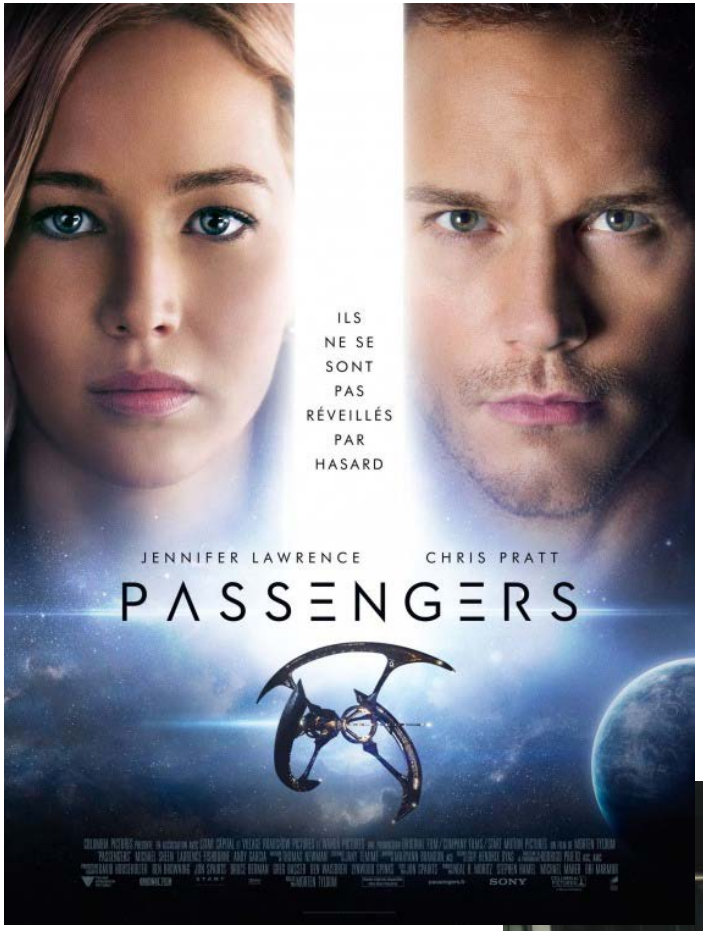
Ivan Djaja/Jean Giaja
(1884 – 1957)

- Respiratorna hipotermia - konfinovanjem

(*hiperkapnička hipoksija*) – primarna, snižava termogenezu (suprotno sekundarnoj, termolitičkoj hipotermiji)

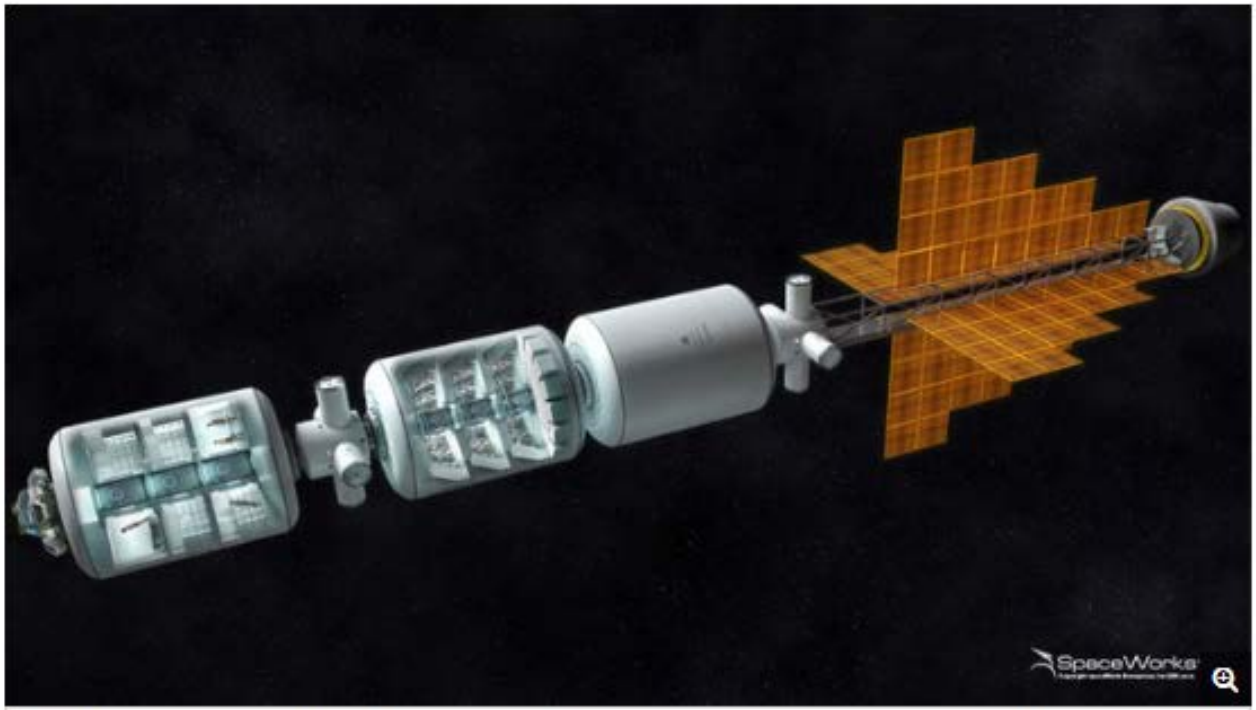
{ postepeno uklanjanje kiseonika +
CO_2 akumulacija }




ILS
NE SE
SONT
PAS
RÉVEILLÉS
PAR
HASARD
JENNIFER LAWRENCE
CHRIS PRATT
PASSENGERS
SONY

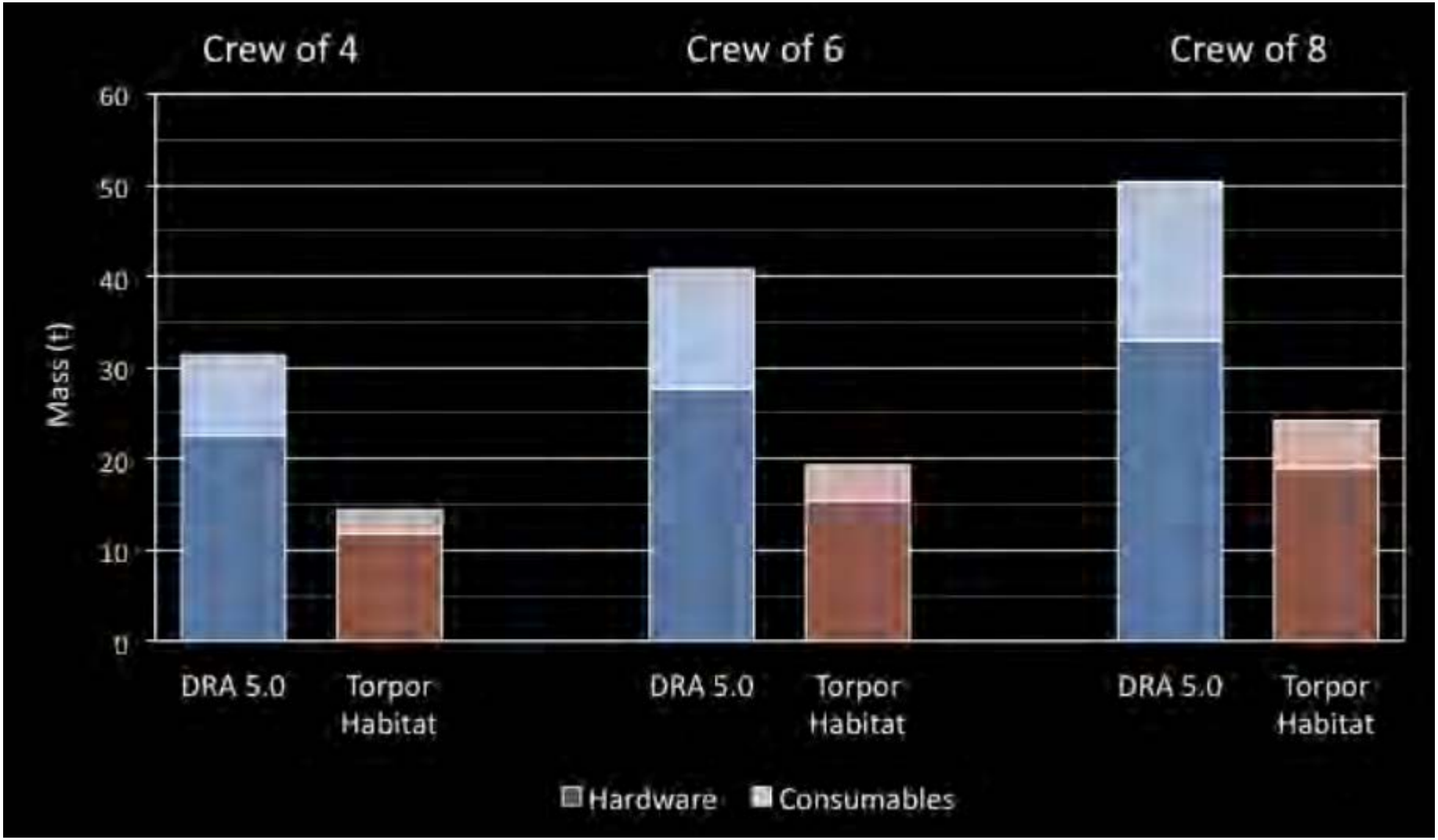
'Hibernating' Astronauts May Be Key to Mars Colonization

