succumbed to the disease in 4 days. Guinea pigs immune to the virus of lymphocytic choriomeningitis and mice immune to the St. Louis strain were all susceptible to intracerebral injection of the Br virus.

Mouse brain antigens, prepared with this virus by methods previously described,[1] gave a positive complement fixation against immune serums of the western type but not against those of the eastern or the Moscow No. 2 equine strains nor of lymphocytic choriomeningitis.

During the summer months of both 1937 and 1938 numerous cases of encephalitis of unknown etiology have been reported from the San Joaquin Valley regions in California; especially from around Fresno and Tulare. Until the present time no virus had been recovered from the few specimens examined, but it had been shown[2] that serums from 56.6 per cent. of the recovered cases in this area gave neutralizing antibodies to the virus of St. Louis encephalitis. Although no virus was found, it was assumed that this strain was present in the locality. However, the clinicians were recognizing several different clinical pictures in their patients; an extremely acute, fulminating form with death in a few days, a lethargic type with a prolonged course usually with residual effects, and others that were milder, sometimes transient, ending in good recovery. Cases were reported in all age groups, with many in children and babies. Definite convulsions were often noted in the young children, persisting for some time. Serums from this latter group and from those having residual after-effects were usually negative when tested for neutralization against the St. Louis virus. At present, serums from three children having the convulsive type at the Kern County Hospital have been found to neutralize the new Br strain of virus and not that of the St. Louis. It seems probable, therefore, that both these viruses are responsible for cases of encephalitis in these regions.

Although the virus of equine encephalomyelitis was first reported by Meyer, Haring and Howitt[3] from the horses in the San Joaquin Valley area in 1931, yet this is now the first time the virus has been recovered from a human brain in California. However, that it very likely could be transmitted to the human host from the equine was early considered by Meyer,[4] who in 1932 reported one fatal and one non-fatal case of suspected encephalomyelitis in two men associated with sick horses. The symptoms were similar to those shown by many of the present cases. That the virus could be recovered from a human being had also been noted by the writer in 1934 when it was found in the cerebrospinal fluid of a man who died under such unusual conditions that the case could not be reported at the time.

Although the equine disease has been endemic among the horses in the valley regions for a long period, yet there have been no unusual number of cases reported among the animals during the past few years.

It is interesting that the virus of equine encephalomyelitis should have been found in man almost coincidently in two widely separated portions of the United States, being first reported recently from Massachusetts by Fothergill, Dingle, Farber and Connerly[5] and by Webster and Wright[6] for the eastern type and now in California for the western form, which is serologically and immunologically distinct from the other.[7]

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SIZE AND STROKE OF THE HEART IN YOUNG MEN IN RELATION TO ATHLETIC ACTIVITY[1]

THERE is a common belief that strenuous athletic activity results in an increased size of the heart. It is also frequently considered that this may be a deleterious adaptation, either because it indicates undue strain or because of the danger of eventual degeneration. The scientific debate on this question is now more than thirty years old,[2] but there are important inconsistencies in the published data. Papers up to 1933 were reviewed by Steinhaus.[3] In a more recent paper Roesler[4] states that the diastolic outline was unusually large in four athletes and that the outline was decreased after cessation of training.

Our comment on previous work may be summarized briefly: (1) Most of the studies have been made with the orthodiagraph, so that the heart shadow is only outlined in diastole. (2) True resting conditions have not always been maintained. (3) When the teleroentgenographic method was used precise correction for distortion was not made from lateral roentgenograms on the different individuals. (4) Strictly comparable controls were not measured under the same conditions.

2 B. F. Howitt, *Jour. Bacter.*, 36: 294, 1938.

3 K. F. Meyer, C. M. Haring and B. F. Howitt, SCIENCE, 44: 227, 1931.

4 K. F. Meyer, *Ann. Int. Med.*, 6: 645, 1932.

5 L. D. Fothergill, J. H. Dingle, S. Farber and M. L. Connerly, *New England Jour. Med.*, 219: 411, 1938.

6 L. T. Webster and F. H. Wright, SCIENCE, 88: 305, 1938.

7 Appreciation is extended to Dr. H. M. Ginsburg, Dr. F. Cooley, Dr. Newell and Dr. S. Simon, of the Fresno County General Hospital, and to Dr. M. A. Gifford and Dr. W. C. Buss, of the Kern County Hospital, for their kind cooperation and many courtesies offered.

1 From the Laboratory of Physical Education and Physiology and the Department of Radiology, University of Minnesota Medical School, Minneapolis, Minnesota.

2 Schieffer, *Deut.* [illegible], [illegible]: 604, 1907.

3 A. H. Steinhaus, *Physiol. Rev.*, 13: 103–147, 1933.

4 H. Roesler, *Am. Jour. Roentgenology*, 36: 849–853, 1936.

(5) It is uncertain that the effect of body size was corrected for properly.

