other proteins was falling. It is interesting however, that the specific activity of G.O.T. in the experimental animals was shown to be above that of the controls (Figure 6, P. 77), while that of G.P.T. did not differ from the control values, (Figure 7, P.78).

The most significant result was obtained however, by relating the specific activity of G.O.T. to that of G.P.T., when the ratio of aspartate to alanine transaminase was seen to increase greatly in salt-treated animals (Figure 8, P. 79). The ratio did not increase in the first 16 days but started at 7 weeks and became three-fold after 11 weeks.

This observed effect was specific for the liver, since neither the activities per unit wet weight (Figure 9, P. 80 & 10 P. 81), nor the specific activities (Figure 11 P. 82 & 12 P. 83) nor yet the ratio of the two enzymes (Figure 13, P. 84) showed any differences between the experimental and control frogs in the kidney.

B. COMPARATIVE SURVEY OF THE LEVELS OF G.O.T. AND G.P.T. IN THE LIVERS OF VARIOUS AMPHIBIA.

A brief survey of the relative levels of the two enzymes in various species was made according to the procedures described in Section B of "Materials and Methods" (P. 49).

The levels of G.O.T. activity per unit wet weight were comparable in all three species of Rana (Rana angolensis, Rana fusciqula and Rana cancrivora) and in Bufo regularis (Figure 14, P. 85). In Xenopus laevis, however, the activity was considerably lower. The activity per unit wet weight of G.P.T. in Xenopus, though lower, is more comparable to that of the other species (Figure 15, P. 86).

Rana cancrivora were adapted to water of different salinity in short term experiments for 1-2 weeks. No correlation was found between the salinity of the environment and the transaminase levels except in animals kept in fresh water where the value was nearly 3 times higher than that in animals kept in different concentrations of saline.

A comparison of the two figures shows that in the ureotelic species, Rana angolensis, Rana fusciqula and Bufo regularis, the activity per unit wet weight of G.O.T. was greater than that of G.P.T., this being most pronounced in Rana fusciqula and least pronounced in Bufo regularis. This was also the case in the Rana

cancrivora kept in saline, but not in those kept in fresh water, nor in the ammoniotelic Xenopus.

If the specific activities of the two enzymes are considered, (Figure 16, P. 87& 17 P. 88), that of G.O.T. was again much lower in Xenopus than in the other species. A comparison of the specific activities of the two enzymes is shown in Figure 18 (P. 89). The ratio was lowest in the ammoniotelic Xenopus and the Rana cancrivora kept in fresh water. It is interesting that the ratio was always above unity (i.e. aspartate transamination showed greater activity than alanine transamination) in the ureotelic species and in the Rana cancrivora kept in saline.

C. CHANGES IN G.O.T. AND G.P.T. LEVELS DURING THE METAMORPHOSIS OF XENOPUS LAEVIS AND RANA ANGOLENSIS.

The two enzymes were studied in the livers of Xenopus tadpoles from stage 54 (near the onset of hind leg growth) to the young froglet. The toads were staged according to the normal table of Xenopus laevis (Nieuwkoop & Faber, 1956). The same study was made in Rana angolensis tadpoles from stage I (the limb bud stage) to stage XXV (where the tail had just disappeared). The frogs were staged according to Taylor & Kollros (1946).

The activities per unit wet weight of both G.O.T. and G.P.T. remained fairly constant in metamorphosing Xenopus tadpoles (Figure 19, P. 90 & 20 P. 91), that of G.P.T. being higher than G.O.T. in all stages except the last, the young adult, in which it was slightly less.

If the specific activities are examined, that of G.O.T. remained fairly constant until the young froglet stage, when a 1½-fold increase was observed (Figure 21, P. 92). The specific activities of G.P.T. were also constant, until a slight increase was seen in the young adult stage (Figure 22, P. 93). The ratios of the two enzymes thus remained constant and below unity, except in the last stage (Figure 23, P. 94).