By Mike Wall, Space.com Senior Writer | August 30, 2016 07:00am ET

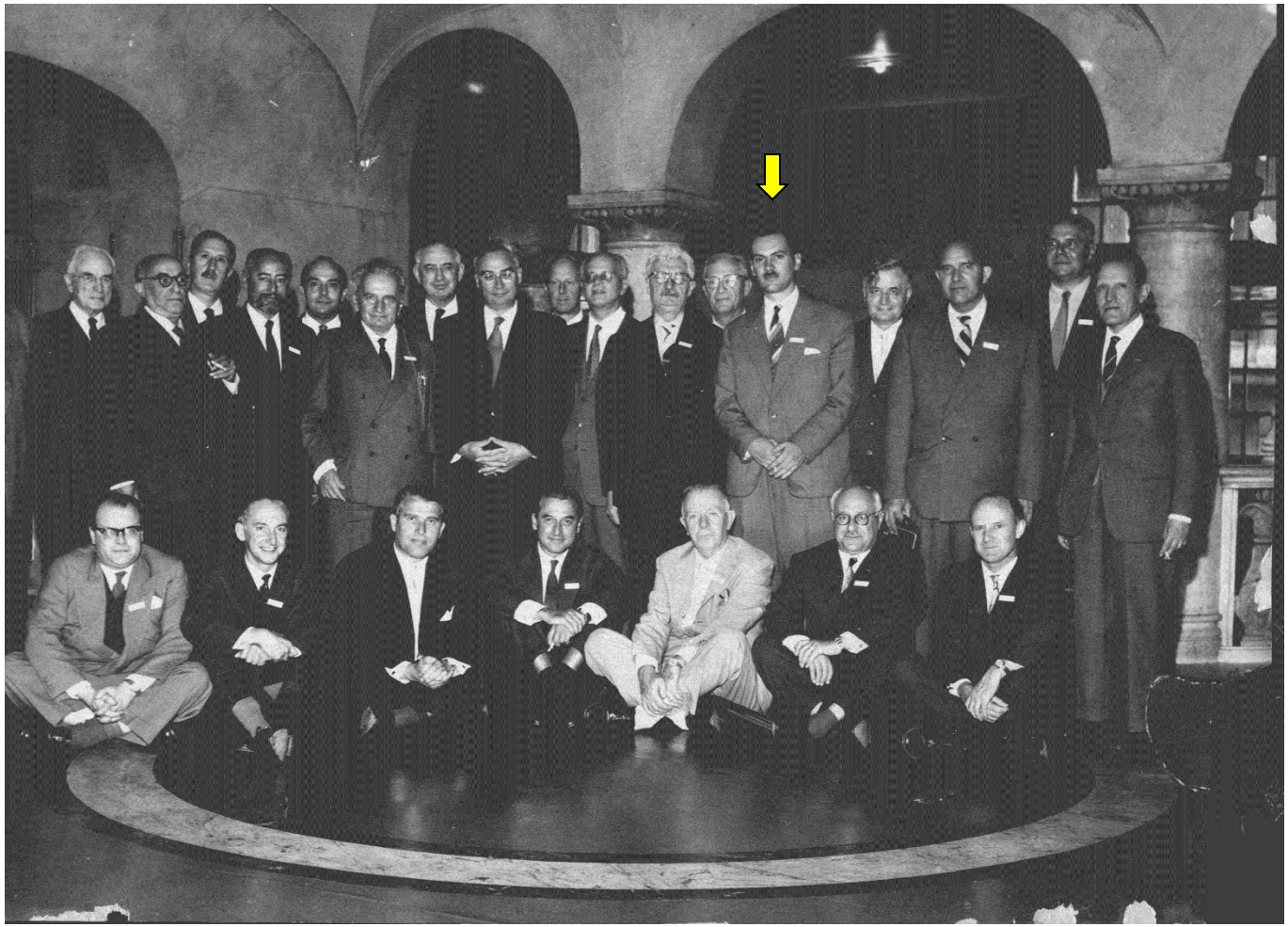


Artist's illustration of a "Mars Transfer Habitat" that could carry 100 colonists — 96 of them in a hibernation-like torpor state — to Mars.

Credit: SpaceWorks Enterprises


Crew of 4
Crew of 6
Crew of 8
60
50
40
30
20
10
0
Mass (t)
DRA 5.0
Torpor Habitat
DRA 5.0
Torpor Habitat
DRA 5.0
Torpor Habitat
Hardware
Consumables

Osnivačka skupština Medjunarodne akademije astronautike



Not in Trade

Reprint from

Second International Symposium on Man in Space, Paris 1965

Proceedings

Springer-Verlag · Wien and New York 1967

Tolerance to the Combined Effects of Hypothermia, Anoxia, and Ionizing Radiation

By

R. K. Andjus, Olivera Matic, and Nadezda Savkovic

Institute of Physiology, University of Belgrade,
and Institute of Nuclear Sciences, Belgrade, Yugoslavia

(With 8 Figures)

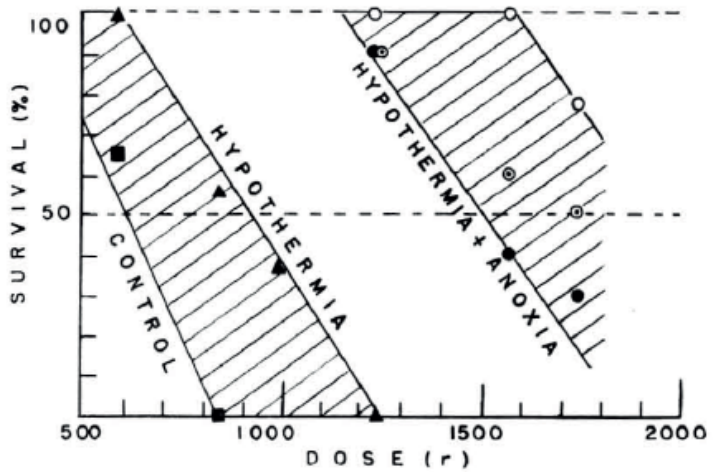


Fig. 6. Survival of animals protected by the combination of hypothermia (16°) and hypoxia during irradiation, compared to the survival of normothermic and hypothermic controls. Squares: normothermic controls (45 rats for each dose). Triangles: hypothermic controls (10—11 animals per dose); black dots: irradiation during post-occlusion phase I in hypothermia; circles with central dots: irradiation during phase II; open circles: irradiation during phase III (9—10 animals irradiated with each dose)

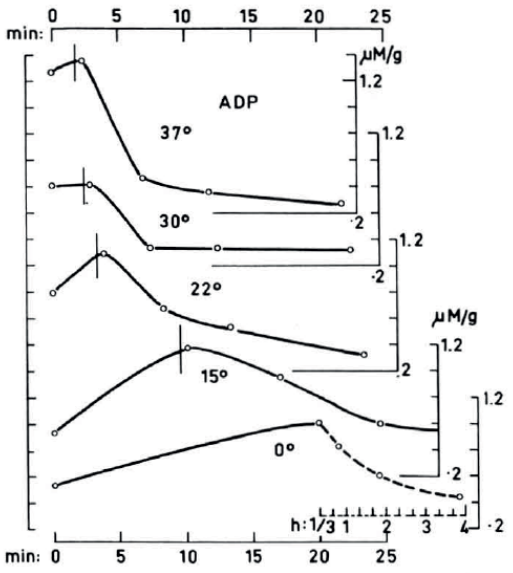


Fig. 4. Changes of ADP concentration in the brain at different levels of body temperature after tracheal occlusion. The end of the survival period is marked by a small vertical line on each curve. Means from experiments on 5 different animals for each experimental point. Data at 0° C were obtained in animals maintained in suspended animation (cardiac and respiratory arrest) induced by cooling the whole body in crushed ice from 15° to 0°, without occluding the trachea (from ANDJUS, HOZIC, and CIRKOVIC, unpublished [4])

