

GRAVIMETRIC STUDIES OF CERTAIN AMPHIBIAN
ORGANS UNDER NORMAL AND EXPERIMENTAL
CONDITIONS.

GENERAL SUMMARY

of a

T H E S I S

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EXPLANATORY NOTE.

The amphibian used in these experiments
was *Xenopus laevis* (The South African
Clawed Toad).

THE OVARIES.

1. A cycle of seasonal ovarian weight changes in *Xenopus* is described, similar in all respects to that described by other workers.

2. Repeated injections of anterior pituitary extract cause an increase in weight of the ovaries when injected into normal animals during the period of aestivation. When injected during the breeding season, they bring about a decrease in the weight of the ovaries. This decrease, however, is due to the ova lost from the ovaries because of ovulation; when the weight of these ova is added to that of the ovaries, the total weight is found to be greater than the weight of the ovaries of control animals.

Thus, it appears that the effect of injection of anterior pituitary extracts during the period of aestivation is primarily the production of ovarian growth; the primary effect of injections during the breeding season is the production of ovulation, but stimulation of growth also takes place.

Injection into recently anterior hypophysectomised animals during aestivation also brings about an increase of ovarian weight, but the increase is smaller than in the case of injected normal animals.

3. Anterior hypophysectomy and starvation each bring about a decrease in ovary weight. The ovaries of hypophysectomised animals begin to degenerate almost immediately after the operation, but in starved animals the degeneration is delayed for five months.

4. The possible sources of the nutrient products required for the regeneration of the ovaries during pre-oestrus are discussed. These are possibly the fat bodies and muscles. Further it is possible that an increase in food consumption occurs during this period.

5. The results of thyroidectomy are inconclusive.

6. Captivity causes no degeneration of the ovaries if adequate nutrition is supplied.

7. The factors controlling the ovarian cycle of weight changes are discussed. Anterior pituitary secretion is probably the controlling internal stimulus. The anterior pituitary gland is in turn, probably affected by variations in temperature, rainfall and, possibly, "population density". Fluctuations in food supply are of no importance.

THE OVIDUCTS.

1. A seasonal variation in the oviduct weight of *Xenopus laevis* similar to the usual seasonal variation in ovary weight is described.

2. Repeated injections of anterior pituitary extract cause an increase in oviduct weight when injected during the period of aestivation and a decrease when injected during the breeding season. These differing results are probably due to the different pre-injection states of the oviducts.

3. Anterior hypophysectomy, castration and starvation each bring about a fall in oviduct weight. Thyroidectomy brings about no significant change.

4. A pituitary-gonadal control of oviduct weight in *Xenopus laevis* is postulated.

THE TESTES.

1. Abnormalities in the gross anatomical appearance of the testes of *Xenopus* described.

2. A seasonal cycle in the weight of the testes is described. The testes attain their maximum weight at the beginning of the breeding season and their minimum weight during aestivation.

3. The injection of anterior pituitary extracts during aestivation causes an increase in the testis weight of both normal and recently hypophysectomised animals. Injection at the beginning of the breeding season causes no change in the weight of the testes.

These differing results are probably due to the different pre-injection state of the testes at the times of the year mentioned.

4. Hypophysectomy causes a marked decrease in the weight of the testes.

5. Thyroidectomised animals show an increase of their testis ratios; the increase, however, is not as marked as that which occurs in control animals.

6. Starvation causes an increase in the testis ratio.

7. The seasonal cycle of testis weight changes is probably primarily under the control of the anterior pituitary. It is possible that the thyroid glands also exert some effect.

THE FAT BODIES.

1. The fat bodies of the male *Xenopus* are heavier than those of the females.

2. A seasonal cycle exists in the weight of the fat bodies of both males and females. The fat bodies attain their maximum weight during aestivation and their minimum weight during the breeding season.

3. The hypothesis that, during pro-oestrus lipid is transferred from the fat bodies to the ovaries has not been proved experimentally.

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4. Even if lipid is transferred from the fat bodies to the ovaries, the decrease in the weight of the fat bodies is not sufficient to account for the increase in the weight of the ovaries.

5. Following from the above, if all the lipid resulting from the decrease in the weight of the fat bodies is transferred to the ovaries, the fat bodies cannot be said also to supply the needs of general body metabolism of the females during pro-oestrus. If only part of the lipid is transferred to the ovary, it is possible that the fat bodies also help to nourish the body as a whole.

6. In males, the increase in the weight of the testes between January and July is much smaller than the decrease in the weight of the fat bodies during the same period. It is, therefore, possible that the fat bodies also supply the needs of general body metabolism.

