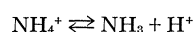


Table 1. Alveolar ammonia tensions and related data in seven dogs following ammonium acetate administration.

Dog No.	Ammonium acetate administered (meq)	Time of administration (min)	Total NH ₃ excretion (mg)		$F_{E(NH_3)}$ (10 ⁻⁷ ml/ml)	$P_{E(NH_3)}$ (10 ⁻⁴ mm-Hg)	$P_a(CO_2)$ (mm-Hg)	$P_{E(CO_2)}$ (mm-Hg)	V_A/V_B	pH	$P_{A(NH_3)}$ (10 ⁻⁴ mm-Hg)
			Control	Experimental							
1	80	90	0	0.073	1.7	1.3	41	12	0.29	7.39	4
2	125	60	0	0.098	4.4	3.3	56	19	0.33	7.36	10
3	100	46	0	0.093	4.7	3.6	41	17	0.41	7.59	9
4	100	64	0	0.079	6.1	4.7	31	16	0.51	7.50	11
5	100	71	0	0.052	1.9	1.5	54	16	0.30	7.48	5
6	115	60	0	0.063	3.3	2.5	37	16	0.43	7.58	6
7	100	70	0	0.044	3.0	2.3	58	22	0.26	7.40	6

be permeable to the free base of this ion. Robin *et al.* (8) have shown that the spinal fluid compartment is permeable to CO₂, a gas, but is relatively impermeable to bicarbonate ion. Free ammonia, a gas, presumably is freely diffusible. This may be the form in which ammonium is transported across cell membranes. The diffusivity of NH₃ may be compared to the diffusivity of O₂ and CO₂ by means of Graham's and Henry's laws. Such calculations show that NH₃ is approximately 30,000 times as diffusible as O₂ and 1500 times as diffusible as CO₂. Under these circumstances it would be expected that NH₃ equilibrium would occur very rapidly indeed across the alveolar membrane. Alveolar and pulmonary capillary NH₃ tensions would thus be essentially equal.

It is important to emphasize that, at present, accurate calculations of arterial NH₃ tensions from experimentally determined total arterial ammonium levels and arterial pH are not possible. Such calculations would require an accurate value for the equilibrium constant, K_a , of the reaction



in blood or plasma, which is certainly different from its value in aqueous solution. Until an acceptable plasma K_a is available, only order-of-magnitude comparisons between alveolar and arterial NH₃ tensions are warranted.

During the past 5 years major emphasis has been given to the role of ammo-

nium metabolism in man. Significant concentrations of total ammonium have been found in the blood of patients with various types of liver disease. An increase in blood ammonium has been implicated in the pathogenesis of hepatic coma. However, correlations between blood ammonium concentrations and the degree of hepatic coma are imperfect. It is generally accepted that the measurement of blood ammonium presents great technical difficulties. Since there may be spontaneous generation of ammonium from nitrogenous substances in blood, the exact significance of blood ammonium levels, after shedding, is difficult to assess.

The demonstration of free NH₃ in alveolar air may be taken to indicate that under special circumstances there are significant levels of circulating ammonium. Jacquez, Poppell, and Jeltsch have demonstrated free NH₃ in the alveolar air of dogs with Eck fistulas (2). Preliminary studies in some patients with hepatic coma have shown measurable levels of ammonia in expired air (9). By utilizing the lung of such a patient as a tonometer, it may be possible to reassess the quantitative aspects of ammonium metabolism and its relation to hepatic coma.

It is interesting to note the similarities between NH₃ and CO₂. Both are gases which are involved in metabolic processes. Under physiologic circumstances neither is present in significant quantity in inspired air. Both gases are highly diffusible. Each gas exists in equilibrium, with an ion constituting a buffer pair. As with CO₂, the study of the excretion of NH₃ by mammalian lung may prove to be a useful approach for further investigation of gas exchange.