Djaja: Primena hipotermije u medicini

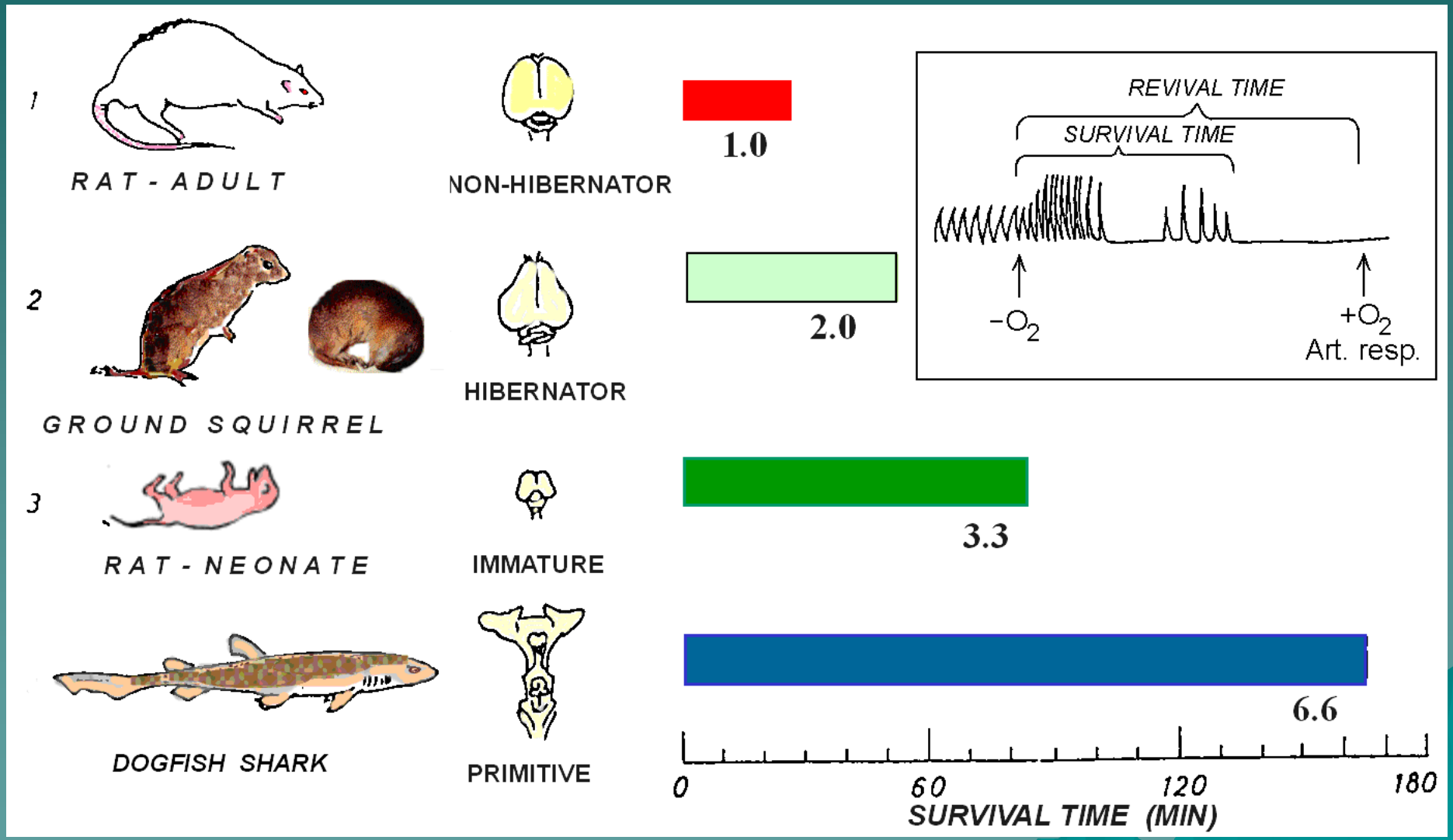
- Duboka hipotermija = idealna fiziološka anestezija
- Hipotermia izaziva energetski odmor = *fiziološki odmor* – normalno neostvariv u eutermniji
- Protekticija od
  - Asfiksije (hipoksije, ishemije i CO trovanje)
  - Insulinski šok i eksperimentalna uremija
  - Trovanje strihninom

Asfiksija (hipoksija)

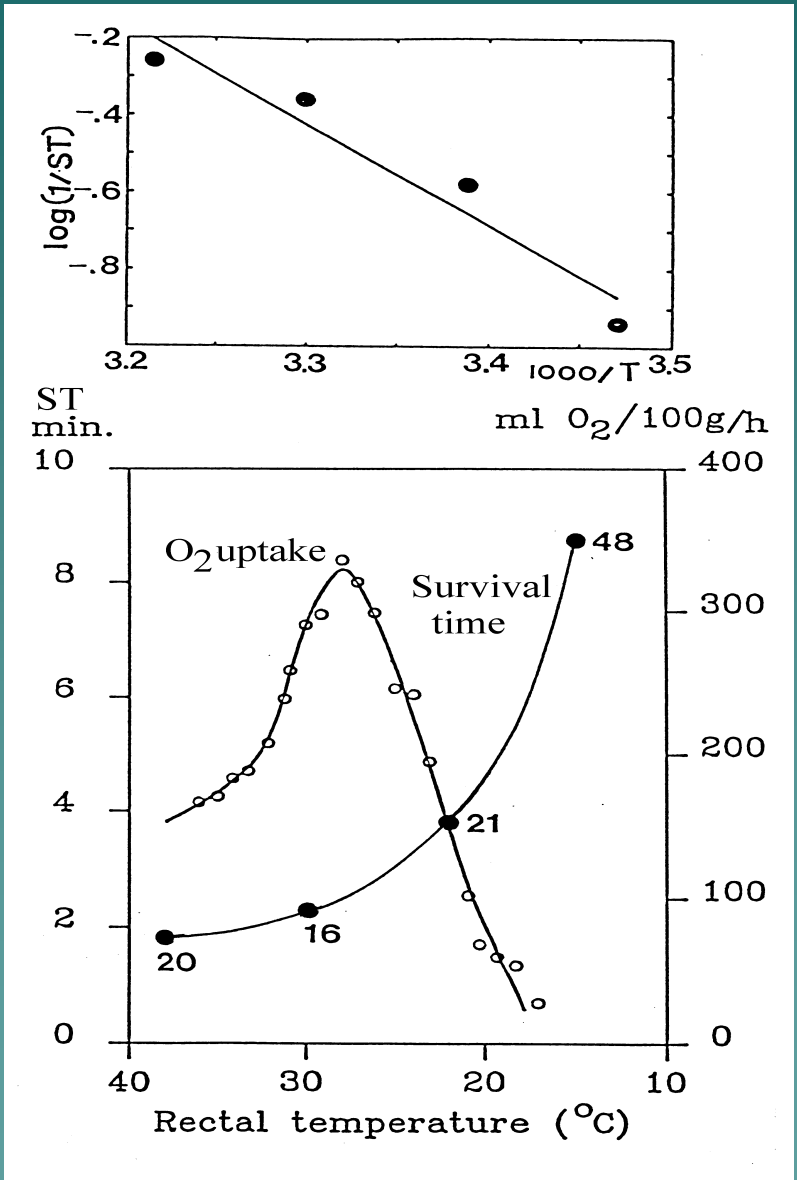
- Potencijacija funkcije srca u post-hipotermiji (*endogeni stimulativni faktori?)*

VREME PREŽIVLJAVANJA (SURVIVAL TIME)

BEZ KISEONIKA na $T_t = 15^oC$



VREME PREŽIVLJAVANJA
u funkciji telesne



Na 15°C:

- brzina usvajanja O_2 pada na <20%
- Vreme preživljavanja u asfiksiji je 5x duže

Đajina zaostavština ?!

The New York Academy of Sciences

Hypothermia — From Threat to Cure

Friday, September 19, 2008 | 7:30 AM - 5:30 PM
The New York Academy of Sciences

Presented by Columbia University School of Medicine and the New York Academy of Sciences

Long considered a threat to survival, hypothermia has received a considerable new look and use in clinical settings in the past 20 years. Recent animal and clinical studies have demonstrated the effectiveness of using hypothermia to treat cardiac arrest and offer a promising treatment paradigm for acute ischemic stroke.

Hypothermia: From Threat to Cure, a one-day conference will increase our understanding of the clinical benefits of hypothermia by examining it as an integrated biological response of the organism. This interdisciplinary meeting will first look at current clinical applications of hypothermia in settings such as neurocritical intensive care units, cardiac surgery, and animal experiments. Hypothermia will then be examined through the perspectives of cellular, thermal, and evolutionary biology. Participants will explore evidence found in biological, cellular, and molecular processes such as thermoregulation, energy metabolism, and immunology.

