where $Z = p/\dot{Q}$ defines the set value around which small changes are examined. The second term in the brackets describes the influence of X on the impedance Z and thus may be called the transfer function of the vasoactive substance. This function is positive if the substance is a vacoconstrictor, and negative if it is a vasodilator.

To demonstrate a simple example a first order transfer function may be assumed; to be inserted into eq. 4:

$$k \frac{\partial Z}{\partial X} \frac{\dot{Q}}{Z} = \frac{G}{1 + \tau s}. \quad (5)$$

Using the Laplace transform technique, the time response of the arterial pressure $\Delta p(t)$ to a flow step increase $\triangle \dot{Q}$ can be derived from eq. 4

$$\triangle p(t) = Z \triangle \dot{Q} \left[1 - G\,(1 - e^{-t/\tau})\right]. \quad (6)$$

As mentioned above G is positive if the vasoactive substance is vasoconstricting. In this case the vascular bed tends to reduce the pressure closer to its previous value after a flow step increase, an effect which may be called humoral autoregulation of pressure. If the substance is a vasodilator, G is negative. According to eq. 6 in this case the pressure will continue to rise after a flow step increase. This reaction is characteristic for a system which tends to regulate blood flow at a certain level and may, therefore, be called humoral autoregulation of flow. Intuitively explained, the pressure rise after a flow increase represents the attempt to reduce the flow to the former value by increasing the resistance.

The Figure shows an experimental example. The femoral arterial bed of an anesthetized dog was perfused with arterial blood using a peristaltic pump. The inflow was recorded by an electromagnetic flowmeter. Into the arterial cannula drugs could be infused by a piston pump. The results were reproduced in 5 different animals.

The upper tracing of the Figure (control) shows the intrinsic autoregulatory response of the femoral arterial bed to a step flow increase. The middle tracing shows the continuing pressure increase after a flow step which is characteristic for the autoregulation of blood flow, during acetylcholine infusion. The lower tracing shows the response of the pressure to a flow step during noradrenalin infusion which is typical for the autoregulation of pressure.

In other words, it can be shown experimentally that a vasoconstricting substance released at a constant rate into the arterial blood stream is able to stabilize the blood pressure in the presence of perturbations of the blood flow. A vasodilating substance, on the other hand, would tend to stabilize arterial flow values in the presence of perturbations of the arterial blood pressure.

The following conclusions can be drawn from this discussion: 1. There exists a phenomenon which may be called humoral autoregulation. We were able to demonstrate this fact under artificial experimental conditions. 2. Certain effects which usually are ascribed to intrinsic autoregulation actually may be due to humoral autoregulation. 3. As can be seen in the Figure intrinsic (nonhumoral) and humoral autoregulation. may interact. As mentioned elsewhere[3] interactions of this type may under certain circumstances lead to instability and vascular autooscillations[4].

Zusammenfassung. Vasoaktive Substanzen im arteriellen Blut können charakteristische Reaktionen des lokalen Strömungswiderstandes hervorrufen. Die einfachsten Beispiele dieser humoralen Autoregulation können durch intraarterielle Infusion von Acetylcholin (Autoregulation der Strömung) oder Noradrenalin (Autoregulation des Drucks) demonstriert werden. Es wird angenommen, dass der humoralen Autoregulation Bedeutung bei der normalen und pathologischen Kreislaufregulation zukommt[5].

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25 October 1971.

[4] Supported by NIH grant No. HE 11747.
[5] The experiments were performed in the Division of Biomedical Engineering, University of Virginia, Charlottesville, USA.
[6] Recipient of NIH research career development award No. HE 50288-01.

Correlation of Ammonia Liberation and Calcium Deposition by the Avian Egg and Blood Ammonia Levels in the Laying Hen

We have previously noted that unfertilized eggs removed from the reproductive tracts of laying hens liberate ammonia in vitro and have suggested that ammonia may function in vivo to cause the dissociation of bicarbonate thereby providing carbonate for egg shell calcium carbonate formation[1]. In this report, we show that there is a negative correlation between the amount of ammonia liberated by eggs and the amount of calcium deposited as calcium carbonate. We also show that there is an increase in the plasma ammonium ion content during the laying cycle that may be due, in part, to the addition of ammonium ion to the blood by the shell gland during eggshell formation.

Materials and methods. White Leghorn laying hens were kept in individual cages under a 14 h light: 10 h dark photoperiod and were fed Purina Eggena (Ralston Purina Co., St. Louis, Mo., USA). The stage of eggshell formation was estimated from the time of the preceeding oviposition. The hens were killed and the eggs removed from the reproductive tract and placed in all-glass metabolic chambers. Ammonia liberation was measured continuously for 24 h as previously described[2]. At the end of this time, the egg shell or outer membrane was separated and ashed at 1300° for 24 h. The ashed residue was dissolved in a minimal amount of concentrated hydrochloric acid (3 to 5 ml), diluted with water and its calcium content determined by a fluorometric method[3].