During metamorphosis of Rana angolensis there is a change from ammoniotelism to ureotelism, concurrently with the change from an aquatic to a terrestrial or semi-terrestrial mode of life. At this time there was a slight increase in the activity per unit wet weight of G.O.T. (Figure 24, P. 95) and a fairly considerable decrease in that of G.P.T. (Figure 25, P. 96). The specific activity of G.O.T. fluctuated about a fairly constant level (Figure 26, P. 97) but that of G.P.T. dropped by 50% (Figure 27, P. 98). This caused a considerable increase in the ratio of the two enzymes, (Figure 23, P. 94). This increase appeared to occur in two stages, the first being just prior to the climax of metamorphosis, and the second after it. In summary, therefore, the ratio of G.O.T. to G.P.T. remained relatively constant in the metamorphosis of Xenopus laevis, while in Rana angolensis, there was an approximately two-fold increase from about 0·8 in early prometamorphosis to about 1·6 in the young froglet.

D. THE EFFECT OF VARIOUS HORMONES ON THE LEVELS OF G.O.T. AND G.P.T. IN THE LIVER AND KIDNEY OF XENOPUS LAEVIS.

The toads were treated with eight hormones as described in "Materials and Methods" (P. 56). The results are given in Tables I (P. 67) & II (P. 68), and in Figures 28 - 37 (P. 99 to 108)

Injections of ACTH increased the activity per unit wet weight of G.O.T. in the liver to almost double that of the control, while that of G.P.T. was decreased. The ratio of the specific activities of G.O.T. to G.P.T. was increased due to both an increase in the specific activity of G.O.T. and a decrease in that of G.P.T. ACTH had little effect on transamination in the kidney, giving a slight increase in the ratio, due to a slight drop in G.P.T. specific activity.

Aldosterone caused a two-fold increase in the activity per unit wet weight of G.O.T. in the liver, while G.P.T. was decreased. The specific activity of G.O.T. was increased, while that of G.P.T. was decreased, resulting in a two-fold increase in the ratio of the two enzymes. In the kidney, aldosterone seemed to have a slightly depressant effect on both enzymes, giving a slight rise in the ratio.

Corticosterone had a marked effect on the level of G.O.T. in the liver, giving the largest increase (more than double

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Corticosterone had a marked effect on the level of G.O.T. in the liver, giving the largest increase (more than double

the control value) in the activity per unit wet weight of all the hormones studied. The increase in specific activity was smaller, but, combined with a slight drop in the level of G.P.T., led to an increase in the ratio. There was not much effect in the kidney.

The effect of hydrocortisone on the liver enzymes was to raise the activity per unit wet weight of G.O.T. and lower that of G.P.T. The specific activity of G.O.T. was not raised significantly, but that of G.P.T. was lowered sufficiently to result in an increase in the ratio. There was very little effect in the kidney.

In the liver, insulin increased the activity per unit wet weight and the specific activity of G.O.T. and decreased quite considerably both parameters of G.P.T. There was therefore a considerable increase in the ratio of the two enzymes. In the kidney, insulin caused a marked depression of both enzymes, so that although the absolute levels of both enzymes dropped considerably, there was little change in the ratio.

Thyroxine only affected G.O.T. in the liver, causing a marked increase in the activity per unit wet weight and specific activity of this enzyme. G.P.T. was practically

unaffected and the ratio was therefore raised by the effect on the former enzyme. In the kidney, thyroxine depressed the levels of both enzymes slightly, leaving the ratio virtually unchanged.

Triiodothyronine increased the activity per unit wet weight and the specific activity of G.O.T. in the liver, and decreased both values of G.P.T. in the liver and kidney, so that the ratio was increased in both organs, but particularly in the liver.

Vasopressin gave a similar effect to most of the other hormones, causing an increase in the activity per unit wet weight and specific activity of G.O.T. and decreasing G.P.T. so that an increase in the ratio of the enzymes was obtained in both organs.