Questions addressed during this meeting will include: What determines whether cells live or die? What specific biological benefits accrue from turning the brain off with cold? How does temperature regulation affect the elderly (a large percentage of the stroke population)? What is the biological phenomenon of hibernations? How does cold regulate the biology of the individual — and from a larger perspective — how has the human species evolved to adapt to cold? These questions and more will be addressed in this comprehensive exploration of a powerful new tool in medicine and biology.

Scientific Organizing Committee

- **Jae H. Choi**, MD, Columbia University Medical Center
- **John Pile-Spellman**, MD, Columbia University Medical Center

Clinical applications of induced hypothermia

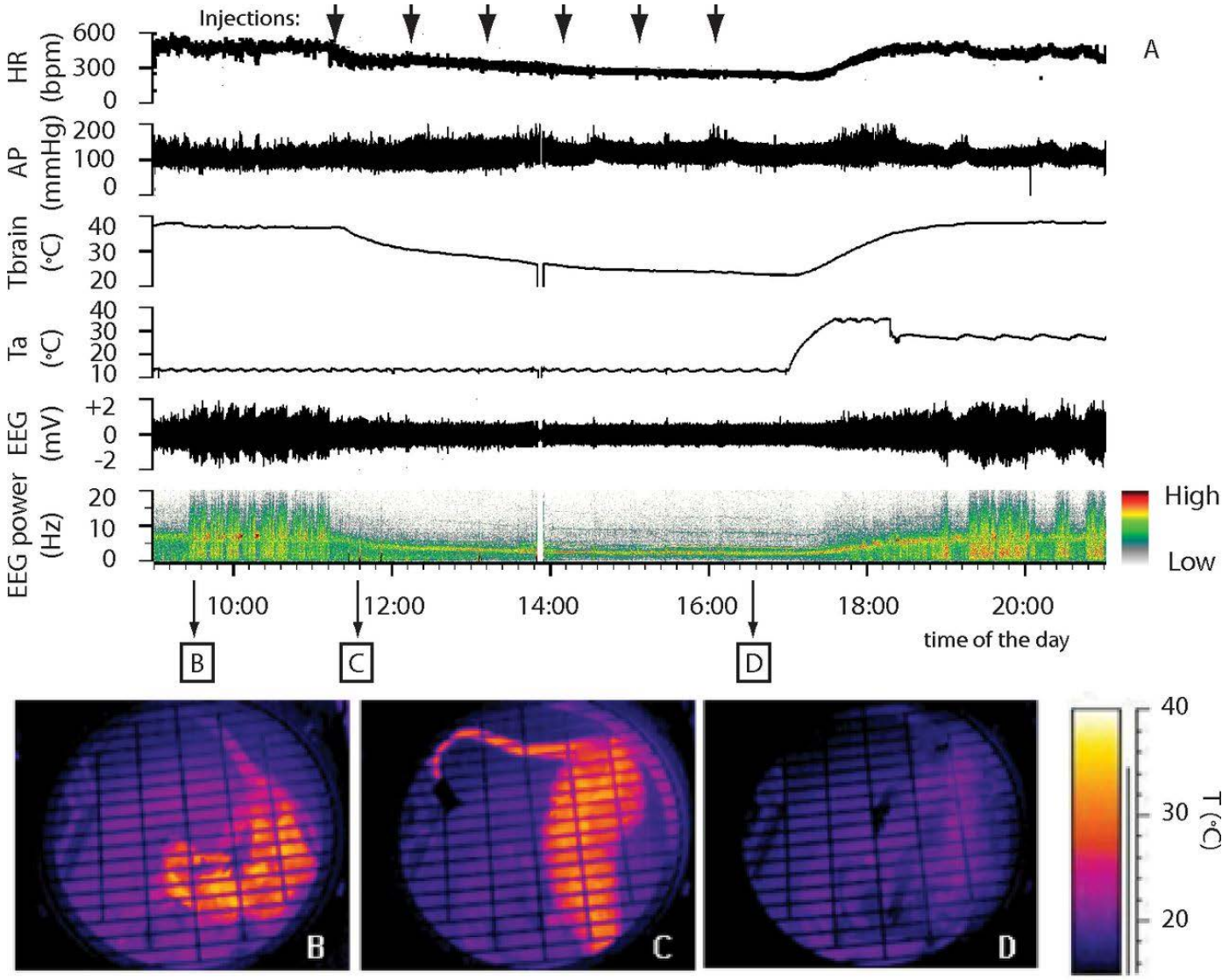
Mark Luscombe
John C Andrzejowski

Techniques used for induced hypothermia

The following techniques can be used to induce hypothermia:

(i) *Antipyretics*, for example, paracetamol.
(ii) *Fans*—may increase infection risk.
(iii) *Ice packs* to the femoral area, major vessels, and armpits. The packs must contain ice plus water to ensure a low temperature. The need changing frequently.
(iv) *Cold fluids*—this has a rapid effect, for example, crystalloid solution 30 ml kg^{-1}at 4°C for more than 30 min. This compensates for anticipated diuresis and helps maintain cerebral perfusion pressure (CPP).
(v) *Water filled blankets or garments* (e.g., Blanketrol)—these are effective with feedback control.
(vi) *Forced cold air*—this is hygienic but has no feedback control. It is very inefficient.
(vii) *Intravascular line*—this is very expensive but control can be excellent. Femoral lines are available.
(viii) *Bypass*—specialist (cardiac) areas only.
(ix) *Cooling caps*—these are mainly used in neonates and infants.

2006

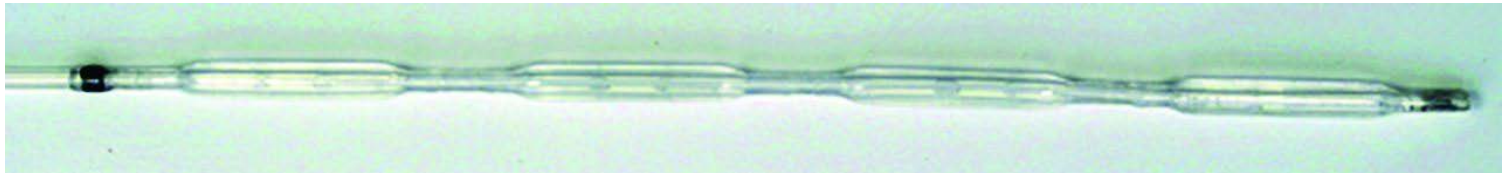


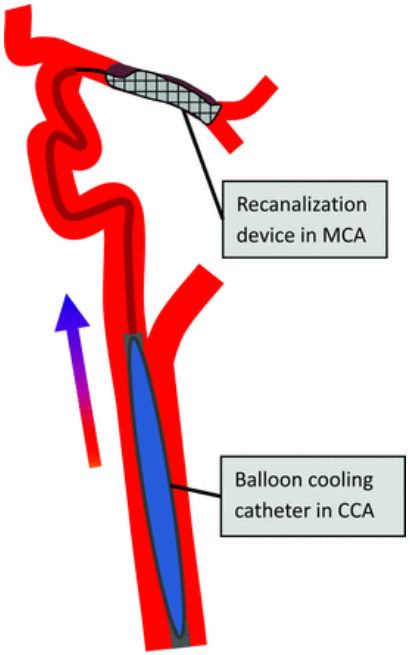
…To the best of our knowledge, these results constitute the first demonstration that a spontaneous activity (SA) state can be induced in a nonhibernator through the inhibition of a specific brain area belonging to the efferent arm of the central nervous pathways for thermoregulatory cold defense….

