

bei einer Pause von 5 sec dagegen wird schon die 3. Reizung zu keiner Antwort mehr führen. Pausen von über 30 min vermögen auf die Antwort keinen Einfluss mehr auszuüben. Diese Erscheinung (Adaptation? Ermüdung?) wird bei anderen, d.h. nicht-elektrischen Knochenfischen unter den gleichen Bedingungen nicht beobachtet.

Reizungen mit impulsförmigem Gleichstrom sollen die grösste Wirkung auf einen Fisch erzielen^{7,8}. Untersuchungen der Elektrofischereiforschung aus neuerer Zeit (mündliche Mitteilungen) bestätigen diese Aussage. Man könnte also erwarten, dass Stromimpulse auch bei *Malapterurus* wirksamer sind als Stromdauerfluss. Das ist aber keineswegs der Fall. Bei Reizungen mit Impulsen müssen beim Zitterwels viel höhere Dichten verwendet werden, um eine Lokomotion («diphasische Galvanotaxis») auszulösen.

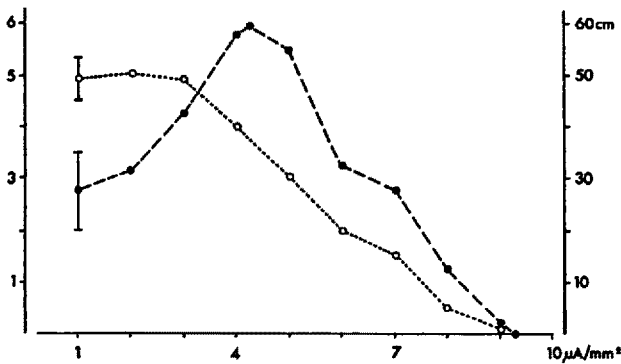


Fig. 2. Mittelwerte von der Anzahl der Körperwendungen (● Ordinate links) sowie der Schwimmstrecken (○ Ordinate rechts) bei verschiedenen Felddichten (Abszisse) während einer Reizung von 30 sec.

Dabei spielen sowohl die Breite des Impulses als auch die Impulsintervalle eine wichtige Rolle. Impulse, deren Breite kleiner als 5 msec oder deren Intervall grösser als 90 msec beträgt, vermögen selbst bei vervielfachter Felddichte nicht mehr zu einer Lokomotion zu führen. Da *Malapterurus* selbst bei seinen Entladungen elektrische Felder in Form von Stromstössen entstehen lässt, wäre es denkbar, dass die höhere Reizschwelle gegenüber solchen hiermit in Zusammenhang steht.

In der Auswertung befinden sich Untersuchungen über das Verhalten von *Malapterurus* mit und ohne eigene Entladungen im inhomogenen Gleich- bzw. Wechselstromfeld, den Verlauf der Feldlinien in Beziehung zum Fischkörper sowie die Lokalisation der Reizstellen unter Ausschaltung z.B. des Ramus lateralis⁹.

Résumé. On a observé que le malaptéreur réagit à des excitations électriques externes (courant continu homogène) par une «galvanotaxie diphasique». Ces résultats avec leurs détails mettent en évidence une différence bien nette entre le comportement du malaptéreur et celui des autres poissons osseux non électriques.

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D-5 Köln 41, Lindenthal (Deutschland), 29. März 1971.

⁷ E. HALSBAND, Arch. Fisch. Wiss. 7, 143 (1954).

⁸ H. W. DENZER, *Handbuch der Binnenfischerei in Mitteleuropa*, (Schweizerbart, Stuttgart 1956), Erg.-Bd. zu V, p. 161

⁹ Mit Unterstützung des «Conseil National de la Recherche Scientifique» (Beirut).