TABLE I

The Effect of Various Hormones on the Levels of G.O.T. & G.P.T. in the Liver of Xenopus Laevis

Hormone	G.O.T. Activity per unit wet weight	G.O.T. Specific Activity (A) & Standard Deviation	Confidence limit of significance of difference from control	G.P.T. Activity per unit wet weight	G.P.T. Specific Activity (B) & Standard Deviation	Confidence limit of significance of difference from control	Ratio A/B	C* / DF
Control	12·8	0·137 ±0·019		26·0	0·242 ±0·017		0·57	1·00
ACTH	21·2	0·227 ±0·003	0·0005	21·5	0·230 ±0·028	N.S.	0·99	1·75
Aldosterone	24·6	0·215 ±0·009	0·0005	21·1	0·190 ±0·008	0·0005	1·14	2·02
Corticosterone	28·5	0·194 ±0·010	0·0005	21·5	0·228 ±0·052	N.S.	0·86	1·52
Hydrocortisone	18·5	0·158 ±0·022	N.S.	20·8	0·174 ±0·037	0·005	0·89	1·58
Insulin	15·5	0·170 ±0·028	0·05	14·3	0·160 ±0·012	0·0005	1·06	1·88
Thyroxine	25·4	0·239 ±0·030	0·0005	26·1	0·250 ±0·031	N.S.	0·96	1·70
Triiodothyronine	20·6	0·188 ±0·022	0·0025	21·5	0·200 ±0·042	0·05	0·94	1·66
Vasopressin	19·0	0·256 ±0·042	0·0005	20·4	0·280 ±0·073	N.S.	0·92	1·63

* Ratio $\frac{\text{G.O.T.}}{\text{G.P.T.}}$ in treated animals

/ Ratio $\frac{\text{G.O.T.}}{\text{G.P.T.}}$ in control animals

TABLE II

The Effect of Various Hormones on the Levels of G.O.T. & G.P.T. in the Kidney of Xenopus Laevis

Hormone	G.O.T. Activity per unit wet weight	G.O.T. Specific Activity (A) & Standard Deviation	Confidence limit of significance of difference from control	G.P.T. Activity per unit wet weight	G.P.T. Specific Activity (B) & Standard Deviation	Confidence limit of significance of difference from control	Ratio A/B	C* D†
Control	20·9	0·264 ±0·044		41·8	0·527 ±0·051		0·50	1·00
ACTH	18·5	0·280 ±0·030	N.S.	29·5	0·442 ±0·060	0·025	0·63	1·26
Aldosterone	28·0	0·254 ±0·046	N.S.	32·3	0·365 ±0·024	0·0005	0·69	1·38
Corticosterone	23·0	0·250 ±0·029	N.S.	41·0	0·420 ±0·098	0·025	0·60	1·20
Hydrocortisone	21·0	0·258 ±0·017	N.S.	36·8	0·424 ±0·102	0·05	0·57	1·14
Insulin	15·7	0·180 ±0·029	0·0025	27·3	0·312 ±0·037	0·0005	0·58	1·16
Thyroxine	18·5	0·229 ±0·027	N.S.	33·2	0·420 ±0·089	0·025	0·54	1·08
Triiodothyronine	21·8	0·279 ±0·054	N.S.	31·9	0·407 ±0·096	0·025	0·69	1·38
Vasopressin	24·4	0·390 ±0·040	0·0005	29·5	0·463 ±0·025	0·01	0·84	1·68

* Ratio $\frac{\text{G.O.T.}}{\text{G.P.T.}}$ in treated animals

† Ratio $\frac{\text{G.O.T.}}{\text{G.P.T.}}$ in control animals

LIST OF FIGURES

Figures 4-13 inclusive showed the effects of starvation and dehydration on the above enzymes.

FIGURE 2

Pyruvic Acid Standard Curve.

A standard solution of pyruvate adjusted to pH 7·4 was used to construct the standard curve.

Fig. 2

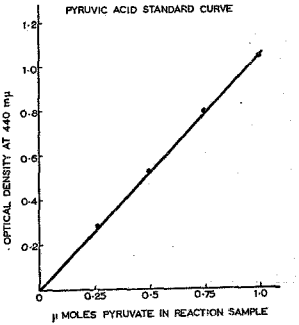
PYRUVIC ACID STANDARD CURVE
OPTICAL DENSITY AT 440 mμ
1·2
1·0
0·8
0·6
0·4
0·2
0
0·25
0·5
0·75
1·0
μ MOLES PYRUVATE IN REACTION SAMPLE

FIGURE 3

Bovine Serum Albumin Standard Curve.