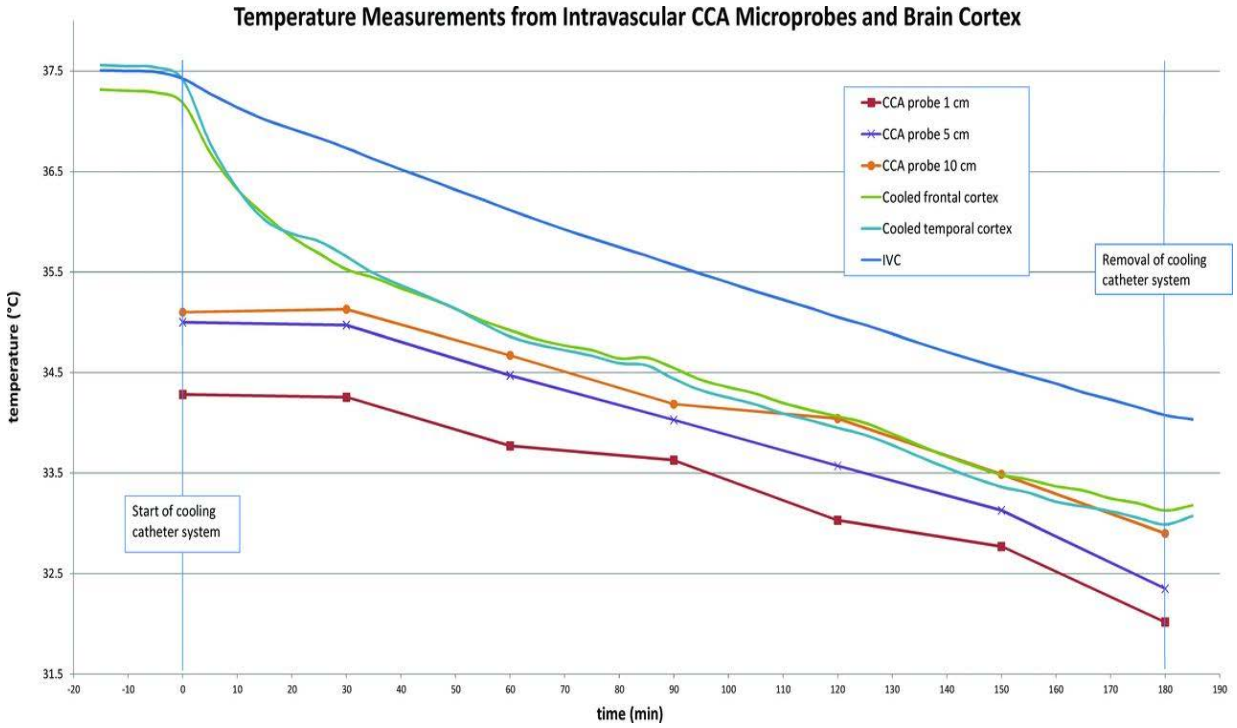
Cerri et al., 2013

Combined Selective Cerebral Hypothermia and Mechanical Artery Recanalization in Acute Ischemic Stroke: In Vitro Study of Cooling Performance

Cattaneo et al., 2015, 2016







Extrait des *Comptes rendus des séances de la Société de Biologie.*
Séance du 25 Octobre 1952. — Tome CXLVI, Octobre 1952, p. 1529

Sur la technique de l'étude du cœur de Mammifère refroidi.

par Jean Giaja, Radoslav Andjus et Mira Senberger.

On peut refroidir le rat jusqu'à environ 15° et dans cet état de poïkilothermie expérimentale étudier la physiologie et la pharmacologie cardiaques dans les mêmes conditions qu'il est classique de le faire avec le cœur de la grenouille ou de la tortue.

Notre méthode de refroidissement fondée sur l'hypoxie hypercapnique consiste à abaisser graduellement l'intensité des oxydations intraorganiques par l'abaissement progressif de la tension de l'oxygène de l'air de la respiration, ce qu'on peut obtenir par la dépression barométrique dans une enceinte close. Le procédé, plus simple, que nous avons adopté consiste à confiner le sujet dans une atmosphère normale limitée et de température inférieure à 15°. Cette méthode est appliquée au rat de la manière suivante :

On enferme le sujet à jeun dans un bocal de la capacité de 3 à 4 litres fermant hermétiquement et qu'on plonge dans de l'eau glacée. Par suite de la diminution progressive de la teneur en oxygène et de l'enrichissement en gaz carbonique de l'atmosphère confinée, dus à la respiration, le sujet se refroidit lentement, de sorte qu'au bout d'une à deux heures sa température rectale est tombée aux environs de 15°. Ainsi refroidi, le rat replacé à l'air libre se comporte comme un poïkilotherme, le mécanisme de la thermorégulation étant aboli dès que la température corporelle est tombée au-dessous de 20°. Complètement anesthésié, immobile, toutes ses fonctions sont ralenties dans la même mesure que la consommation d'oxygène qui n'est plus que de 10 p. 100 environ de celle de l'état normal et qui varie avec la température corporelle dans le même sens que la température ambiante. Cet état de poïkilothermie expérimentale peut être mis à profit, entre autres, pour l'étude physiologique et pharmacologique du cœur de Mammifère *in situ*. Le rat étant refroidi à environ 15° comme il vient d'être dit, on ouvre le thorax et met le cœur à nu. Tandis que chez l'animal à température normale le cœur cesse de battre 6 min environ après l'ouverture du thorax, chez le rat refroidi à 15° la durée est prolongée à 1 heure environ, sans emploi de la respiration artificielle. Pour avoir un travail cardiaque régulier et prolongé se prêtant à des études pharmacologiques avec enregistrement graphique, on procède comme il suit. L'animal à thorax ouvert est plongé dans un bain salé à température constante de 15° environ, pour que la marche du cœur ne soit pas modifiée par des variations de la température ambiante. Ensuite, en appliquant contre le museau du rat un tube en caoutchouc en communication avec l'obus à oxygène, on remplit les poumons distendus et puis on ferme la trachée par une petite pince, constituant ainsi une réserve d'oxygène qu'il suffit de renouveler de temps à autre, tous les quarts d'heure par exemple, pour assurer par ce procédé de ventilation pulmonaire « type baleine » un travail régulier du cœur sans arythmie pendant une durée de plus de deux heures. L'immobilité complète du sujet, l'absence de mouvements permanents de la respiration artificielle, sont des conditions très favorables pour l'enregistrement graphique des mouvements du cœur par les méthodes courantes. De plus, l'in-

lens, that of total internal reflexion seems to provide a reasonable preliminary hypothesis.

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Sept. 28.

[1] Denton, E. J., and Pirenne, M. H., *J. Physiol.*, **116**, 33P (1952).
[2] Wright, W. D., and Nelson, J. H., *Proc. Phys. Soc.*, **48**, 401 (1936).
[3] O'Brien, B., *J. Opt. Soc. Amer.*, **41**, 882 (1951).

Survival of the Heart following Deep Hypothermia

Deep hypothermia of warm-blooded animals favours the survival of their organs. For example, in the rat at normal body-temperature the heart ceases to beat several minutes after opening the chest, whereas in the rat cooled to 15° C. by the closed-vessel technique cardiac contractions can be seen approximately 1 hr. after respiratory arrest[1]. The intestine removed from a hypothermic dog contracts spontaneously when re-warmed and retains this property longer than an intestine isolated from a normothermic dog[2]. We have shown that the heart continues to beat for a much longer period after opening the thorax in rats which have been severely chilled and then re-warmed to normal body-temperature than in rats at the same temperature which had not been previously chilled[3].

The effect of profound hypothermia is shown equally well by survival of the heart after functional arrest. This is illustrated by the experiments to be described here.

When rats at normal body-temperature are killed by destroying the medulla and opening the chest, their hearts cease to beat after several minutes. If the bodies are then placed in the refrigerator at 6–9° C., cardiac contractions can be induced 6–12 hr. later in about half the animals by pouring Ringer's solution at 38–40° C. directly on to their hearts. Even after 48 hr. this technique sometimes elicits weak signs of activity around the orifices of the great veins.

Much more striking results are obtained if the rats are in a state of deep hypothermia when killed. Rats cooled by the closed-vessel technique[4] to body-temperatures between 13° and 16° C. were killed as described above and put with open thoraces in the refrigerator at 6–9° C. At this temperature the heart soon stops beating. Next day and on subsequent days the hearts are re-warmed by pouring over them Ringer's solution at 38–40° C. As a result, ventricular contractions are frequently seen several days after death, while rhythmic movements near the openings of the great veins have actually been seen when the corpses had been kept at 6–9° C. for as long as eighteen days.

Re-warming the heart for several moments daily by our method seems to prolong the functional survival which we have just described. We also noticed that this phenomenon is more regularly seen in exsanguinated hearts.

It is known that, in rats cooled to the point of freezing or even below, cardiac activity can be completely re-established approximately one hour after cessation of breathing and circulation[5]. Certain manifestations of myocardial activity can, as we have just seen, be observed many days after death provided that the rat was killed in deep hypothermia and the corpse stored at a low temperature.

The point is not, of course, that there is a genuine re-establishment of the functions of the heart, but only that there are a few signs of activity of the myocardium. Our results nevertheless indicate that deep hypothermia before death is favourable for survival of the myocardium. It might also be an advantage when transplanting or culturing organs and tissues from homoeotherms to remove them from animals in deep hypothermia.

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Université de Belgrade.

