chromaffin cells lie between the interrenal and the connective tissue of the vein wall (Fig. 1, *C, D*). This peculiar arrangement of cells was observed in all of the species of Scaridae examined, which included *Scarus dubius, S. formosus, S. perspicillatus*, and *Scarops rubroviolaceus*. In regions of the anterior kidney where the interrenal is markedly thickened, however, the interrenal and chromaffin cells were often interspersed.

Among the Labridae studied, the relationship between interrenal and chromaffin cells illustrated in Fig. 1 (*C, D*) was seen in the following species: *Cheilinus rhodochrous* (Fig. 1, *C, D*), *Cheilio inermis, Hemipteronotus baldwini, Novaculichthys taeniourus, N. woodi, Thalassoma duperreyi*, and *T. umbrostigma*. In most of these fishes, other arrangements were also seen, especially in those regions where the interrenal cells are stratified. In five other species of Labridae (*Bodianus bilunulatus, Coris flavovittata, C. ballieui, Cymolutes leclusei, Thalassoma ballieui*), this unusual relationship of interrenal and chromaffin cells was not observed.

Modifications of interrenal location and morphology may be related to the maintenance of an adequate blood supply to this gland, particularly as it increases in size. The function of the sinusoids visible in the interrenal of *Chaetodon* (Fig. 1*A*) may be performed by the larger blood vessel in *Cheilinus* (Fig. 1*C*), as long as only a single layer of interrenal cells lies adjacent to the vein lumen. It is noteworthy that the chromaffin cells maintain a relatively constant position in the vein wall despite marked variations in the distribution of interrenal tissue. The significance of these morphologic variations is not apparent, and attempts to correlate interrenal structure with habitat or taxonomic position of the species have thus far been unsuccessful (*8*).

JEAN NANDI

Cancer Research Genetics Laboratory, Department of Zoology, University of California, Berkeley, and Hawaii Marine Laboratory, University of Hawaii, Honolulu

References and Notes

1. I. C. Jones, *The Adrenal Cortex* (Cambridge University Press, New York, 1957), pp. 131–141.
2. J. Nandi and H. A. Bern, *Endocrinology* **66**, 295 (1960).
3. E. Giacomini, *Monit. zool. ital.* **18**, No. 7 (1902).
4. R. Baecker, *Z. mikroskop. anat. Forsch.* **15**, 204 (1928).
5. A. P. van Overbeeke, *Histological Studies on the Interrenal and the Phaochromic Tissue in Teleostei* (Van Munster, Amsterdam, 1960).
6. Most of the fish were collected at the Friday Harbor Laboratories of the University of Washington and at the Hawaii Marine Laboratory of the University of Hawaii. I am indebted to Spencer Tinker and the staff of the Honolulu Aquarium and to Lester Zukeran of the Hawaii Marine Laboratory for their assistance in obtaining many of the specimens.
7. R. D. Lillie, *Histopathologic Technic and Practical Histochemistry* (Blakiston, New York, 1954), p. 44.
8. I am indebted to Howard A. Bern for his advice during the course of this study, as well as for his help in the collection of much of the material. I thank Lillian Pissott and David Stiller for making many of the histologic preparations, and Victor Duran for the photomicrography. This study was aided by National Science Foundation grant G-8805 and U.S. Public Health Service grant CRT-5045, and by a predoctoral fellowship from the National Science Foundation. This study is contribution No. 157 from the Hawaii Marine Laboratory.

10 April 1961

Potassium Deficiency in Marmots during Hibernation

Abstract. Semiquantitation of potassium deficiency in the renal papillae indicates that woodchucks (*Marmota monax*) are deficient in potassium annually during the time they subsist on stored fats. The deficiency begins prior to hibernation, progresses during hibernation, and, in males, continues during the immediate postemergence period.

A deficiency of potassium appears to be a regular annual event in woodchucks (*Marmota monax*). The deficiency begins prior to hibernation and reaches a maximum immediately after hibernation. During this part of the year the animals subsist on stored fats rather than on ingested food.

Potassium deficiency in these animals is shown by the presence in the cells of the tips of the renal papillae, especially of the collecting tubules, of PAS positive intracytoplasmic granules, or droplets, identical to those which result from potassium deficiency in laboratory rodents (*1–3*). These droplets alone are presumptive evidence of a potassium deficit (*3*). However, the fact that the degree of granulation in woodchucks correlates with serum potassium levels establishes the identity of the droplets as being those produced by a potassium deficit. This relationship permits the use of papillary granulation as an index of potassium deficiency and roughly of its relative degree and duration.