A standard solution of bovine serum albumin adjusted to pH 7·4 was used to construct the standard curve.

Fig. 3.

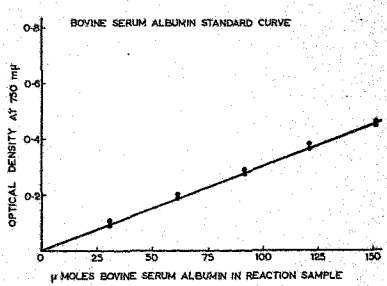
BOVINE SERUM ALBUMIN STANDARD CURVE
OPTICAL DENSITY AT 750 mμ
0·8
0·6
0·4
0·2
0
25
50
75
100
125
150
μ MOLES BOVINE SERUM ALBUMIN IN REACTION SAMPLE

FIGURE 4

Activity per unit wet weight of G.O.T. in the liver of Xenopus laevis.

——— control frogs.

- - - - - - experimental frogs.

Experimental conditions:

The control frogs were starved for the duration of the experiment.

The experimental frogs were kept in 0·15M NaCl for 16 days and then returned to fresh water. They were starved for the duration of the experiment.

Each result represents a mean of 4 animals.

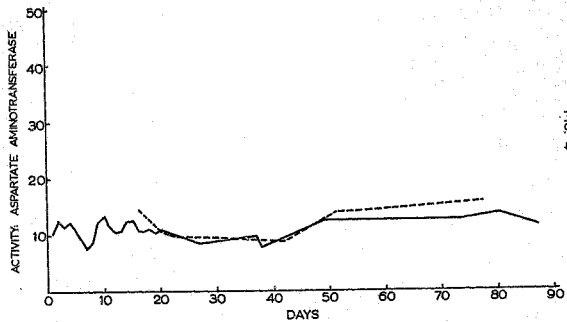
ACTIVITY, ASPARTATE AMINOTRANSFERASE
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 4

FIGURE 5

Activity per unit wet weight of G.P.T. in the liver of Xenopus laevis.

_____ control frogs.

------ experimental frogs.

Experimental conditions - see oppoaite Figure 4.

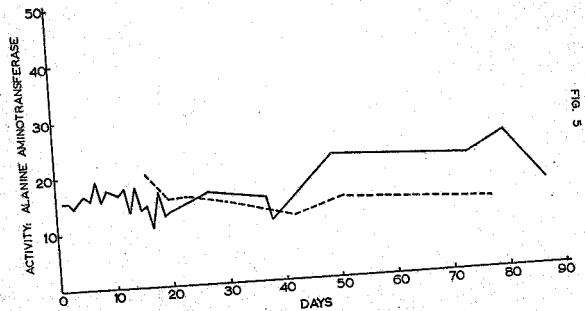
ACTIVITY: ALANINE AMINOTRANSFERASE
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 5

FIGURE 6

Specific activity of G.O.T. in the liver of Xenopus laevis.

_____ control frogs.

\- - - - - experimental frogs.

Experimental conditions - see opposite Figure 4.

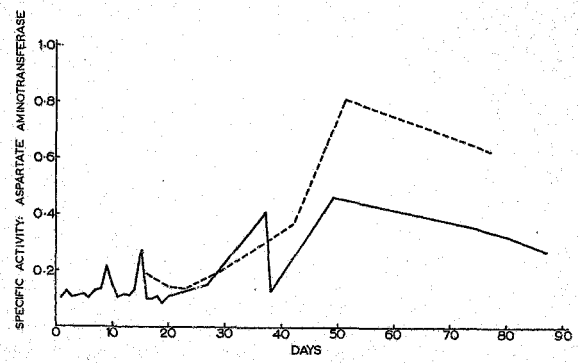
SPECIFIC ACTIVITY: ASPARTATE AMINOTRANSFERASE
1·0
0·8
0·6
0·4
0·2
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 6

FIGURE 7

Specific activity of G.P.T. in the liver of Xenopus laevis.