[1] Giaja, J., Andjus, R. K., and Senberger, M., *C.R. Soc. Biol., Paris*, **146**, 1529 (1952).
[2] Montini, T., Rossi, O., and Dacha, U., *Archivio Maragliano*, **10**, 421 (1955).
[3] Giaja, J., and Radulović, J., *C.R. Acad. Sci., Paris*, **242**, 2039 (1956).
[4] Giaja, J., *Bulletin de l'Academie Royale Serbe.* Sciences Mathématiques et Naturelles, B, **6**, 65 (1940); *C.R. Acad. Sci., Paris*, **210**, 80 (1940).
[5] Andjus, R. K., *Srpska akademija nauka. Glas*, **200**, 249 (1951); *C.R. Acad. Sci., Paris*, **232**, 1501 (1951); *J. Physiol.*, **128**, 547 (1955). Andjus, R. K., and Lovelock, J. E., *J. Physiol.*, **128**, 541 (1955). Andjus, R. K., and Smith, A. U., *J. Physiol.*, **128**, 446 (1955). Goldzveig, S. A., and Smith, A. U., *J. Physiol.*, **132**, 406 (1956).

Effect of Surface-active Agents on the Living Cell

It was observed some time ago[1] that treatment with surface-active agents influences the freshness and the keeping qualities of picked fruit and the development of cut flowers. When freshly picked fruit were sprayed with a dilute (0·01–0·1 per cent) solution of a surface-active substance the fruit kept about twice as long as the controls. It has also been demonstrated that similarly treated buds of freshly picked flowers can be forced to open prematurely.

Experiments have been carried out on the action of such compounds on living plants. Undiluted non-ionic surface-active agents were used, as earlier investigations seem to indicate that little effect can be obtained with dilute solutions.

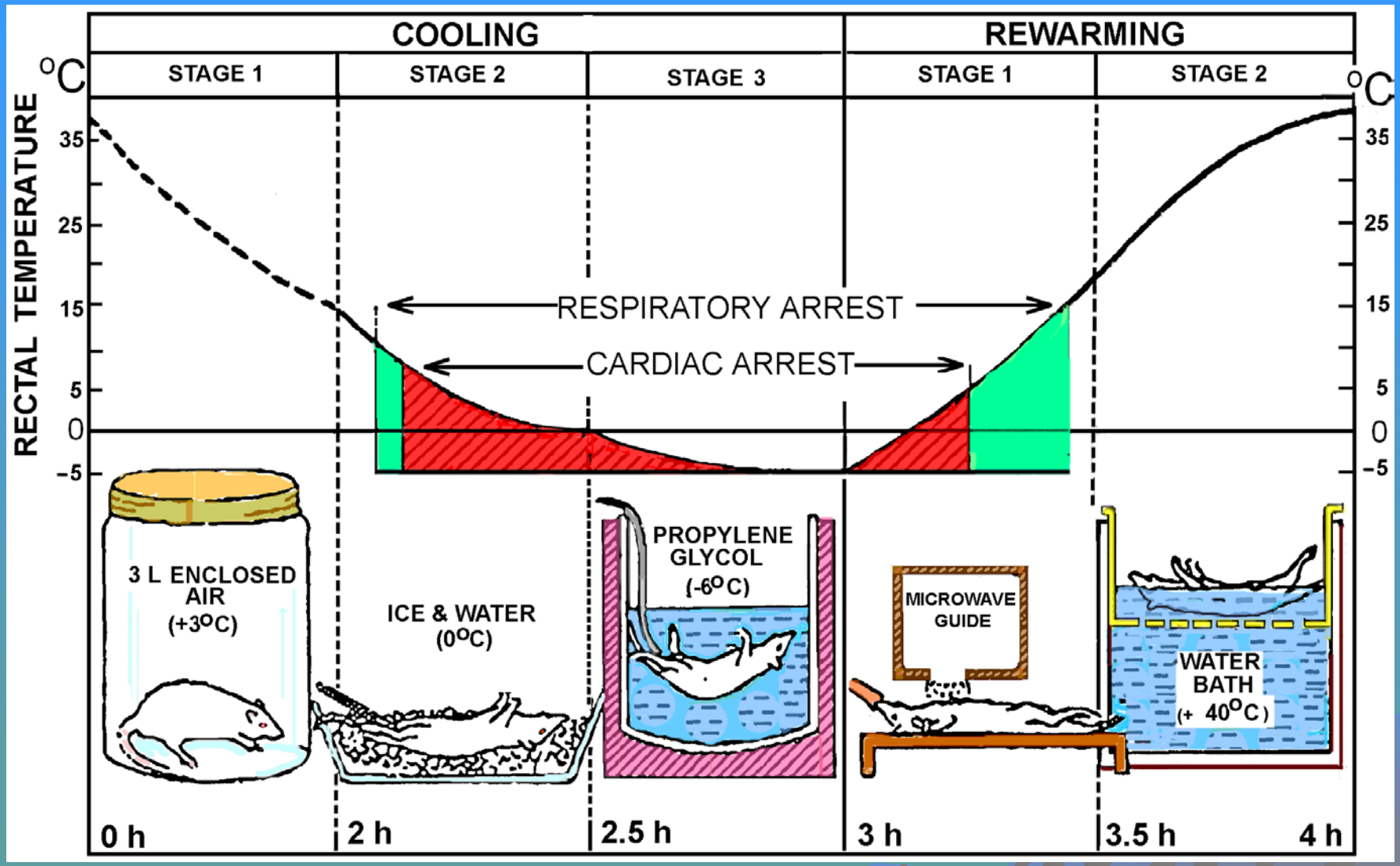
Twelve bare twigs on a shrub of mock orange (*Philadelphus coronarius*) were painted with 'Tween 40' (polyoxyethylene sorbitan-mono-palmitate) at the beginning of August; on six of the twigs the treatment was repeated twice at intervals of one week. On the twigs which had been treated only once, the first green buds appeared six weeks later, 12–14 days before they did on any of the untreated branches. The twigs which had been treated three times remained bare throughout the summer.

On a red flowering rosebush three small rosebuds were painted with 'Triton *X* 100' (alkylated aryl poly-ether alcohol). Three days later the buds started to open, although they were only half the size of the buds which open under normal conditions. The flowers were distorted; their petals nearly colourless. This distortion was also observed when the experiment was repeated using other surface-active substances.

Four *Hibiscus* buds were painted with *G* 8916-*P* (polyoxyethylene-sorbitan esters of mixed fatty and resin acids). The buds started to open two days after the treatment, five days before the control buds which were at the same stage of development. In

Profesor Andjus i njegovi saradnici na terasi Fiziološkog zavoda

SUSPENDOVANA ANIMACIJA I REANIMACIJA



БЮЛЛЕТЕНЬ
ЭКСПЕРИМЕНТАЛЬНОЙ
БИОЛОГИИ
И МЕДИЦИНЫ

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МЕДИЦИНА · МОСКВА

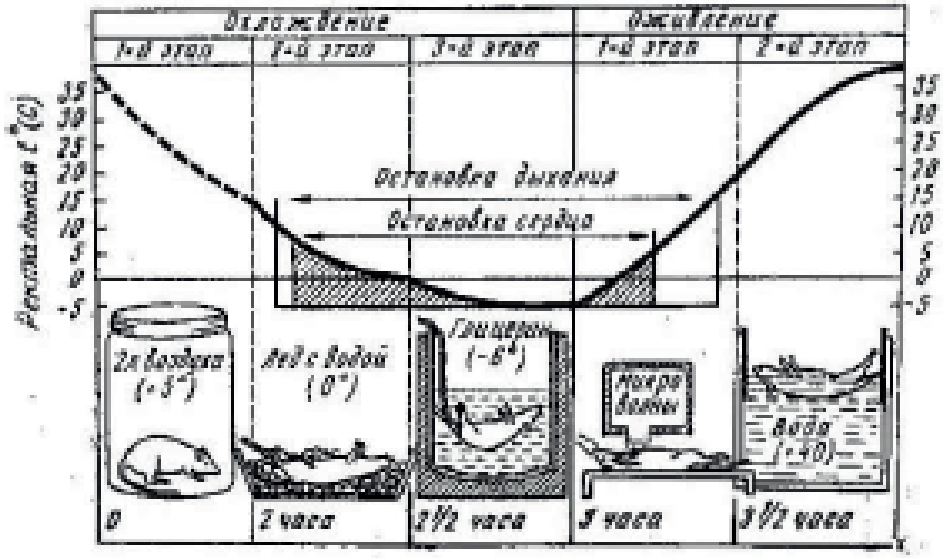


Рис. 1. Схема методики охлаждения и оживления.

J. Physiol. (1955) 128, 446–472

REANIMATION OF ADULT RATS FROM BODY TEMPERATURES BETWEEN 0 AND +2° C

By R. K. ANDJUS* and AUDREY U. SMITH

From the National Institute for Medical Research Mill Hill, London, N.W. 7

(*Received 4 October* 1954)

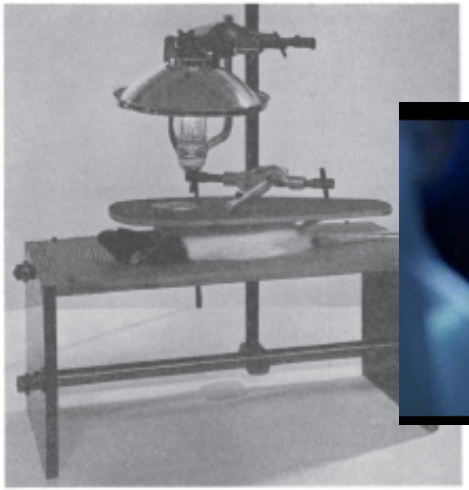


Fig. 1. The projection lamp and set-up for local rewarming.

