The Relation of the Thymus Gland to Sexual Maturity

Thomas Francis Ahearn Jr.
Loyola University Chicago

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LOYOLA UNIVERSITY

THE

RELATION OF THE

THYMUS GLAND

to

SEXUAL MATURITY.

A THESIS SUBMITTED

IN CANDIDACY

FOR THE DEGREE

OF

MASTER OF SCIENCE

THOMAS FRANCIS AHEARN JR.

1929
Introduction.

While the thymus gland has been the subject of experimentation as far back as 1840, there seems to be little actually known as to its true function. An investigation of the literature brings to light a collection of reports that are in many instances widely divergent. The thymus has been considered to be intimately associated with the growth and development of bone, calcium metabolism, immunity and has been even considered as essential to life.

Such conclusions, however, are not surprising when one considers the unfavorable conditions which often existed in early experiments. In the first place many of the experiments were poorly controlled, if at all. Often the technique was at fault, and more important, the experimental animals in a great majority of cases were kept in an unsuitable environment. The practice of utilizing animals gathered at random from the streets, in all stages of malnutrition, especially susceptible to disease and infection, is not compatible with accurate results.

The work of recent investigators, in which such unfavorable conditions have been satisfactorily overcome, fails to corroborate many of the wide claims presented in the early literature. Although some workers steadfastly hold that there is a relation between the thymus and sexual maturity, we believe that there has been presented little conclusive evidence
up to the present time, to affirm or deny this possibility. This particular work was undertaken with the hope of presenting definite, conclusive information regarding thymus function as related to sexual maturity.
Investigations regarding the function of the thymus have been conducted as a rule, along one of three different lines. The first, and the records of which appear to be most abundant, is surgical removal of the thymus.

What is probably the first attempt at extirpation of the thymus was performed by Restelli (1) in 1845, using various species of animals. His work, however, is only of historical interest. His successor in this field, Friedleben (2), operated upon different species of animals also. Of the entire group, he considered seven as complete thymectomies. He concluded from his observations that although the thymus was not essential to life, it was concerned with the growth of bone and general metabolism. Langerhans and Saveliew (3), several years later, also found the thymus unnecessary to life, but reported no other definite effects.

In two successive papers, Tarulli and Lo Monaco (4,5) reported the results of thymectomies in puppies. They claimed to have observed temporary changes in the blood picture, temporary retardation in growth and development of strength, and, permanent alterations in the hair of the animal.

Abelous and Billard (6) then announced that in frogs, after removal of the thymus, a marked pathological condition seemed to occur, eventually followed by death. However, later work by Vincent (7), Hammar (8), Pari (9) and others failed to
substantiate this claim. Furthermore, Adler (10) found that in three completely thymectomized frogs life was not only unimpaired, but that the testicles were considerably larger than those of the controls.

In 1905, Paton (11) reported the results of thymus extirpations in guinea pigs. He removed the gland from his animals at the ages of one to forty-five days. When the animals had attained the weights of 115 or 355 grams the testes and epididymes were removed and weighed. Controls were subjected to the same procedure. It was found that the testes of thymectomized animals below 300 grams (i.e. before the time at which the thymus is considered to undergo involution) were heavier than those of the controls. He concluded that removal of the thymus produces a more rapid development of the testes. No definite results were obtained with female guinea pigs.

Bracci (12) thymectomized eleven rabbits. He stated that his examination of the thyroids, testes, ovaries and suprarenals showed no gross or microscopic changes.

From 1902 to 1908, Basch (13,14,15) did very extensive work on the thymus, chiefly in dogs. He perfected an operative technique that was closely followed by subsequent workers. As a result of his observations Basch concluded that the thymus was not essential to life, but was intimately concerned in the growth and development of bone and the process of calcification. Evidently no studies were made on the side of sexual development.
Soli (16,17,18), in 1909 published a paper in which he discussed the results of thymus removal on the sex organs. In his experiments he used rabbits, fowl and guinea pigs. The ages or weights of the experimental subjects are not given. However, Soli claimed that removal of the thymus produced a delayed development of the gonads in all three species. This lack of development, it may be mentioned was most marked in the cock, but not so obvious in the rabbit and guinea pig.