Acid-Base Balance in Artificially Respired Guinea-Pigs under Normal Conditions and During Exposure to Hyperbaric Helium

Certain drug evaluation procedures being used in this laboratory necessitate the use of artificial respiration of guinea-pigs during exposure of the animals to a hyperbaric helium atmosphere. In order to ascertain that the artificial ventilation maintained normal acid-base balance, arterial blood pH was measured in guinea-pigs during artificial respiration either at normal or elevated pressure. In animals respired at normal pressure, arterial blood pO_2 and pCO_2 were also measured. The pH and gas values were compared with values found in unanesthetized and in anesthetized, non respired animals. The values for pH and pCO_2 determined for normal animals were not in good agreement with previously reported values¹.

Four groups of male guinea-pigs of the NMRI (H) strain, weighing 300–500 g, were used. In group I (normal, unanesthetized), a length of PE-50 tubing was inserted in the carotid artery while the animals were under light ether anesthesia. 4 h following recovery from anesthesia, carotid artery blood samples were drawn for analysis. In group II, animals were anesthetized with Dial-urethane solution (0.6 ml/kg, i.p.) and the carotid artery was cannulated as in the first group. Duration of anesthesia was greater than the remainder of the experiment, and arterial blood samples were drawn 4 h after completion of surgery. Groups III-A and III-B (artificially respired animals exposed to normal or high pressure, respectively) were treated in the same manner as animals in group II, but, in addition, the trachea was cannulated and the animals were connected to a

piston-type small animal respirator with inflation volume set to provide an inflation pressure of 65 mm H_2O .

The respirator was set at a rate that just prevented animals from breathing spontaneously, and this rate was determined by trial and error for each animal. The suppression of spontaneous respiration was considered to result primarily from operation of an inhibitory respiratory reflex (Hering-Breuer inflation reflex). The possibility that hyperventilation contributed to the suppression cannot be totally ruled out, but this contribution must have been quite small in view of the normal arterial blood pH values subsequently measured in these animals.

Blood samples from animals in group III-A were obtained after 1 and 4 h of artificial respiration. Animals in group III-B were pressurized in a hyperbaric chamber² to a total pressure of 282 Ψ (final composition of the hyperbaric atmosphere was $\text{pHe} = 19.0 \text{ atm.}$; $\text{pO}_2 = 0.2 \text{ atm.}$). Blood samples from animals of group III-B were obtained 1 and 4 h after pressurization. Gas and pH values for group III-A, and pH values for group III-B, measured in

¹ P. L. ALTMAN and D. S. DITMER, *Biology Data Book* (Federation of American Societies for Experimental Biology, Washington, D.C. 1964), p. 260.

² A. SMALL, *Toxic. appl. Pharmac.* 17, 250 (1970).

Arterial blood pH and gas tensions in guinea-pigs *

	Unanesthetized Animals (Group I) ^b				
	Present Data	Data of HAWKINS ^c	Group II ^b	Group III-A ^b	Group III-B
pH	7.50 ± 0.02	7.35 ± 0.03	7.40 ± 0.03 ^e	7.50 ± 0.02	7.49 ± 0.03
pCO ₂	31 ± 1	33 ± 3 ^d	47 ± 3 ^e	32 ± 2	—
pO ₂	81 ± 2	—	73 ± 5	85 ± 3	—
n ^f	15	12	11	10	10

* Values represent mean ± S.E. ^b Designation of groups: Group I: unanesthetized, spontaneously breathing; Group II: anesthetized, spontaneously breathing; Group III-A: anesthetized and artificially respired at normal pressure; Group III-B: anesthetized and artificially respired at 282 ψ . ^c Blood obtained by cardiac puncture¹. ^d Reported as volume percent CO₂ and converted to pCO₂ by standard formula⁴. ^e Significantly different than values for animals in Group I ($p < 0.01$, Student t -test). ^f n = number of animals.

the 1-hour sample, served as a guide for adjusting the rate of artificial respiration for the remainder of the experiment.