_____ control frogs.

- - - - - - experimental frogs.

Experimental conditions - see opposite Figure 4.

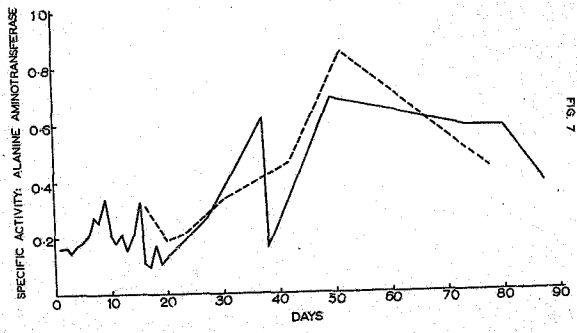
SPECIFIC ACTIVITY: ALANINE AMINOTRANSFERASE
1·0
0·8
0·6
0·4
0·2
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 7

FIGURE 8

Ratio of the specific activities: G.O.T./G.P.T. in the liver of Xenopus laevis.

_____ control frogs.

------ experimental frogs.

Experimental conditions - see opposite Figure 4.

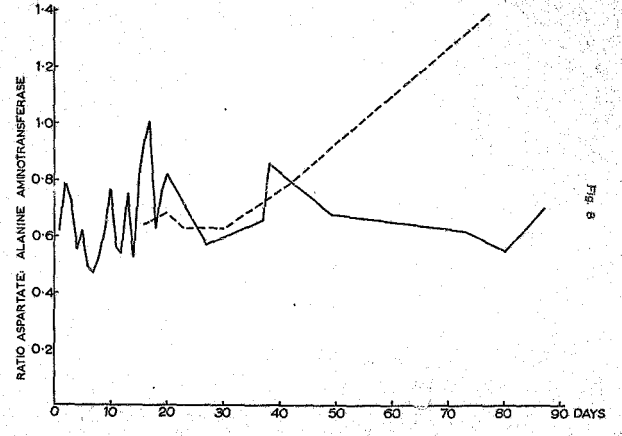
RATIO ASPARTATE: ALANINE AMINOTRANSFERASE
1·4
1·2
1·0
0·8
0·6
0·4
0·2
0
10
20
30
40
50
60
70
80
90 DAYS

Fig. 8

FIGURE 9

Activity per unit wet weight of G.O.T. in the kidney of Xenopus laevis.

_____ control frogs.

------ experimental frogs.

Experimental conditions - see opposite Figure 4.

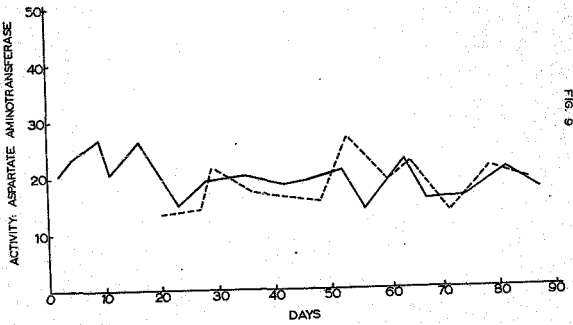
ACTIVITY: ASPARTATE AMINOTRANSFERASE
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 9

FIGURE 10

Activity per unit wet weight of G.P.T. in the kidney of Xenopus laevis.

_____ control frogs.

------ experimental frogs.

Experimental conditions - see opposite Figure 4.

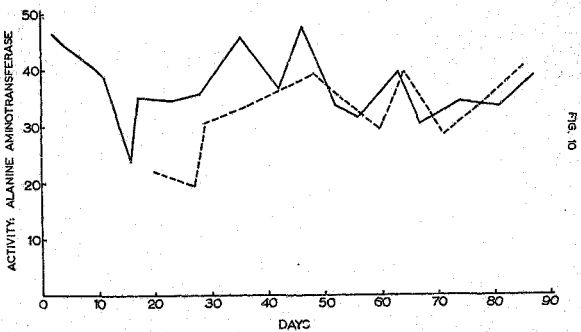
ACTIVITY: ALANINE AMINOTRANSFERASE
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 10

FIGURE 11

Specific activity of G.O.T. in the kidney of Xenopus laevis.

