by aluminum oxide adsorption and elution, gave the following positive reactions: polypeptide (biuret and ninhydrin), nitrogen, and sulfur. Negative results were obtained in tests for tryptophan (*p*-dimethylaminobenzaldehyde) and carbohydrate (Molisch).

The antibiotic activity present in the culture filtrate can be separated into at least two components by development of one-dimensional paper chromatograms with buffered methanol as solvent. The component which remains at the point of application will be referred to as synnematin A and the component which moves with the methanol as synnematin B.

When 20 units of synnematin, as culture filtrate, were applied to paper strips (Whatman No. 1), developed with buffered methanol, and placed on agar plates seeded with 5 organisms, the inhibition zones shown in Fig. 1 were obtained after 16 hr incubation at 37° C. From Fig. 1 it is apparent that synnematin A is the most active against *Proteus vulgaris* and *Sarcina lutea,* nearly as active against *S. typhimurium,* and shows some activity against *B. subtilis* and *Staph. aureus.* Fig. 2 shows that the purified fraction described above with an activity of 80 u/mg is synnematin B and contains no observable amount of synnematin A. Synnematin B is very active against *Sarcina lutea, Proteus vulgaris,* and *S. typhimurium* and shows little or no activity against *B. subtilis* and *Staph. aureus.* It is to be noted that the inhibition zone of purified synnematin against *B. subtilis* extends only the width of the paper strip itself. Neither component is effective against *E. coli* at these activity levels.

References

1. ROBERTS, J. M. *Mycologia,* **44,** 292 (1952).
2. GOTTSHALL, R. Y., ROBERTS, J. M., and PORTWOOD, L. M. Presented at Michigan Branch, Soc. Am. Bacteriol. (Oct. 6, 1949).
3. GOTTSHALL, R. Y., *et al. Proc. Soc. Exptl. Biol. Med.,* **76,** 307 (1951).

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The Relation of Adrenal Weight to Body Weight in Mammals[1]

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Most reports concerned with adrenal gland weights have dealt, as a rule, with a limited weight range, with a single species, or with a few closely related species. The adrenal weight is usually expressed as mg/100 g body weight. We are unaware of any reports giving the absolute adrenal and body weights for a large group of species. This is particularly pertinent to data collected from wild mammals. In addition, there usually has been a failure to state whether the data have been collected from captive or feral specimens. Rogers and Richter (*1*) have shown that there is a wide divergence in adrenal weight with respect to body weight between captive and wild rats (Norway and alexandrine). In addition, material collected at the Philadelphia Zoo (*2*) and in our laboratory (*3*) indicates that relative adrenal atrophy is a frequent occurrence in captive, closely confined mammals, particularly in the normally very active varieties. Hence, data from captive wild mammals do not necessarily portray the state of affairs under feral conditions and are often ill-suited for comparative purposes. This paper presents data on feral mammals, man, and a few captive mammals.

During the past five years adrenal weights have been collected from 19 wild species (Fig. 1), including representatives of the orders Insectivora (families Soricidae, Talpidae), Chiroptera (family Vespertilionidae), Carnivora (families Procyonidae, Mustelidae), Rodentia (families Sciuridae, Muridae, Cricetidae, Zapodidae), and Marsupialia (family Didelphiidae). Use has been made of data for muskrats collected by Beer and Meyer (*4*), since their data include a much larger number of muskrats than the author's. These data were given as monthly averages throughout the year, separately for adult males, adult females, immature males, and immature females. For the present purpose, the monthly means for each group are arranged in order to obtain an over-all figure with equal weight for each month. The figures for man are those of Holmes, Moon, and Rinehart (*5*) and represent 200 people dying from traumatic or natural causes. The material on the jaguar, polar bear, and some of the raccoons was obtained from the Philadelphia Zoo by H. L. Ratcliffe. The adrenals of the jaguar and polar bear are included in spite of their being captive mammals, since they fall on the curve for unatrophied glands, and there is reason to believe that these animals were about as active in captivity as their feral counterparts. The published weights for 100 male guinea pigs (*6*) are included, as well as our own, for a smaller series of active animals of both sexes, since they too failed to show evidence of atrophy of the adrenals for similar reasons, although closer confinement is known to produce this effect (*3*).

The wild rats represent captures from the city of Baltimore, Md., and from a rather isolated colony on a farm north of Baltimore. All rats have been lumped together in weight groups for the purposes of this paper. The average combined adrenal weight for the rats in each weight class has been plotted. A similar procedure has been followed for the big brown bats (*Eptesicus*) and the guinea pigs from our laboratory.