An enzymatic method[4] was used to determine plasma levels of ammonium ion; readings were normally made within 20 after withdrawing a blood sample and the

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recovery of added ammonium ion ranged from 94 to 103%. For constant monitoring of the plasma ammonium ion levels, a chronic catheter was inserted under local anesthesia to the level of the heart through the branchial vein. For samples from the shell gland vein, this organ was exposed by laporotomy[5] under sodium pentobarbital anesthesia. Blood was also withdrawn from the heart after taking the shell gland venous sample; ammonium ion analyses were made at 20 and 40 min, respectively, after collecting the two samples. It was established that little or no change (less than 3% decrease) took place in the ammonium ion content of blood within these time limits.

Results and discussion. The rate of ammonia liberation by 3 eggs taken from the shell gland and in different stages of calcification is shown in Figure 1. As can be seen in this Figure, there is a rapid diminution in the rate of ammonia liberation with time. One interpretation of this decreasing rate is that ammonia is present on the surface of the eggs when removed from the shell gland and is simply 'washed off' by the air flow through the metabolic chambers. It is also possible that the substrate from which ammonia is formed is rapidly depleted in vitro. In either case, the amount or rate of ammonia formed by the intact system in vivo in which the shell gland tissue is supplying ammonia to the surface either directly or indirectly in the form of substrate could be quantitatively far more significant than is observed under the artificial conditions in vitro.

The relationship between ammonia liberation and amount of calcium deposited as calcium carbonate is also illustrated in Figure 1; the more calcium deposited, the less the amount of ammonia liberated. Because of the general permeability of the avian eggshell to most gases[6], it seems

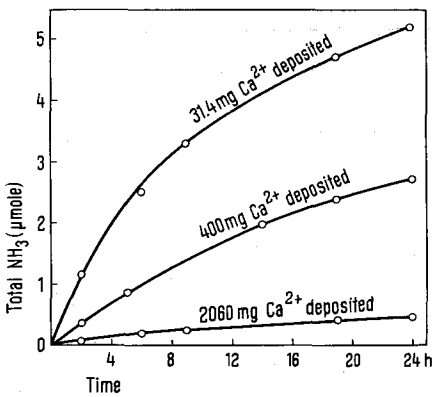

Fig. 1. Rate of ammonia liberation by eggs taken from shell gland. The amount of calcium deposited as calcium carbonate on each egg is indicated.

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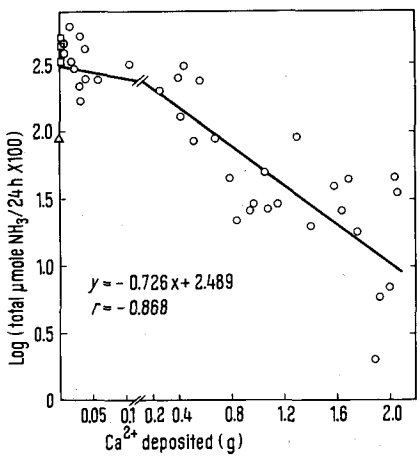

Fig. 2. Correlation of ammonia liberation with calcium carbonate deposition by eggs removed from the reproductive tract of laying hens. The open squares refer to eggs removed from the isthmus; the open triangle, to an egg from the magnum; and the open circles, to eggs from the shell gland. The linear regression line was calculated by the method of least squares; the break in this line is due to the different scale used for the low calcium values (0 to 0.13 g calcium).

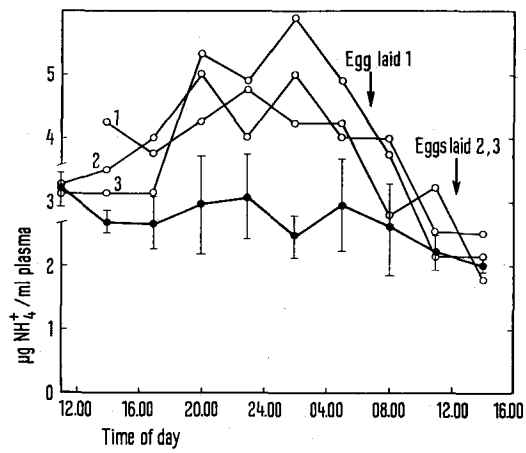

Fig. 3. Plasma ammonium ion concentrations in laying and non-laying hens. The closed circles represent the average ammonium ion content of blood from 5 non-laying hens (shown ± SD) and the open circles, that in 3 layers designated as 1, 2 and 3. The time of oviposition is indicated.