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References and Notes

1. H. W. Smith, "The excretion of ammonia and urea by the gills of fish," *J. Biol. Chem.* 81, 727 (1929).
2. While our studies were in progress, we learned that Jacquez, Poppell, and Jeltsch had independently measured alveolar ammonia tensions in dogs with Eck fistulas. An exchange of data between our two groups was undertaken, and the experimental results obtained were found to be similar (see J. A. Jacquez, J. W. Poppell, R. Jeltsch, *Science*, this issue).
3. This investigation was supported in part by a research grant (H2243) from the National Heart Institute of the National Institutes of Health, Public Health Service, and in part by a grant from the Massachusetts Heart Association. We are grateful to Dr. A. B. Hastings for advice and encouragement in the course of this study; to Drs. Rudi Schmid and Charles S. Davidson for the measurements of arterial ammonium concentrations; and to Drs. Jacquez, Poppell, and Jeltsch for their cooperation and assistance.
4. E. J. Conway, *Micro-diffusion Analysis and Volumetric Error* (Crosby-Lockwood, London, ed. 3, 1951).
5. J. H. Comroe, Jr., Ed., *Methods in Medical Research* (Year Book Publishers, Chicago, 1956), vol. 2.
6. C. Bohr, "Über die lungenathmung," *Skand. Arch. Physiol.* 2, 236 (1890).
7. M. H. Jacobs, "Some aspects of cell permeability to weak electrolytes," *Cold Spring Harbor Symposium Quant. Biol.* 8, 30 (1940).
8. E. D. Robin, R. D. Whaley, C. H. Crump, A. G. Bickelmann, D. M. Travis, "Acid-base relations between spinal fluid and arterial blood with special reference to the control of ventilation," *J. Appl. Physiol.* 13, 385 (1958).
9. E. D. Robin, P. A. Bromberg, C. E. Forkner, Jr., D. M. Travis, unpublished.

14 August 1958

A Case of Ootestes in the Sea Urchin *Strongylocentrotus Purpuratus*

Abstract. A hermaphroditic sea urchin, *Strongylocentrotus purpuratus*, with three ootestes and two testes is described. Neither cleaving eggs nor embryos were found in *corpore*. Fertilization *inter se* gave normal larvae. The specimen was collected from Palos Verdes, Calif., a region which has yielded an unusually large number of hermaphroditic *S. purpuratus*.

In a former report we listed known cases of hermaphroditism in echinoids, discussed the exceptional occurrence of ootestes, and mentioned other publications in which such cases are recorded (1). On 19 Jan. 1958 one of us (R.A.B.) collected 30 specimens of *Strongylocentrotus purpuratus* at Palos Verdes, Los Angeles County, Calif. This is in the region which has yielded an unusually large number of hermaphroditic *S. purpuratus* (1 to 500), according to the report of Albert Tyler (2). One of the specimens collected at Palos Verdes, when opened, was found to contain both ovaries and testes. This specimen weighed 24.4 g and had a test diameter of 38.4 mm. The five gonads comprised two testes and three ootestes. In the latter, the ovary occupied the dorsal half and the testes the ventral half, hence only the eggs could escape. The gonads were ripe and easily broken. No

Table 2. Comparison of estimated arterial and experimentally determined alveolar ammonia tensions.

Dog No.	Arterial ammonium concentration (umole/lit)	Arterial pH	Estimated arterial ammonia tension		Alveolar ammonia tension $P_{A(NH_3)}$ (10 ⁻⁴ mm-Hg)
			$P_a(NH_3)$ (10 ⁻⁴ mm-Hg)		
5	610	7.48	1.7		5
7	520	7.40	1.2		6

cleaving eggs or embryos were found *in corpore*.

Eggs and sperm from each of the ovotestes were isolated in dishes of sea water. Fertilization *inter se* gave entirely normal larvae. Normal eggs fertilized with sperm from the ovotestes gave normal larvae, as did also the eggs of the ovotestes fertilized with normal sperm.

Subsequently all five gonads were preserved and sectioned. There were thus three types of section: ovarian, testicular, and ovotesticular (from the median zone). Both ovarian and testicular lobes showed normal structure, with masses of ripe and immature eggs or sperm, as the case might be. In the median section, where the ovarian and testicular structures lie side by side, the acini were intermingled. Ripe ova occurred among the sperm. A few eggs showed fertilization membranes, which must have been the result of the recent handling, since no division stages or embryos were found *in corpore*.

It is worthy of note that in a similar hermaphroditic specimen of *Strongylocentrotus pulcherrimus*, Okada and Shimoizumi (3) found that, when selfed, the eggs and sperm resulted in imperfect larvae, while larvae resulting from outcrossing were normal. Thus, their findings differed from those in the experiments described above (4).

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References

1. R. A. Boolootian and A. R. Moore, "Hermaphroditism in echinoids," *Biol. Bull.* 111, 328 (1956).
2. A. Tyler, personal communication.
3. K. Okada and M. Shimoizumi, "Remarks on an hermaphrodite in the sea urchin, *Strongylocentrotus pulcherrimus*," *Bull. Exptl. Biol.* 2, 147 (1952).
4. This study was aided by a University of California research grant.

25 August 1958

"Shutoff Pulse Illusion"

Abstract. Visual signals produced by sharp illumination decrements are commonly misinterpreted because of the presence of an illusory sharp increment at the moment of switching. Conditions for occurrence of the illusion are outlined, as well as conditions under which it is not reported.