Ranzi and Tandler (19), in a series of thymectomies on dogs, reported that they did not obtain results akin to those of Paton. That is, the removal of the thymus did not produce acceleration in the growth of the testes. Soon after an account of the very extensive work by Klose and Vogt (20,21) on thymus removal was published. Their experiments were chiefly on dogs. These workers claimed that their thymectomized animals developed a great number of pathological symptoms, such as trophic disturbances of the skin and hair, lowered resistance to infection, interference with bone growth and repair and changes in various endocrine glands. Hypertrophic conditions of the spleen, thyroid, pancreas and genital organs appeared, the hypertrophy being especially noticeable in the latter two organs. In most cases the gonads of the thymectomized animals were said to weigh almost twice as much as those of the controls. Microscopically, no variation from the normal histology was apparent.

Matti (22), also used dogs in a series of thymus extirpations. He arrived at the conclusion that the thymus was essential
to life, and had an important relation to growth and development. Furthermore, he believed that some relationship existed between the thymus, thyroid and medullary portion of the suprarenal. No statement is made concerning the gonads.

In 1911, Paton (23) again published an article concerning the relation of thymus and testes. As a result of some further experiments he concluded that in the guinea pig the thymus and testes both exercise an influence on the growth of the sexually immature animal; on removal of either testes or thymus, the one can compensate in growth impulse for the loss of the other, and in doing so may undergo a more rapid development, or, as in the case of the thymus, persist for a longer period than is normal. In the female the interrelation of thymus and ovaries was not so apparent.

In contrast to the results of Patons' experiments were those obtained by Lucien and Parisot (24). They performed thymectomies on several rabbits and noticed that the testes of two, killed two and one-half months following the operation, were considerably lighter in weight (one-fifth) than those of the controls. The ovaries of three thymectomized females were slightly larger than those of the controls, and the follicles seemed somewhat retarded in development. Then again, Magnini (25), in his thymectomies upon rats, reported that he was unable to detect any changes in the testes or other endocrine glands.

Pappenheimer (26,27) thymectomized several white rats at the ages of three weeks or less, eleven of which he later
proved to be thymus-free by means of serial sections. He reported the following observations: white rats may survive the operation for 131 days, although operated upon in the first two weeks of life; there is no arrest or retardation of body growth or development; qualitative changes in the teeth or skeleton were not found; no characteristic effects on spleen, testes, suprarenals or thyroid; the relative proportion of lymphocytes in the blood was diminished for the first few weeks after the operation.

In reporting their results of thymectomies in guinea pigs, Halnan and Marshall (28) flatly contradict the results claimed by Paton. They state that thymectomy does not result in hypertrophy of the testes, and that simultaneous removal of thymus and testes does not affect the growth of the immature animal.

Park (29) in 1917 studying the effect of thymus extirpation in the guinea pig, came to the conclusion that complete removal of the organ in this animal was impossible. He consequently considers all previous thymectomies on these animals as only partial. Again in 1919 Park working with McClure (30) in a series of thymus removals in puppies, report negative results as regards any effect on development, growth, alterations in the hair or teeth, and the absence of any abnormalities in the organs of internal secretion. They state that the thymus is not essential to life in the dog.

Recently, workers have attacked this problem of thymus
function by endeavoring to produce a condition of "hyperthymism" in their experimental animals. In 1914 E.E. Hewer (31) using fresh lambs thymus, claimed to have caused this condition to occur in rats. She stated that the males seemed to be more susceptible to such feeding than the females. No definite growth changes took place. With moderate doses of thymus, sexual maturity in the animals treated was noted to be delayed. This retardation of sexual maturity was observed to be related to delayed development of the testes. Large doses of thymus, four grams or more per day, produced a definite effect in the structure of the testes; in the young rat a retardation of development; in the mature animal a degeneration. This degeneration was confined to the testes. Hewer also stated that animals in this hyperthymic condition appeared to be sterile. The thymus itself apparently was not affected by the feeding.

Olkon (32) in 1918, injected a preparation of thymus extract intraperitoneally into guinea pigs. In his report he mentions well marked changes; muscle spasm, dyspnea, convulsions and death of several of the animals soon after the injection. The general appearance of the animals indicated grave metabolic disturbances, with emaciation accompanied by dryness and roughness of their fur. He also mentioned that a reduction of body weight occurred in his animals.