J. Physiol. (1955) 128, 541–546

REANIMATION OF RATS FROM BODY TEMPERATURES BETWEEN 0 AND 1° C BY MICROWAVE DIATHERMY

By R. K. ANDJUS* and J. E. LOVELOCK

From the National Institute for Medical Research, Mill Hill, London, N.W. 7

(*Received 3 December* 1954)

J. Physiol. (1955) 128, 547–556

SUSPENDED ANIMATION IN COOLED, SUPERCOOLED AND FROZEN RATS

By R. K. ANDJUS*

From the National Institute for Medical Research, Mill Hill, London, N.W. 7

(*Received 3 December* 1954)

...ted from Nature, Vol. 176, *pp.* 1015–1016, *Nov.* 26, 1955)

EFFECTS OF HYPOTHERMIA ON BEHAVIOUR

By R. K. ANDJUS*, F. KNÖPFELMACHER†, PROF. R. W. RUSSELL and AUDREY U. SMITH

National Institute for Medical Research, Mill Hill, London, and Department of Psychology, University College, London

ARHIV BIOLOSKIH NAUKA — ARCHIVES DES SCIENCES BIOLOGIQUES
X. 1—4/1958 BEOGRAD

R. K. ANDJUS, J. GLIGORIJEVIĆ, V. RAJEVSKI, B. DIMITRIJEVIĆ

ULTRAZVUK I REANIMACIJA SRCA

(Saopšteno na III jugoslovenskoj konferenciji o elektronici, 5 novembra 1958 u Ljubljani)

Termofiziologija

Djaja i Andjus su prvi koji su pokazali da se nehibernatori takodje mogu ohladiti do odredjenje temperature (za pacova 15 °C) sa koje se spontano mogu oporaviti.

Prof. RK Andjus je pokazao da se odrastao pacov može ohladiti i do 0 °C, a novorodjeni pacov čak i do -6 °C. Pri tome, životinje prestanu da dišu i zaustavi im se rad srca, i ako taj zastoj nije duži of 90 min moguće je životinje povratiti u život. Veliki uspeh predstavljalo je ponovno uspostavljanje kardiovaskularne i disajne funckije kod životinja koje su bile pod niskom temperaturom. Tim postupkom negativan efekat odsustva kiseonika na organe značajno je umanjen. Kod hibernatora ni hladjenje do 1 °C ne dovodi do zastoja rada srca ni disajnih organa.

dr Stanko Stojilkovic, NIH (SAD)

Istraživanja metabolizma mozga

- Marina Marjanović, vanredni profesor, Univerzitet u Ilinoisu
- Tasa Ćirkovic, Instituta za biološka istraživanja u Beogradu (preminuo)
- Slobodan Macura, redovni profesor biohemije i molekularne biologije, Mejo klinika, Ročester

DOGFISH SHARKS AND EELS AS EXPERIMENTAL MODELS: I.- BRAIN ENERGETICS AND TOLERANCE OF THE DOGFISH TO ANOXIA AND LOW TEMPERATURE

Radoslav K. ANDJUS*, Tanasije ĆIRKOVIĆ, and Ružica GENCI

374 IUGOSLAV.PHYSIOL.PHARMACOL.ACTA, Vol. 34, No.2, 371-380, 1998

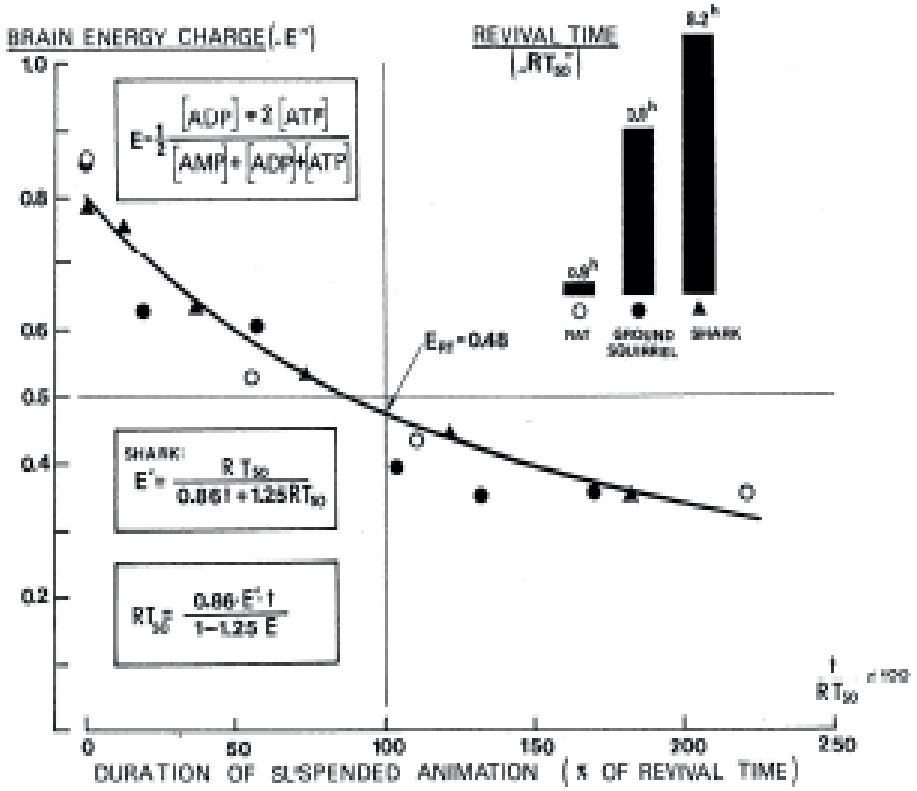
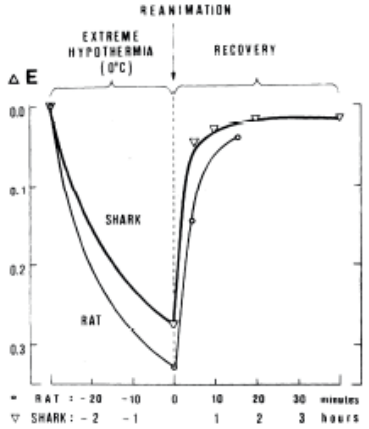
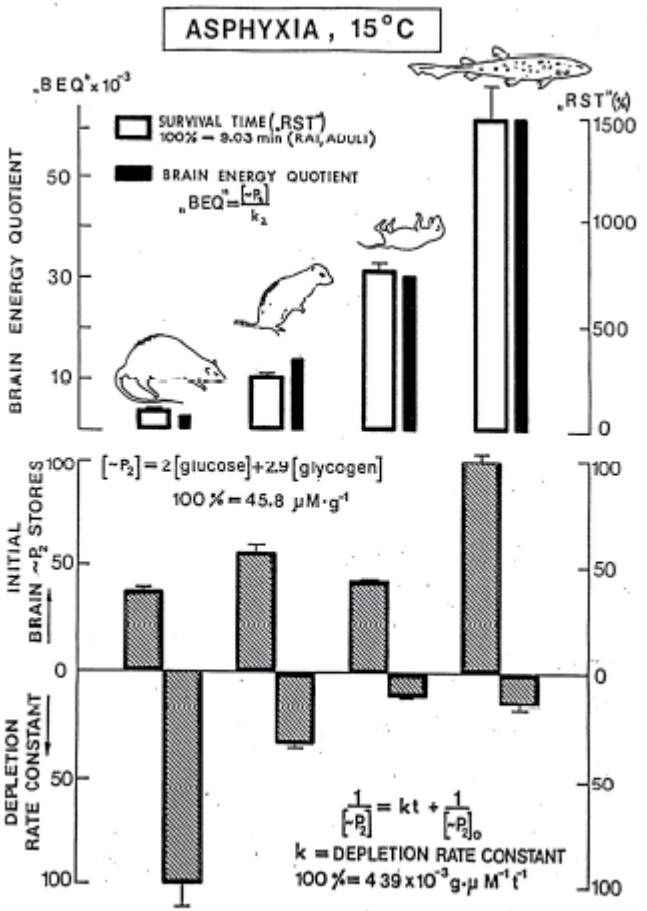