In this laboratory we have studied college students between the ages of 18 and 28. All measurements have been made in the afternoons of days on which the subjects had not had any strenuous exercise. The subjects had had light luncheons from 3 to 4 hours previously, except in a few cases where the interval after luncheon was slightly less. In the laboratory each subject rested quietly in bed for 15 to 30 minutes and was then wheeled into the x-ray room on a litter. After receiving instructions, the subject stood up and a Roentgen kymogram was taken immediately. Effort was made to secure the same degree of inflation of the lungs in all subjects. The x-ray tube was kept at 66 inches and the period of exposure was either 2.5 or 3 seconds. The slits in the lead kymograph grid were 1 mm in width and the distance between slits was 10 mm. Immediately following the Roentgen kymogram, an ordinary lateral plate was made from 6 feet.

The outlines of the diastolic and systolic shadows were traced in pencil directly on the x-ray negative; in the small uncertain region of the upper and lower margins the diastolic and systolic outlines were made to coincide.[5] The outlines were transferred to tracing paper for measurement of the areas by the planimeter. The area measurements were made in triplicate. Body surface was calculated from the formula of DuBois.[6]

On the basis of complete records of college, high school and outside muscular activities, the subjects were graded into three groups with the following general characteristics: (1) *Athletes*—highly successful competitors in several major sports involving severe and prolonged exertion (football, basketball, rowing, distance swimming and running). (2) *Non-Athletes*—those who indulged in no more than occasional mild athletic recreation. (3) *Intermediates*—moderately successful competitors in one major sport, such as football, or several sports, such as baseball, tumbling, field events, etc.

The relative sizes of the hearts in systole are shown for the three groups in Fig. 1. In terms of square centimeters of heart shadow per square meter of total body surface, there is no significant difference between the three groups.

A very different result emerges when we compare the relative stroke areas (diastolic area minus systolic area, per square meter of total body surface). There is a regular progression from large to small—athletes, intermediates, non-athletes—in both the means and the ranges, and these differences are significant.

The number of individuals compared here is some-

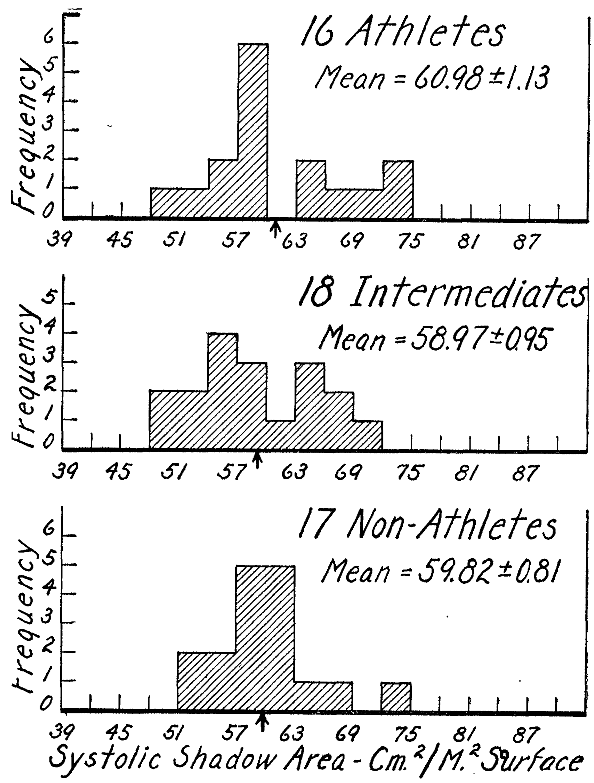

FIG. 1. Size of the posterior-anterior projection of the systolic heart in rest. Means, probable errors and numbers of individuals in groups separated by intervals of 3 square cm per square meter of body surface.

what small, but several tentative conclusions seem justified: (1) Continued successful participation in strenuous sports through the college years does not lead to any significant increase in the size of the contracted heart in rest. If we may assume, as seems reasonable, that there is no great difference in the degree of emptying of the ventricles at contraction, this would mean that the relative muscle mass of the heart is also practically unaffected. In this connection it should be noted that, as we have drawn the outlines of the Roentgen-kymograms, the ventricles represent nearly the entire measured shadow.

(2) The degree of relaxation and filling of the heart in diastole is very much greater in the athletes than in the non-athletes, the moderate athletes being intermediate but closer to the non-athletes.

The main requirement for the blood circulation provided by the heart is the transport of the gases involved in metabolism. Under resting conditions the metabolism is normally most closely related to the total body surface. For this reason we have expressed heart size in terms of body surface in order to correct for the effect of the varying sizes of the individuals. However, the same relations as reported above are found when comparisons are made of heart size per

[5] C. R. Bardeen, *Am. Jour. Anat.*, 23: 423–487, 1918.

[6] E. F. DuBois, "Basal Metabolism in Health and Disease," Philadelphia, Lea and Febiger, 1936.