Downs and Eddy (33) also injected an extract of thymus into rabbits, using however, subcutaneous injections in their procedure. They report that large doses, while checking the
putting on of weight in young rabbits, did not otherwise impair growth or development. A considerable increase in weight of the thyroid and spleen and a decrease in weight of the thymus was also noted.

A number of investigators have made studies of the effect of castration upon the thymus. Among these we find Soli (16), Calzolari (34) and Henderson (35) reporting a persistence and delayed involution of the thymus resulting from such an operation. Henderson also states that in bulls and unspayed heifers, the normal atrophy of the thymus which begins after the period of puberty, is greatly accelerated when the bulls have been used for breeding and when the heifers have been pregnant for several months.

In the brief review presented above we have seen that the various claims of thymus function persistently advanced by early workers have been shown to be incorrect by the more recent investigations. Since the results of this later work have been practically negative, we have been satisfied to assume that the thymus is purely a lymphoid organ. Still, there is enough variance of opinion regarding this matter to cause one to hesitate before accepting this rather sweeping assumption. It is our belief, therefore, that the problem requires more investigation.
Problem.

On the suggestion of Dr. Thesle T. Job that the thymus may have some intimate relation to the advent of sexual matur-
ity in animals, a series of experiments have been conducted, and are being continued at the present time to determine if sucha relation exists. The work has been done along lines proposed by Dr. Job, who by his invaluable counsel and hearty co-operation has been a kindly stimulus in the carrying on of this investigation.

From the literature on thymus function it can be seen that many workers persistently have believed that some relation exists between it and the sex organs, and a great deal of the later work on the thymus has been done with this possibility in mind. However, the results obtained have been so conflicting that the majority have rejected them and our actual knowledge concerning the true function of the thymus is speculative to a great extent.

While the literature contains a large number of records of work on the thymus and sex organs, in which the latter were weighed, measured and examined grossly and microscopically for "pathology" following thymectomy, little evidence can be found of a series of well controlled experiments designed to demonstrate a normal physiological relationship between the two, i.e., whether the thymus has an inhibitory influence on
the development of the sex organs, by removing it and observing if a precocious sexual development or puberty occurs. The following experiments then, were undertaken with this purpose in view, and with the hope that they may contribute to our knowledge regarding the thymus.
Material and Technique.

The experimental animal used in our investigation is the Mus Norvegicus Albinus, or Norwegian white rat, an excellent colony of which exists in our department. The original matings were obtained from the Wistar Institute, and a large and exceptionally healthy colony has been raised. The animals are bred and quartered in a clean, favorable environment, are provided for by a well balanced scientific diet, and matings are only of selected stock material. We believe that better experimental material could not be obtained.

Furthermore, in using these white rats we have avoided many of the pitfalls that have beset former investigators. Infection, in our opinion, is one of the most serious of these. The resistance of our animals to infection has been truly remarkable. Up to the present not one of the thymectomized animals, as far as can be observed, has shown any infectious disturbance, in spite of the seriousness of the operation. Thus we have evaded many of the misleading effects reported by earlier workers, which were undoubtably due to such a cause. There is also the advantage of easily obtaining litter mate controls, and accurate data regarding the age of the animals, their parents and condition of health.

It has been shown by Pappenheimer (26) that complete extirpation of the thymus is possible in albino rats, aberrant thymus being uncommon. This, we believe is a point well worth
considering, as the inability to obtain complete thymectomies would render valueless the results of such experimentation. It is this fact which leads us to question the work of some of the earlier investigators. While it may be objected that the rat is too small an animal from which to obtain accurate results, we have found that once a suitable technique has been developed, the operation can be performed most successfully. As far as can be determined from gross inspection, most of our animals have been completely thymectomized.

The feeding of thymus tissue or the injection of its extracts, in our opinion will not produce dependable results. The feeding of food containing such a large amount of fat, as does thymus tissue, will produce sterility in any animal, which may be due to the large deposition of fat in its tissues. The injection of considerable amounts of thymus extract has been seen to produce effects akin to those typifying severe anaphylactic shock. Likewise the use of the roentgen ray introduces new factors which may be the cause of erroneous conclusions. Consequently, we believe that surgical removal of the thymus in our experimental animals is the most dependable line of procedure.
Technique.