7. The injection of anterior pituitary extracts during the period of aestivation causes significant decreases in the fat body ratios of normal and castrated males and females, but no significant decrease in the fat body ratios of male or female hypophysectomised animals. This latter result is possibly due to the existence in the fat bodies of the hypophysectomised animals of a decreased sensitivity of response to anterior pituitary extracts.

Injection of anterior pituitary extracts during the period of aestivation probably causes a transference of lipoids from the fat bodies and other fat depots of the body to the liver and ovaries in normal females and to the liver alone in female castrates. In males, lipoids are probably transferred to the liver and testes.

8. The repeated injection of anterior pituitary extracts during the breeding season causes no significant change in the fat body ratio of male or female normal or castrated animals.

9. Anterior pituitary extract possibly acts directly upon the fat bodies and other fat depots of the body.

10. Anterior lobe hypophysectomy causes an increase in the fat body ratios of females. The fat body ratios of hypophysectomised males are not significantly different from those of controls.

11. Thyroidectomy causes a decrease of fat body weight in females. The fat body ratios of males are high as compared with those of controls.

12. Castration causes no significant change in the fat body ratios of males but a decrease in the fat body ratios of females.

13. The anterior pituitary is probably the primary factor concerned in the regulation of the seasonal cycle of fat body weight changes. It is possible that the

gonads and thyroid glands also play a part.

14. The topography of the fat depots of *Xenopus* - as distinct from the fat bodies - is described.

15. Seasonal variations, similar to those described in the fat bodies, occur in the size of these fat depots.

16. The effects upon these fat depots of anterior pituitary injections, anterior lobe hypophysectomy, castration, thyroidectomy and starvation are similar to the effects upon the fat bodies.

17. The fat bodies of *Xenopus* are ordinary fat depots and, in all probability, possess no physiological properties peculiar to themselves.

THE LIVER.

1. A seasonal cycle of liver weight changes is described, similar to that described in the ovaries.

2. No sexual difference exists in the weight of the liver of *Xenopus*.

3. The injection of anterior pituitary extracts in January (i.e. during aestivation) causes an increase of liver weight in normal, anterior hypophysectomised and castrated males and females. This is probably chiefly due to a transference of lipoid from the fat depots of the body to the liver.

Injection in July (i.e. during the breeding season), causes no significant change in the liver weight of normal and castrated females or of castrated males; in normal males it causes a decrease in liver weight.

4. Anterior lobe hypophysectomy causes an increase of liver weight in females but no change in males.

5. Thyroidectomy causes an increase in liver weight followed by decrease back to the control value both in males and females.

6. Castration has approximately the same effect as thyroidectomy.

7. Starvation causes a decrease in liver weight both in males and females.

8. No clear out theory can be postulated regarding the factors concerned in the control of the seasonal cycle of liver weight changes. The anterior pituitary, the thyroid glands and the gonads probably exert an effect.

THE KIDNEYS.

1. A seasonal cycle in kidney weight is described in males and females similar to the seasonal cycle of weight changes described in the ovaries, oviducts and liver.

2. The kidneys of females are heavier than those of males.

3. Injection of anterior pituitary extract in January (i.e. during the period of aestivation) causes an increase in the kidney ratios of male and female normals and castrates and of recently hypophysectomised males, but no significant change in the kidney ratios of female hypophysectomised animals.

Injection in July (during the breeding season) causes an increase in the kidney ratios of male and female castrates and of normal females, but no significant change in the ratio of normal males.

The possible mechanisms involved in the production of an increase in kidney weight by anterior pituitary extracts are discussed.

4. The kidney ratios of hypophysectomised males are smaller than those of controls; they do not however show a significant decrease from the pre-operative value at the beginning of the experiment.

The kidney ratios of hypophysectomised females are not significantly different from those of controls.

5. Castration in females causes an increase in the kidney ratio followed by a decrease back to the value of the controls. In males it causes an increase then a decrease and finally an increase again.

6. Thyroidectomy in males causes a decrease of the kidney ratio followed by an increase up to the value

of the controls.

Thyroidectomy in the females causes a marked increase of the kidney ratio. This may possibly be due to a concomitant decrease in body weight.

7. Starvation causes a decrease of the kidney ratio both in males and females.

8. The factors concerned in the regulation of the seasonal cycle of kidney weight changes are discussed. These are possibly the anterior pituitary, the thyroid glands and the gonads.

THE SPLEEN.

1. Seasonal cycles in the spleen body weight ratios of male and female *Xenopus* are described.

2. The spleen ratio of females is significantly higher than that of males between November and September; at other times of the year there is probably no significant difference between the ratios of males and females.

3. The injection of anterior pituitary extracts in January (i.e. during aestivation) brings about (a) an increase in the spleen ratios of castrated and hypophysectomised males and of castrated females, (b) a decrease in the spleen ratio of normal females and (c) no significant change in the spleen ratios of normal males or hypophysectomised females.