Blood pH, pCO₂, and pO₂ were measured with an Instrumentation Laboratories Model 113 analyzer. In animals of group III-B, only pH could be measured accurately because effervescence in decompressed blood interfered with measurement of pCO₂ and pO₂. A 2-ml sample of blood was sufficient for the analyses. Results for the 4 groups of animals are shown in the Table. The data demonstrate that anesthesia significantly depressed respiration in spontaneously breathing guinea-pigs (group II) as compared with normal animals (group I). However, the Table also shows that the artificial respiration used in these studies (groups III-A or III-B) successfully reversed the respiratory depression and maintained the animals in normal acid-base balance. Apparently, artificial ventilation was not appreciably affected by the use of a gas mixture that was approximately 2.9 times as dense as air at a pressure of 1 atm.

It is interesting to compare the present data with previously published values for pH and pCO₂ in guinea-pigs, also given in the Table. Currently cited values for normal guinea-pigs¹ are based on the work of HAWKINS³, who analyzed blood obtained by cardiac puncture, using the Van Slyke method to determine total CO₂, and a comparator block method to estimate pH. Results obtained with cardiac puncture blood should be interpreted with caution because of the likelihood of aspirating a mixture of arterial and venous blood. The Table shows that HAWKINS reported nearly the same pCO₂, but a much lower pH than was found in the present study.

In conclusion, the present data demonstrate that artificial respiration of guinea-pigs, as performed in this laboratory, provided adequate ventilation of the animals, both

at normal pressure and in a hyperbaric helium atmosphere. In addition, the pH and pCO₂ reported here for unanesthetized animals may be closer to true values for normal guinea-pigs than are the currently cited values^{5,6}.

Zusammenfassung. Säure-Basen-Werte von Meer-schweinchen (*Cavia porcellus* L.) wurden unter künstlicher Atmung bei normalem Druck und bei Druck von 19.2 Atm. gemessen und festgestellt, dass künstliche Atmung unter erhöhtem Druck normale Säure-Basen-Gleichgewichte gewährleistet, während die Säure-Basen-Werte normaler Tiere mit denjenigen der Literatur nicht übereinstimmen.

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³ J. A. HAWKINS, J. biol. Chem. 61:147 (1924).

⁴ J. H. COMROE, JR., R. E. FORSTER II, A. B. DuBOIS, W. A. BRISCOE and E. CARLSEN, *The Lung* (Year Book Medical Publishers, Inc., Chicago, Ill. 1962), p. 155.

⁵ From Bureau of Medicine and Surgery, Navy Department, Research Task No. M4306.02.5011. The opinions or assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Navy Department or the Naval service at large.

⁶ Experiments reported herein were conducted according to the principles enumerated in *Guide for Laboratory Animal Facilities and Care*, prepared by the committee on the Guide for Laboratory Animal Resources, National Academy of Sciences, National Research Council, Washington, D.C.

Dopa and Dopamine in the Pigment of Substantia Nigra

The cells of substantia nigra contain a pigment which is generally thought to be a melanin. Investigations using histochemical methods, electron microscopy and IR-spectroscopy have, however, revealed several differences between the substantia nigra pigment and other melanins¹⁻⁵.

The chief structural difference between substantia nigra and extra-neural melanin granules is the presence of lipid globules in the melanin granules of Substantia nigra. The chemical nature of Substantia nigra melanin is unknown, but it has been suggested that the pigment is formed from

dopa, dopamine, adrenaline, noradrenaline or 5-hydroxytryptamine⁶⁻⁸.

Although the structure of different melanins is very complex, it is possible to get an idea of the nature of different melanins by degradation experiments⁹. Therefore Substantia nigra melanin was hydrolyzed in hydrochloric acid and the hydrolysate investigated for dopa, noradrenaline, adrenaline, dopamine and 5-hydroxytryptamine.

Material and methods. Substantia nigra was obtained at autopsy from 16 humans. The tissue specimens were homogenized in 6 N HCl (5 g tissue in 20 ml acid) and