Fig.2. Tolerance to cardiac arrest at 0°C body temperature

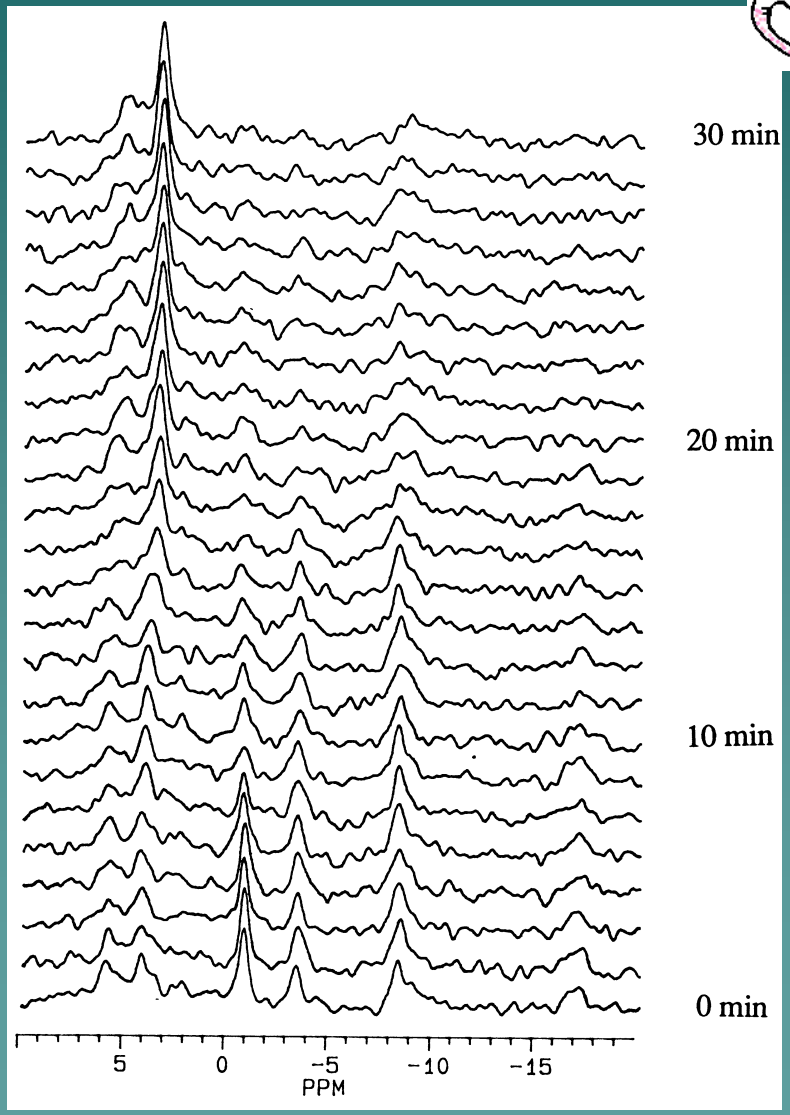




Radoslav Andjus i Slobodan Macura u MRI laboratoriji klinike Mejo

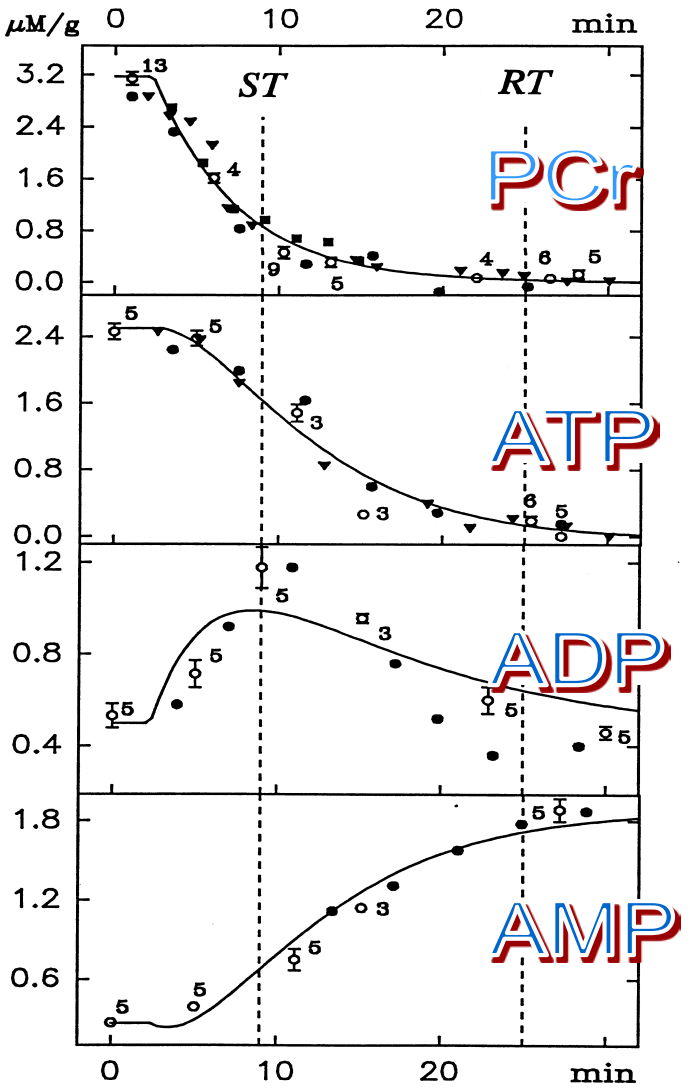
Andjus, Macura et al., Ann. N.Y. Acad. Sci. 2005

IN VIVO BRAIN ^{31}P NMR SPECTRA DURING ASPHYXIA at T_b=15°C



BRAIN MACROERGIC PHOSPHATES

ADULT RATS , DEEP HYPOTHERMIA (15°C)



Istraživanja metabolizma mozga

- 1. Biohemijska merenja u izolovanom mozgu;
- 2. Merenja u sinaptozomalnim preparatima mozga.
- *3. In vivo* NMR (nuklearna magnetna rezonanca) merenja;

- ❖ Postoji tesna veza izmedju podnošenja ekstremne hipotermije i nivoa energetskih rezervi.
- ❖ Hladjenje do 15 ^{o}C dovodi so usporavanja potrošnje kiseonika za više od 80%.
- ❖ Značaj katjonske pumpe pri savladjivanju inhibitornog uticaja hladjenja

dr Stanko Stojilkovic, NIH (SAD)

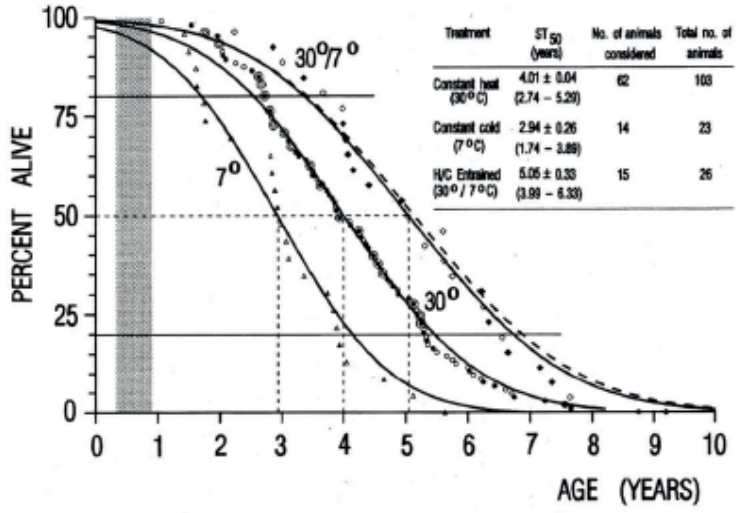
Izučavanje hibernacije i bioloških ritmova -

- **Dragoslava Živadinović, Univerzitet medicine u Teksasu, Gavston**
- **Marina Rakić-Marjanović**
- **Tasa Ćirković**

Adaptations to the Cold: Tenth International Hibernation Symposium.
Edited by Geiser F., Hulbert A.J. & Nicol S.C. University of New England Press, Armidale, 1996

Life span of the European ground squirrel *Spermophilus citellus* under free-running conditions and entrainment

Dragoslava Zivadinovic and [1]R. K. Andjus
Institute for Biological Research and [1]Center for Multidisciplinary Studies of the University of Belgrade, 29. Novembra 142, 11000 Belgrade, Yugoslavia



Hibernatori pokazuju dva osnovna godišnja ritma. Jedan je smena stalne telesne temperature tokom proleća i leta (hometermija) i promenljive telesne temperature tokom jeseni i zime (heterotermija). Drugi je promena telesne mase, koja ujedno prati prethodni ritam. Izučavanje ovih ritmova zahteva dugotrajne eksperimente, i stoga postoji ograničeni broj publikacija.

Usporavanje starenja hladjenjem tela???

HVALA!