With the exception of human, muskrat, guinea pig, jaguar, polar bear, and raccoon data, all weights are after fixation in neutral formalin. The author has found that the weights of adrenals fixed *in situ* and subsequently dissected free are as dependable as fresh weights, and in the case of the small mammals prob-

[1] The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

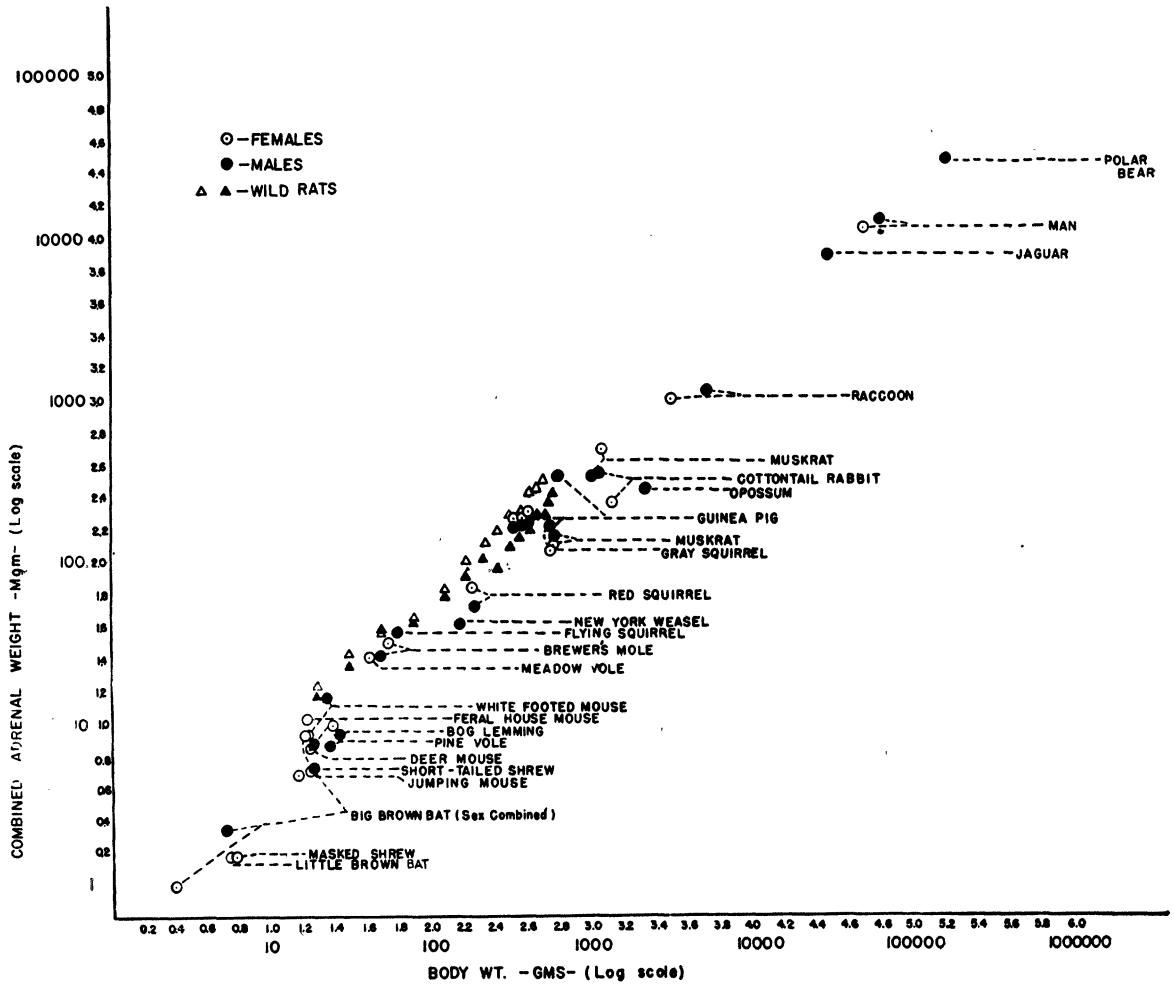

FIG. 1.

ably more so, since the glands may be rid of all excess tissue with ease, and there appears to be considerably less variation in weight because of evaporation. A more detailed analysis of this point will be presented at a later date. All adrenal weights were obtained on appropriate balances (a 10-mg Roller-Smith precision balance, a 500-mg Roller-Smith, or pan balances).

The data are plotted in Fig. 1 as the log of the combined adrenal weight in milligrams *vs.* the log of the body weight in grams. It will be noted that all species fall on the same curve, including man, with the possible exception of those mammals weighing less than 15 g. The latter apparently show a slight degree of relative adrenal atrophy. Inspection of the log adrenal weight/log body weight ratios will reveal that, for the lower end of the curve, ratios should be based on tenths of milligrams and grams, respectively, if one is working with mice or smaller animals. The usefulness of these logarithmic ratios cannot be overemphasized if one must deal with relatively large weight ranges. The fact that the points fall on a straight line justifies the use of mg adrenal weight/100 g body weight for relatively small weight ranges, but it also shows that this relationship cannot be used over a large weight range. It appears that the concept of relative adrenal atrophy with increasing size has arisen as a result of using the direct rather than logarithmic relationship between adrenal and body weight. There can be little doubt that, for the species so far examined, the adrenal weight is a logarithmic rather than a linear function of the body weight. It will be noted that the curve for all the species closely follows that for wild rats from 15 to 650 g body weight. Finally, with the exception of the rabbit, in all species for which there are adequate data, the adrenals of the mature female are relatively heavier than those of the mature male, and are approximately the same in both sexes in the immature animals.