The kidneys of about 2000 woodchucks from the Letterkenny Army Ordnance Depot near Chambersburg, Pa., were examined from 1956 through 1960. Sections through the tips of the renal papillae, cut at 3 μ and stained by Lillie's allochrome procedure (*4*), were available for about 1000 of these (Table 1). The degree of granule formation was graded for each kidney on a scale of 0 to 4, in which 0 indicated no granules and 4 corresponded to the marked degree of granulation observed in rats made severely deficient in potassium experimentally (*1*).

Animals were collected in all months but January and the first half of February, although samples were necessarily small in the months immediately preceding and during hibernation (Table 1). Both males and females begin hibernation in October in the study area. The midpoint of emergence from hibernation is 22 February for adult males and 5 March for adult females. Two torpid animals were taken from underground burrows in December (Table 1). More animals from December and January would be desirable, but woodchucks are difficult to locate in their burrows during hibernation. Serum potassium levels were determined for a

Table 1. Mean grade of PAS positive granulation in epithelial cells of the collecting ducts of the renal papillae of woodchucks. Grading based on a scale of 0 to 4, where 0 = no granules and 4 = the granulation seen in severe experimental potassium deficiency in rats. Data are combined for 1956 through 1960. *P* differences are as follows: between males and females in February, <0.05; between males and females in March, <0.001; between males for February/March and March/April, <0.001; between females for February/March, <0.05; between females for March/April, <0.02; between males for April/May, <0.05. Differences between all other paired successive means: no significance.

Month	Males			Females			Sexes combined		
	No.	Mean	S.E.	No.	Mean	S.E.	No.	Mean	S.E.
February	30	3.47	0.14	4	2.50	0.41			
March	139	2.23	.12	108	1.58	.12			
April	121	1.33	.12	152	1.20	.10	273	1.26	0.07
May	25	0.84	.21	54	0.68	.11	79	0.73	.10
June	32	0.48	.16	45	0.54	.14	77	0.52	.11
July	32	0.61	.27	78	0.40	.07	110	0.46	.09
August	7	0.57	.28	21	0.48	.15	28	0.50	.13
September	45	0.74	.15	51	0.81	.18	96	0.78	.11
October	10	0.95	.34	5	0.80	.34	15	0.90	.25
November	3	1.00	.58	5	1.00	.71	7	1.00	.44
December	1	2.00		1	3.00		2	2.50	

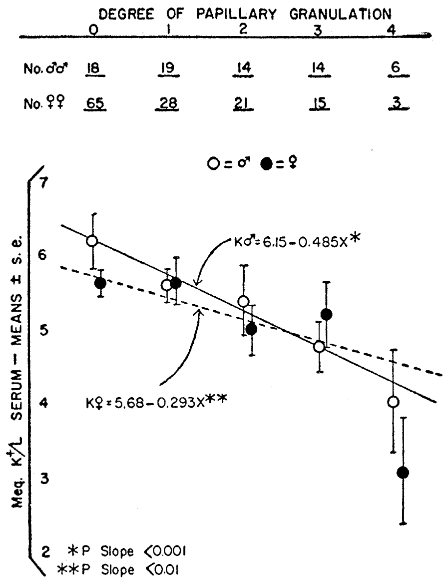

Fig. 1. Degree of granulation in the renal papillae on a basis of 0 to 4 plotted against serum potassium levels for 71 male and 132 female woodchucks.

random sample of 346 animals (*5*). Comparisons between serum potassium and degree of granulation were possible for 203 of these for which there were sections through the papillary tips. Muscle potassium was not measured.

Serum potassium levels declined significantly as the degree of granulation increased in both sexes (Fig. 1). However, the relationship was poorer in the females, as indicated by the lower slope and lower degree of significance, in spite of a much larger sample size. The adjusted mean serum potassium levels of the two regressions were not different (5.15 for males and 5.45 for females), but the difference between the slopes approached significance ($P < 0.10$). Pregnancy and lactation may account for the greater variability in the females. Nevertheless, use of the degree of papillary granulation as a rough index of the degree of potassium deficiency is justified by the significant correlation between papillary granulation and serum potassium levels in both cases.