Together with Dr. Louis River of the department of Surgery, to whom we are indebted for much of the operative technique, a dissection of the thymus was made in dead animals of various ages to obtain a definite idea as to the relations and extent of the gland. Having accomplished this we were ready to attempt the operations. The animals selected at first were mostly males, and were between the ages of 20 and 30 days, as a rule (the first was 39 days old when operated upon). Later the limits of age were narrowed and at present all the thymectomies are performed at the ages of 18-21 days.

The rat is anesthetized by means of ether and the hair shaved at the base of the neck and upper part of the thorax around the sternum. The skin is incised and the manubrium cut through in the midline for about one quarter of an inch. Care is taken to avoid cutting the muscles that are encountered, the fibres being separated only. After separation of the muscles just below the manubrium retractors are applied and the superior part of the thymus is exposed. Two definite lobes are usually seen, their superior attachments being two fibrous strands on either side of the trachea. The gland is intimately related to the pleurae laterally, the trachea and great vessels of the heart posteriorly, while the inferior end lies over the pericardium in the region of the atria. The inferior end of each lobe is usually attached by means of some fibrous tissue to
the mediastinal pleurae.

In the first few operations the gland was removed by applying gentle traction with a pair of toothed forceps to the exposed superior part, until the inferior ends of the two lobes were seen and torn away from their attachments, the superior part being lastly removed. However, the friability of the thymus tissue often resulted in parts being broken off, especially at the inferior attachments and the resulting delay in searching for them, often coupled with a unilateral pneumothorax (due to tearing of the pleura), caused death in many cases.

This unsatisfactory condition was soon remedied. A blunt curved probe was used and gently worked about the gland to remove any adhesions; then it was hooked around the posterior surface and with a slight pull the entire thymus was brought up into the incision, the inferior ends with their pleural attachments being plainly seen. These were carefully separated, the tracheal end detached and the whole gland quickly taken out. The incision is then closed by a continuous suture which is placed in position before the actual removal of the gland, in order to facilitate quick closure in the event of a pneumothorax.

The animals recover very rapidly and move about with little difficulty in 10 to 15 minutes. After twenty-four hours they are as lively as their control mates.

After being allowed about two weeks to fully recover, the males and females are separated. The latter, in groups of
two and three, are mated with normal, mature males (79-90 days old). The females at this time are from 35 to 40 days of age. These matings are placed under observation until all the females have delivered their first litter. The time of delivery of the litter is carefully noted and the period of gestation, which is 23 days in the albino, is subtracted from the age of the animal at the time of parturition. The remainder represents the age of the female at the time of insemination. This we accept as the time of the advent of sexual maturity in the animal.

In the case of the males, the original procedure was to make use of mating experiments also. However, due to the fact that the female can be inseminated only during the period of "heat" in the estrous cycle, thus tending to give inaccurate data, we were faced with the alternative of either using two or three normal, mature females, or of taking a chance on mating a single female near her period of "heat". It was decided that it was impractical to attempt the former, and instead another method was then used. We have been determining the state of sexual maturity of the males by removing a testicle and its epididymis at various ages, ranging from 45 to 65 days, in both the experimentals and the controls. The tissue is fixed in formalin and stained with hemotoxylin-eosin. We are greatly indebted to O.I. Warren, the technician of our department for his expert advice and assistance in preparing these sections. A careful microscopical examination is made of the tissue and
the presence or absence of sperm in the epididymis and the degree of spermatogenesis in the testicle itself noted. The occurrence of a considerable number of sperm in the epididymis is taken as an indication of the attainment of sexual maturity.
Results.

Table 1:

Results of microscopical examinations of testes and epididymes, indicating the degree of spermatogenesis and the presence or absence of sperm in the epididymis. Thymectomized animals having litter mate controls are indicated by the dotted line. Controls I, II, III, IV and 30x constitute an independent series of controls. In the cases of numbers 25, 26, 30 and 30x, the Roman numerals indicate that both testicles were removed at different intervals. In the others, only one testicle was taken out for examination.

The first column represents the age of the animal at the time of the thymectomy; the second, the age of the animal when the testicle was removed; the third, the degree of spermatogenesis and the fourth, the presence or absence of sperm in the epididymis.
Table 1.