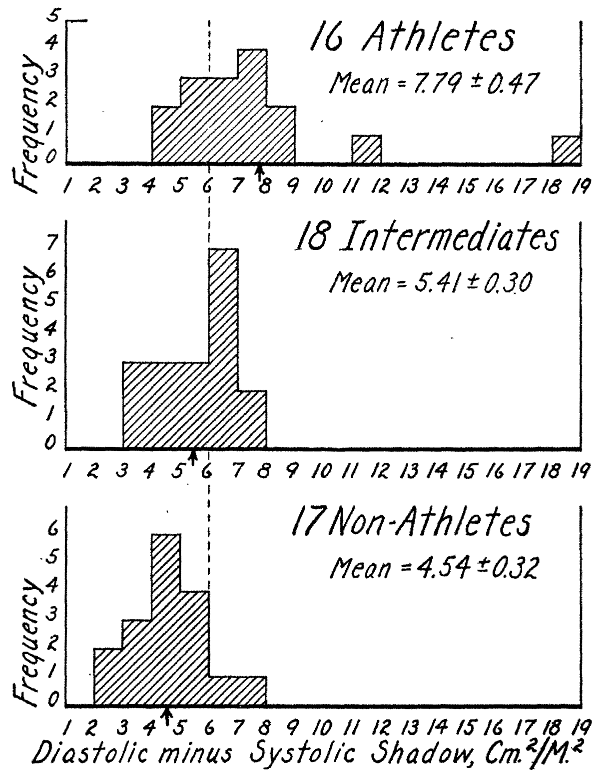

FIG. 2. Size of the stroke of the heart in posterior-anterior projection. Means, probable errors and numbers of individuals in groups separated by intervals of 1 square cm per square meter of body surface.

unit of body weight. We found, however, that the variation between individuals was 12 per cent. greater when body size alone was used.

In our series bradycardia was well marked in the athletes, and the slowness of pulse was, on the whole, proportional to the extent of participation in strenuous sports. It would be tempting to estimate rates of circulation from these data, but special experimental studies are needed to provide the numerical factors and to evaluate the accuracy of such a procedure. These experiments, on which we are now engaged, include:

(1) Simultaneous Roentgen kymography and direct cardiac output studies on the heart-lung preparation of the dog.

(2) Simultaneous Roentgen kymography and cardiac output measurement by the acetylene method in man.

(3) Roentgenograms on the heart in the intact cadaver followed by direct measurements on the heart removed from the chest.

(4) Calculations from mean cardiac outputs and mean cardiac shadows in normals.

The results thus far indicate that the estimation of cardiac output and total heart volume is perfectly feasible from the Roentgen kymograms. Since completion of this note we have partially completed an analysis on a larger series of subjects with the results in full agreement with those given here.

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TOBACCO-MOSAIC VIRUS CONCENTRATED IN THE CYTOPLASM[1]

INVESTIGATIONS carried out by Chibnall[2,3] and by Phillis and Mason[4] indicate that the vacuolar sap and the cytoplasmic extract can be obtained as essentially separate fractions when the leaves are subjected to suitable treatments. Phillis and Mason separated the vacuolar sap from the cytoplasm of cotton leaves by simple application of 6,000 to 16,000 pounds per square inch pressure to the whole leaves. It was found that this method is unsuitable for tobacco leaves, the texture of the leaf being destroyed at pressures much less than those to which cotton leaves were subjected. We were successful in using the method of Chibnall,[2] which was also used by Livingston and Duggar[5] in similar studies.

Fresh leaves were harvested from mature *Nicotiana tabacum* L., variety Maryland Medium, systemically infected with tobacco common mosaic. Midribs were removed, and 175 grams of leaf tissue completely immersed in 100 grams of ether for 10 minutes. Surplus ether was poured off and the leaves placed flat in a pile of cheese cloth, between flat plates of a hydraulic press. Pressure was applied slowly, up to 5,000 pounds per square inch, and the vacuolar sap obtained as a clear brown liquid, amounting to 45 cc. The pressed tissue was frozen over night at zero degrees F. and thoroughly pulped in a meat grinder. The ground pulp was diluted with 50 cc of water and 20 cc of 0.5 M disodium phosphate solution added. After extracting at two to four degrees C. over night the whole juice was pressed out. This extract was dark green and contained much pigment and cell debris. After filtering through Celite, 78 cc of clear brown solution was obtained, which was regarded as cytoplasm sap.

In agreement with the results of Chibnall[2] on spinach, the vacuole sap contained a very small amount of protein. It was partially insoluble in 0.5 saturated ammonium sulfate and precipitated by trichloro-acetic acid. The 45 cc of vacuolar sap contained 0.317 mg/cc of total N, and only 0.022 mg/cc of protein N. Most of the protein was in the 78 cc of cytoplasmic extract, which contained 0.583 mg/cc of total N, and 0.389 mg/cc of protein N. On this basis the vacuolar sap

[1] Studies conducted under Bankhead-Jones Project S.R.F. 2-17, U. S. Department of Agriculture, Bureaus of Plant Industry and Chemistry and Soils cooperating. Food Research Division Contribution No. 387.

[2] A. C. Chibnall, *Jour. Biol. Chem.*, 55: 333, 1923.

[3] *Ibid.*, *Jour. Biol. Chem.*, 61: 303, 1924.

[4] E. Phillis and T. G. Mason, *Nature* (London) 140: 370, 1937, No. 3539.

[5] L. G. Livingston and B. M. Duggar, *Biol. Bull.*, 67: 504, 1934.