Ammonium ion contents of cardiac and shell gland venous blood

Conditions	Plasma NH_4^+ content (µg/ml ± SD)		
	Cardiac	Shell gland vein	
No egg in reproductive tract (n = 8)	2.68 ± 0.52	2.78 ± 0.44	$P > 0.5$
Eggs in shell gland in various stages of calcification (n = 18)	3.35 ± 0.82	4.24 ± 1.46	$P < 0.05$

unlikely that this parameter is responsible for the dimunition in ammonia liberation with increasing calcification of the shell. Again, in keeping with the hypothesis that ammonia facilitates carbonate formation[1], we interpret these results as indicating that in the earlier stages of calcification, more ammonia is being elaborated onto the surface membranes of the egg to facilitate calcium carbonate deposition. Once calcification ceases (at around 2 g calcium), little or no ammonia is being elaborated in vivo and subsequently only a small amount is liberated from the eggs in vitro. Ammonia liberation decreases exponentially with increasing calcification; a plot of log ammonia liberated per 24 h times 100 vs. the amount of calcium deposited for several eggs is shown in Figure 2. The correlation coefficient (r) for these two parameters in such a plot is -0.868.

If ammonia is in fact involved in proton neutralization and/or transport in the avian shell gland[7] there is the question of whether the resulting ammonium ion leaves the shell gland via the venous blood supply or is in some way recycled to an ammonia-yielding substrate in the shell gland tissue. The urinary excretion of ammonium ion is quite high during the laying cycle and this has been attributed to the response of the renal compensatory mechanism to the metabolic acidosis imposed by eggshell formation[8]. As shown in Figure 3, there is also an increase in the plasma ammonium ion content which corresponds with the laying cycle. The maximum plasma concentraion of ammonium ion occurs approximately 8 h prior to oviposition; at this point, ammonium ion excretion by the kidney is also maximal and urine pH, minimal[1,8]. In the dog, the renal venous ammonium ion content shows very little increase even in severe metabolic acidosis[9]: the normal ammonium ion content is about 1.8 µg per ml and with the arterial infucion of 100 µmole ammonium lactate per min, decreases to about 1.7 µg per ml. With the infusion of 300 µmole ammonium lactate per min, the venous value increases to only 2.3 µg per ml. If the same renal mechanism is operative in the chicken, it thus seems unlikely that the increased plasma concentrations of ammonium ion observed during the laying cycle are due to the addition of this cation to the renal venous blood by the kidney. As shown in the Table, there is a small but significant addition of ammonium ion to the shell gland venous blood when an egg is present in the shell gland which does not occur when an egg is absent. In the experiment for the Table, the amount of calcium deposited on eggs taken from the shell gland ranged from 7.9 mg to 2.12 g. However, there was no correlation ($r = 0.002$) between the amount of calcium deposited and the shell gland venous ammonium ion content[10].

Zusammenfassung. Mittels biochemischer Daten wird der Nachweis erbracht, dass im Ovidukt des Huhnes während der Schalenbildung zwar vermehrt NH_4^+ freigesetzt wird, jedoch eine negative Korrelation zwischen NH_4^+-Produktion und Ca^{++}-Abscheidung besteht.

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Importance of the Anti-Serotonin Effect for Mounting Behaviour in Rats

The effect of parachloropenylalanine (PCPA) on sexual behaviour in animals has been extensively explored in recent years. It was shown that mounting behaviour in male rats was facilitated by PCPA[1-3]. Copulative behaviour in male rats[4] and oestrous behaviour in female rats[5] was facilitated by PCPA. Contradictory results are available[6]. The essential role of testosteron for the stimulative effect of PCPA on mounting behaviour[7] and copulative behaviour[8] in male rats was also shown. PCPA inhibits the biosynthesis of serotonin[9]. The question must be raised whether mounting behaviour induced by PCPA was prompted non-specifically by lowering the serotonin brain level or specifically by the compound PCPA. Thus we were interested in this study to observe the effect of serotonin-antagonists on mounting behaviour in rats compared with PCPA.

Testosteron pretreated rats were given PCPA and the serotonin-antagonists mesorgydine[10], methysergide[11] and WA 335-BS[12]. The antiserotonin effect of mesorgydine was described by VOTAVA and LAMPLOVA[13]. The antiserotonin agent methysergide is used in the prevention of migraine. Also the new compound WA 335-BS has an antiserotonergic effect besides an antihistaminic activity[14].

Methods. Male Sprague-Dawley rats, weighing 250–300 g were used. The rats were isolated 4 days before in a room with artificial light. The light was extinguished at 18.30 for 12 h. At this time the observation of mounting behaviour was started by 2 observers. Just before the beginning of the observation 4 isolated rats were placed together in a cage. The number of mountings over 3 h were added in periods of 15 min. Testosteronpropionate

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