<table>
<thead>
<tr>
<th>Thymectomized animals.</th>
<th>Controls.</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>age sper-</td>
</tr>
<tr>
<td>thy-</td>
<td>at mato-</td>
</tr>
<tr>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>25I</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>30I</td>
<td>20</td>
</tr>
<tr>
<td>26I</td>
<td>20</td>
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<tr>
<td>2</td>
<td>29</td>
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<td>3</td>
<td>35</td>
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<td>7</td>
<td>21</td>
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<td>10</td>
<td>25</td>
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<tr>
<td>30II</td>
<td>20</td>
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<tr>
<td>25II</td>
<td>20</td>
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<tr>
<td>4</td>
<td>35</td>
</tr>
<tr>
<td>26II</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
</tr>
</tbody>
</table>
Table 2:

In this table are compiled the results of the mating experiments conducted with the thymectomized males, together with a record of post-mortem examinations performed upon animals purposely killed. The arrangement is according to the ages at insemination. In two of the matings, no litters were delivered by the mates of the thymectomized males. In the averages given below, the records on males #1 and #2 are not taken into consideration because of the late period of thymectomy.

<table>
<thead>
<tr>
<th>#</th>
<th>age at thymect.ed.</th>
<th>age at mating</th>
<th>del. litter</th>
<th>age at insemination</th>
<th>post-mortem examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>18</td>
<td>49</td>
<td>74</td>
<td>51</td>
<td>No evident thymus</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
<td>48</td>
<td>81</td>
<td>58</td>
<td>&quot;</td>
</tr>
<tr>
<td>8</td>
<td>21</td>
<td>42</td>
<td>85</td>
<td>62</td>
<td>&quot;</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
<td>42</td>
<td>85</td>
<td>62</td>
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</tr>
<tr>
<td>10</td>
<td>25</td>
<td>50</td>
<td>86</td>
<td>63</td>
<td>&quot;</td>
</tr>
<tr>
<td>1</td>
<td>37</td>
<td>46</td>
<td>88</td>
<td>65</td>
<td>Sm. Amt. thymus</td>
</tr>
<tr>
<td>14</td>
<td>21</td>
<td>45</td>
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<td>74</td>
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<tr>
<td>2</td>
<td>29</td>
<td>40</td>
<td>97</td>
<td>74</td>
<td>&quot;</td>
</tr>
<tr>
<td>7</td>
<td>21</td>
<td>42</td>
<td>107</td>
<td>84</td>
<td>Sm. amt. thymus</td>
</tr>
<tr>
<td>11</td>
<td>25</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>No evident thymus</td>
</tr>
<tr>
<td>13</td>
<td>21</td>
<td>45</td>
<td>-</td>
<td>-</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

Average age at mating: 46 days.

Average age at time of insemination: 65 days.
Table 3.

The results of mating experiments with thymectomized females, indicating ages at thymectomy, mating, delivery of first litter and at the time of insemination, which is taken as the time of sexual maturity. Females 19 and 24 are omitted in the averages. Post-mortem examinations have not been conducted on all the females, as yet.

<table>
<thead>
<tr>
<th>#</th>
<th>age at thymectomy</th>
<th>age at delivery</th>
<th>age at first litter</th>
<th>age at insemination</th>
<th>post-mortem examination</th>
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<tbody>
<tr>
<td>20</td>
<td>22</td>
<td>45</td>
<td>69</td>
<td>46</td>
<td>No evident thymus</td>
</tr>
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<td>21</td>
<td>22</td>
<td>45</td>
<td>71</td>
<td>48</td>
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<tr>
<td>17</td>
<td>26</td>
<td>49</td>
<td>72</td>
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</tr>
<tr>
<td>27</td>
<td>20</td>
<td>43</td>
<td>78</td>
<td>55</td>
<td>No evident thymus</td>
</tr>
<tr>
<td>28</td>
<td>20</td>
<td>41</td>
<td>80</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>20</td>
<td>41</td>
<td>81</td>
<td>58</td>
<td></td>
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<tr>
<td>18</td>
<td>24</td>
<td>47</td>
<td>89</td>
<td>66</td>
<td>No evident thymus</td>
</tr>
<tr>
<td>23</td>
<td>24</td>
<td>42</td>
<td>97</td>
<td>74</td>
<td></td>
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<tr>
<td>19</td>
<td>24</td>
<td>47</td>
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<tr>
<td>24</td>
<td>24</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>Incomplete thymect.</td>
</tr>
<tr>
<td>22</td>
<td>24</td>
<td>42</td>
<td>82</td>
<td>59</td>
<td></td>
</tr>
</tbody>
</table>

Average age at mating: 44 days.