Renal papillary granulation is marked when the woodchucks emerge from hibernation (Table 1). It then declines exponentially through June, remains at a low level through August, and begins to increase again to reach a relatively marked degree by December (Table 1). The pattern of change in the degree of granulation throughout the year was the same for every year, from 1956 through 1960. During February and March the degree of granulation is significantly greater in males than it is in females (Table 1), but by April the values for both sexes were the same. These differences are accounted for by the fact that males begin to emerge from hibernation about a month before the females, although the mid-points of emergence are about 2 weeks apart. During this period there is little or no food available, and the gastrointestinal tracts of the males invariably are empty (*6*). Consequently, the males are living entirely on stored fat then and, to a lesser extent, afterwards (*6*). On the other hand, the females emerge at about the time food becomes available. The greater degree of granulation and, therefore, presumably, potassium deficiency in males apparently is due to continuing potassium losses without dietary repletion during the 2 to 4 weeks immediately following hibernation. On the other hand, it is clear that the granulation begins to develop immediately prior to hibernation and continues to progress during, and particularly after, hibernation when the animals again are depending on stored fat without ingesting food and, consequently, potassium.

From the preceding evidence, it appears that woodchucks experience an uncompensated loss of potassium during the period of the year in which they subsist largely on stored fats; that is, immediately prior to and during hibernation and, for males, during the immediate postemergence periods. The loss apparently is progressive and cumulative until repletion begins early in March. The loss of potassium could be aggravated by a relatively increased activity of sodium and water-retaining endocrine mechanisms, such as a relative increase in aldosterone secretion, during hibernation. However, this aspect of the problem has not been explored. The adrenal glands in these animals weighed the least during hibernation and increased in weight every year from the end of hibernation until June, apparently as a result of stimulation by social factors (unpublished data). So changes in adrenal weight correlate negatively with the degree of papillary granulation and serum potassium levels. The significance of this relationship, if any, is not apparent.

The rate of potassium repletion, in terms of the disappearance of specific granulation, appears to occur at a constant rate, as indicated by the data in Table 1. Degranulation follows closely a negative exponential curve for each year.

Based on the above evidence it would appear that the development of a relative potassium deficit is a regular feature of hibernation in woodchucks, brought about by continuing losses of potassium without dietary replenishment during the period of dependence on stored fats (*7*).

JOHN J. CHRISTIAN
Penrose Research Laboratory, Zoological Society of Philadelphia, and Department of Pathology, University of Pennsylvania, Philadelphia

References and Notes

1. B. Spargo, *J. Lab. Clin. Med.* **43**, 802 (1954).
2. A. G. H. Pearse and C. R. MacPherson, *J. Pathol. Bacteriol.* **75**, 69 (1958).
3. B. Spargo, F. Straus, F. Fitch, *A.M.A. Arch. Path.* **70**, 599 (1960).
4. R. D. Lillie, *Histopathologic Technic and Practical Histochemistry* (Blakiston, New York, 1954).
5. Measurements of serum potassium were made through the courtesy of Capt. H. C. Sudduth, MC, USN, by the Division of Experimental Medicine, U.S. Naval Medical Research Institute, Bethesda, Md.
6. R. L. Snyder, D. E. Davis, J. J. Christian, *J. Mammal.*, in press.
7. This study was supported by grants H-4836 and H-4759 of the U.S. Public Health Service and by the U.S. Naval Medical Research Institute.

18 April 1961

Existence of Absorption Bands at 730–740 and 750–760 Millimicrons in Algae of Different Divisions

Abstract. Absorption studies, made on suspensions of *Anacystis nidulans*, *Chlorella pyrenoidosa*, and *Porphyridium cruentum* by means of an integrating spectrophotometer, suggest the existence of pigments absorbing "extreme red" light in the 720- to 800-mμ region. In the blue-green alga *Anacystis*, one pigment of this type exists, which produces a relatively strong absorption band at 750 mμ. In the green alga *Chlorella* and the red alga *Porphyridium*, two considerably weaker absorption bands appear, at 730 to 740 mμ and 750 to 760 mμ, which may be due to one or two pigments. These pigments must be responsible for the photoinhibition of photosynthesis observed in these algae in the same spectral region; as yet, no photoinhibition has been observed in *Anacystis*.

Rabinowitch *et al.* (*1*) and Govindjee *et al.* (*2, 3*) have demonstrated the occurrence of photoinhibition of both photosynthesis and the Hill reaction by extreme red light in various algae. This caused us to make a search for the presence in algal cells of pigments absorbing in the extreme red region of the spectrum. The green alga *Chlorella pyrenoidosa*, the red alga *Porphyridium cruentum*, and the blue-green alga *Anacystis nidulans* were used. *Chlorella* and *Porphyridium* were grown as previously described (see *4*); *Anacystis* is now be-