The outstanding fact that these data show is that the adrenal gland weight follows a definite logarithmic relationship to body size for all species examined, and that this relationship parallels that in a single

species (*Rattus*) over a wide age and weight range. Additional material collected in the future for the same and different species might be expected to define this curve more sharply, but not to alter it in any essential manner. The two extremities, in particular, need further validation.

References

1. ROGERS, P. V., and RICHTER, C. P. *Endocrinology,* **42**, 46 (1948).
2. CHRISTIAN, J. J., and RATCLIFFE, H. L. *Am. J. Path.,* **28**, 725 (1952).
3. Unpublished data.
4. BEER, J. R., and MEYER, R. K. *J. Mammal.,* **32**, 173 (1951).
5. HOLMES, R. O., MOON, H. D., and RINEHART, J. F. *Am. J. Pathol.,* **27**, 724 (Abstr.), (1951).
6. LATIMER, H. B. *Anat. Record,* **111**, 299 (1951).

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Effect of X-Rays on Micronuclear Number in *Paramecium aurelia*[1]

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The reduced viability of exautogamous descendants of *Paramecium aurelia* exposed to x-rays or nitrogen mustard has been interpreted as the result of gene mutations or small chromosomal aberrations in the micronuclei (*1, 2*). In addition, other inherited changes may be involved (*2*). Among these, one that could be important is the loss of micronuclei immediately after irradiation. Although circumstantial evidence against such loss has been reported (*1*), no quantitative data on micronuclear frequency after exposure to mutagens have been available by which to test this hypothesis directly.

Experiments were therefore designed to evaluate the magnitude of variation of micronuclear number in relation to x-ray dosage to determine whether such variation could, in fact, contribute appreciably to the genetic results previously obtained with this organism.

Tube cultures of stock OR, variety 1 of *P. aurelia,* maintained by standard methods (*3*) were centrifuged and resuspended in fresh culture medium. One-ml samples of the resuspended cultures were exposed to x-rays in Lucite dishes on a rotating turntable. The x-ray source was a GE Maxitron operated at 250 kvp and 30 ma, with approximately 1 mm of Al inherent and no added filtration. The intensity measured by a nylon Victoreen chamber in air was 15–17 kr/min.

After exposure, samples of 15 animals were isolated individually from each group so that the effect on division and survival could be determined. The remaining animals were placed in test tubes with an excess of culture fluid and allowed to multiply for 24 hr at 27° C. At the end of this period, they were fixed in Schaudinn's fluid (60° C), stained by Dippell and Chao's (*3*) modification of the DeLamater technique, omitting the formalin mordant. The number of micronuclei per animal was then counted. The following types of animals were excluded from the count: animals containing more than two macronuclear fragments, animals partially hidden by other animals or debris, broken or fragmented animals, and animals that were not differentially stained. Dividing animals were accepted as single animals and the number of micronuclei taken to be half the total found.

Data from these studies are given in Table 1. It is of interest to note that there is a small variation in micronuclear number in unirradiated animals. In irradiated animals, the fraction with less than two micronuclei increased with increasing dose, whereas the fraction with two decreased. No unequivocal change occurred in the group with more than two micronuclei. By pooling the data from each exposure into groups of animals with (1) more than two micronuclei, (2) two micronuclei (the usual number), and (3) less than two micronuclei, the classes are large enough to test statistically. The data are heterogeneous, as shown by a χ^2 value of 112 for 12 degrees of freedom ($P < 0.01$).

The present study does not throw light on the mechanism by which abnormal numbers of micronuclei arise. However, the failure to produce more than about 10% of animals with less than two micronuclei

TABLE 1

EFFECTS OF X-RAYS ON MICRONUCLEAR DISTRIBUTION IN *Paramecium aurelia*

Dose (kr)	Survival in sample of 15 animals	Mean No. fissions of survivors (in 24 hr)	Percentage of animals with various numbers of micronuclei					Total No. animals counted
			4	3	2	1	0	
0	15	3.2	0	4	93	3	0.4	435
214.2	15	2.1	2	2	91	1	4	86
275.4	15	1.6	0	3	87	7	3	30
335.7	7	1.1	3	2	83	10	2	100
336.6	14	1.0	6	16	72	0	6	18
402.8	5	1.2	0	5	78	6	11	100
469.9	3	1.3	1	9	79	4	7	100*
537.4	2	0.5	0	7	57	19	17	83

* One animal exposed to this dose, but not included in the count, had 7 micronuclei.

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