Average age at time of insemination: 57 days.
Table 4.

The data in this table was obtained through the courtesy of G.J. Leibold of the department of Anatomy and is similar to that in table 3, except that it represents matings of normal animals. These rats are members of the same colony and are strictly stock material.

<table>
<thead>
<tr>
<th>age</th>
<th>age</th>
<th>age</th>
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<tbody>
<tr>
<td>at</td>
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<tr>
<td>del.</td>
<td>ed.</td>
<td>litter</td>
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<td>sem.</td>
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<tr>
<td>54</td>
<td>81</td>
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<tr>
<td>57</td>
<td>121</td>
<td>98</td>
</tr>
</tbody>
</table>

Average age at mating:
54 days.

Average age at time of insemination:
76 days.
Discussion.

The tables presented above by no means represent the results of a completed investigation. The work is still in progress, and will be continued until sufficient material has been obtained to warrant a definite final statement. The experiments now being conducted are being checked by a greater number of both male and female litter mate controls, which in the case of the mating experiments have been lacking, up to date. The perfected operative technique also enhances the worth of the new series of experiments.

In the present report, which must be regarded as preliminary in character, the number of cases is admissibly meagre. Nevertheless, we believe that certain possibilities have been brought to light that are well worth considering. The outstanding fact that has been shown by the results up to date is a sex difference in the reaction of the sexual development in the male and female to early thymectomy. In table I it is seen that in the testes of a normal rat at the age of 55 days considerable spermatogenesis is taking place, and that sperm are already present in the epididymis. We have been unable to find, so far, any case in which sperm appear in the epididymis earlier than this age, in either control or thymectomized animal. No difference in the state of spermatogenesis can be found between the testes of the experimental animals or their controls. The mating experiments performed with thymectomized males
at the start of our investigation also fail to produce definite evidence of an interrelation of thymus and sexual maturity. In table 2, the average age at which sexual maturity was attained was 65 days, which is very close to that accepted as normal. We have seen no signs of any pathological change occurring in the gonads of the experimental animals.

On the female side we are able to present more definite information. A comparison of tables 3 and 4 demonstrates a considerable difference in the time of the advent of sexual maturity. In table 4 the average age at which insemination occurred was 76 days; in table 3, representing the matings of thymectomized animals, we find the average age at the time of insemination at 57 days. We also notice that the earliest time at which insemination took place was 46 days, while the latest is 74 days. The consistency with which early coitus has taken place in the experimental group cannot be laid to mere coincidence. In these experiments, as stated before, we have to cope with the unfavorable occurrence of the "heat" period in the estrous cycle. Hence the necessity of obtaining a large number of thymectomized animals from which to draw conclusions.

In table 4 it is apparent that the normal females were mated at an age average of 54 days, while the average mating age of our thymectomized females was 44 days. While we doubt if the earlier time of mating is responsible for the early time of insemination in the experimentals, still, we are investigating this point by the use of female litter mate controls in all
of our present series of matings. We can see that although many of the normal females were mated at earlier periods than the others, all were well within the period recognized as the normal time of the attainment of sexual maturity when inseminated.

In addition, we may state that in accordance with the observations of recent workers, we have not perceived any abnormalities in development of bone or health in our thymectomized animals. Their life span is apparently unaffected, and their offspring exhibit no defects whatever.
Conclusions.

From the material obtained in our research up to the present time, we present the following conclusions, which we hold as tentative:

1). Early thymectomy in the female albino rat produces a precocious sexual maturity.

2). Early thymectomy in the male albino rat apparently has no effect on sexual maturity.

3). No detrimental or pathological phenomena appear to result from the thymectomy.
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For the translations of most of the foreign papers we are indebted to the review in an excellent article by Park and McClure on thymus extirpation (30).

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