During evaluation of a device in which information was transmitted by means of a step-modulated light beam, the visual appearance of certain light signals was found to disagree consistently with these same signals as electronically received and recorded. The discrepant element

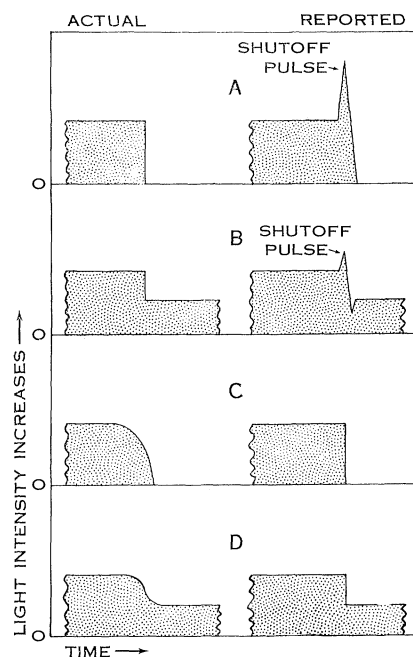


Fig. 1. Conditions associated with "shutoff pulse" illusion.

in all instances was found to be a positive pulse of short duration, reported when the illumination ceased or declined sharply. This illusory signal, here called the "shutoff pulse," is shown diagrammatically in Figs. 1A and 1B. It was noted regardless of whether the light source was a high-temperature filamentary lamp or a glow lamp, provided the lamp supply was direct-current; it was noted at all supply frequencies above about 40 cycles/sec with high-temperature filamentary lamps and at all supply frequencies above about 250 cycles/sec with glow lamps. It was not noted with low-temperature filamentary lamps, and it was masked by flicker and stroboscopic effects at low supply frequencies.

The illusion could be lessened or removed entirely by "fading" the light source in place of "stepping" it, as shown in Figs. 1C and 1D, but the amount of "rounding" seemed to be different for different observers, and some inconsistencies suggested hour-to-hour changes for the same observer.

No simple relation could be observed between the rate of change of illumination and the observed "iris overshoot" of the observer. This well-known "hunting" phenomenon is an oscillatory change in the iris aperture in response to a rapid change in illumination. When illumination changes by a factor of 2, the iris attains a new equilibrium aperture in from 50 to 250 msec with most subjects. When the rate of change of illumination was slow enough for the iris overshoot to be undetectable, the "shutoff pulse" was never reported.

The conditions for maximum illusory

effect appear to be moderate illumination, light intensity change by a factor of 2 or more, and illumination filling at least several degrees of the observer's visual field. With very strong illumination, the illusion, if present, is masked by afterimages. At very weak illumination, it is not reported. If the change in light intensity is very small, the illusion is not reported, and, in some instances, the step modulation is not perceived.

When the key light source is not only weak but also fills only a small portion of the observer's visual field, such as 30 min of arc, the shutoff pulse is not reported. If the light is near the edge of the observer's visual field and is relatively weak, he is likely to report that "it moved" when the intensity is keyed.

This illusion is possibly related to some phenomena recently reported by Baker (1) and Bouman (2). It is roughly analogous to the subjective portions of the "key click" problem, which has plagued the wire and radio-communications industries since their inception, and the "shutoff pulse" illusion is one of the reasons why keyed or step-modulated light beams, with visual reception, are not a satisfactory means of rapid communication.

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References

1. H. D. Baker, "Some direct comparisons between dark and light adaptations," *J. Opt. Soc. Am.* 45, 839 (1955).
2. M. A. Bouman, "Absolute threshold conditions for visual perception," *ibid.* 45, 36 (1955).

11 August 1958

Venom of the Stonefish *Synanceja verrucosa*

Abstract. Moderate doses in rabbits produced hypotension, increased respiratory rate, and myocardial injury. Respiratory arrest occurred with fatal doses when the blood pressure had declined to very low values. The active substance (or substances) was nondialyzable, and the potency of the protein-containing lyophilized or glycerol-treated extracts was maintained well on prolonged storage.

Stonefishes of the genus *Synanceja* have caused a number of deaths in human beings through stings by the venomous spines (1, 2). Two large venom sacs are present on each of the 13 dorsal spines, and much smaller ones on two pelvic and on three anal spines (1). Wounds have occurred commonly on the hand or foot as a result of punctures by the dorsal spines of the fish, which inhabits shallow water over wide areas of the tropical Indian and Pacific oceans. Extreme pain ensues within a few minutes after the sting and then spreads from the wound over the entire extrem-