The injection of anterior pituitary extracts in July (i.e. during the breeding season) brings about no significant change in the spleen ratio of normal or castrated males or females.

4. Anterior lobe hypophysectomy causes no change in the spleen ratios of males or females.

5. Castration in males brings about an increase followed by a decrease of the spleen ratio, but even after the decrease the ratios are greater than those of the controls.

Castration in females brings about no significant change.

6. Thyroidectomy brings about an initial increase followed by a decrease in the spleen ratios of males and females.

7. Starvation brings about a decrease in the spleen ratio of males but no significant change in females.

8. No precise theory can be postulated regarding the factors concerned in the control of the seasonal cycles of spleen weight changes. It is possible that the anterior pituitary, the gonads and the thyroid glands each play a part.

THE PANCREAS.

1. A seasonal cycle in the pancreas ratio of male and female *Xenopus* is described. The cycle is somewhat different in the two sexes.

2. The pancreas ratio of the female is consistently higher than that of the male.

3. The injection of anterior pituitary extracts in January (i.e. during aestivation) produces a decrease in the pancreas ratio of normal and castrated females but no significant change in the pancreas ratios of hypophysectomised females or of normal, hypophysectomised or castrated males.

Injection in July (i.e. during breeding season) brings about a decrease in the pancreas ratio of normal and castrated females but no significant change in the ratios of normal or castrated males.

4. Anterior lobe hypophysectomy and starvation each produce a decrease in the pancreas ratios of males and females.

5. Thyroidectomy produces a decrease in pancreas ratio of females; this decrease may be the result of malnutrition. The pancreas ratios of thyroidectomised males are not significantly different from those of controls.

6. Castration produces a decrease in the pancreas ratio of females after ten months. Male castrates show an increase followed by a decrease.

7. No clear out theory can be postulated regarding the factors concerned in the control of the cycles of pancreas weight changes which occur in males and females.

THE ANTERIOR PITUITARY.

1. A seasonal cycle of anterior pituitary weight changes occurs in the male *Xenopus*; the pituitary attains its maximum weight during the breeding season and reaches its minimum during aestivation. The data obtained in females are suggestive of a similar cycle but are not conclusive.
2. The anterior pituitary-body weight ratio is bigger in males than in females.
3. The injection of anterior pituitary extracts during aestivation causes an increase in the weight of the anterior pituitaries of female castrates and of normal and castrated males, but no significant change in the anterior pituitary weight of normal females.
Injection during the breeding season causes no significant change in the pituitary weight of either male or female normal animals.
4. Castration causes an increase of anterior pituitary weight in females; in male castrates the increase is significant for five months but after ten months there is no significant difference between the ratios of castrates and of controls.
5. Thyroidectomy in males causes no significant change in the anterior pituitary ratio.
6. Starvation causes a marked increase in

the anterior pituitary ratio of females; this increase is probably due to a decrease in the body weight of the starved animals.

THE THYROID GLANDS.

1. A seasonal cycle in the thyroid-body weight ratios of males and females is described.

2. The injection of anterior pituitary extract into normal, recently hypophysectomised or recently castrated animals (males or females) causes no significant change in thyroid weight when injected during the period of aestivation, and similarly, no significant change occurs when normal animals are injected during the breeding season.

3. Anterior lobe hypophysectomy causes no significant change in the thyroid ratios of males or females.

4. Starvation causes a marked increase in the thyroid ratios of females. This may be a result of a decrease in body weight.

5. No theory can be postulated regarding the factors concerned in the control of the seasonal cycle of weight changes described.

THE FORELIMBS AND THE BONES OF THE FORELIMBS.

1. The forelimbs of male *Xenopus* are heavier than those of females both during the breeding season and during aestivation.

2. The forelimbs of the male are heavier during the breeding season than during aestivation. The forelimbs of females weigh the same at both these periods.

3. The bones of the forelimbs of the male are heavier than those of the female both during the breeding season and during aestivation.

4. In males a decrease of about 13% occurs in the weight of the musculature of the forelimbs between the breeding season and the period of aestivation. No change occurs in the weight of the bones.

5. In females a decrease of about 8% occurs in the weight of the muscles of the forelimbs during the same period. A corresponding increase of about 8% occurs in the weight of the bones.

6. The seasonal variations which occur in the musculature of the male forelimbs are probably under the control of the secretion of the testes, which in turn is probably controlled by the secretion of the anterior pituitary. The secretion of the testis thus exerts a rhabdomytrophic effect.

7. No hypothesis can be formulated regarding the factors concerned in the control of the seasonal variations which occur in the bones and muscles of the forelimbs of the female.

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