_____ control frogs.

------ experimental frogs.

Experimental conditions - see opposite Figure 4.

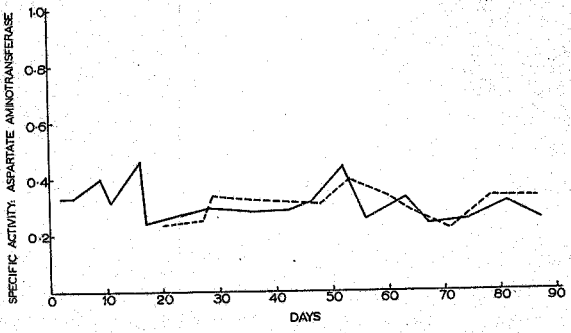
SPECIFIC ACTIVITY: ASPARTATE AMINOTRANSFERASE
1·0
0·8
0·6
0·4
0·2
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 11

FIGURE 12

Specific activity of G.P.T. in the kidney of Xenopus laevis.

_____ control frogs.

------ experimental frogs.

Experimental conditions - see opposite Figure 4.

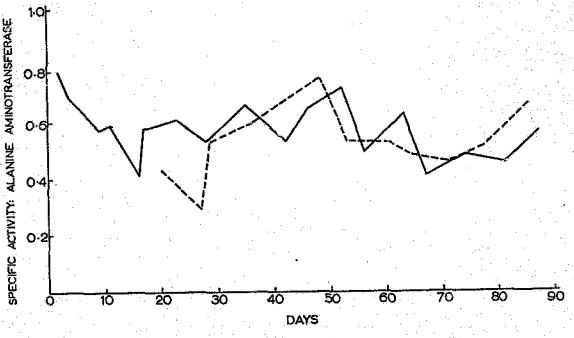
SPECIFIC ACTIVITY: ALANINE AMINOTRANSFERASE
1·0
0·8
0·6
0·4
0·2
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 12

FIGURE 13

Ratio of the specific activities of G.O.T./G.P.T. in the kidney of Xenopus laevis.

_____ control frogs.

------ experimental frogs.

Experimental conditions - see opposite Figure 4.

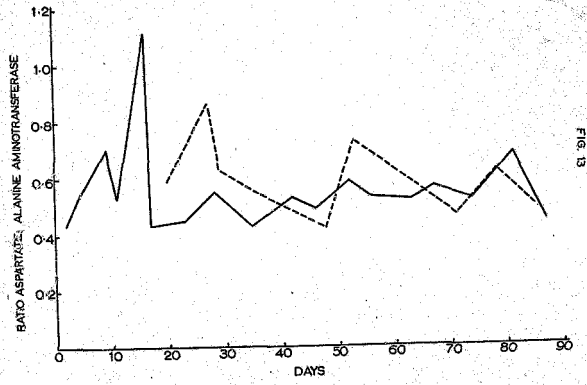
RATIO ASPARTATE: ALANINE AMINOTRANSFERASE
1·2
1·0
0·8
0·6
0·4
0·2
0
10
20
30
40
50
60
70
80
90
DAYS

FIG. 13

FIGURE 14

Comparative activities per unit wet weight of G.O.T. in the livers of various species of Amphibia.

Experimental conditions:

Xenopus: The results given represent an average of 4 animals per day for 10 days. The frogs were kept in fresh water and starved.

Rana angolensis: The results given are from two lots of four frogs used at different times after capture, the second lot having been in captivity longer and hence starved for longer.

Rana fuscigula: As for Rana angolensis.

Bufo regularis: The results are from animals obtained from two different sources. Each result is a mean from 4 toads.

Rana cancrivora: 1. Control frogs kept in water.

2. Frogs kept in 10% saline for 1 week.

3. Frogs kept in 30% saline for 1 week.

4. Frogs kept in 50% saline for 1 week.

5. Frogs kept in 50% saline for 2 weeks.

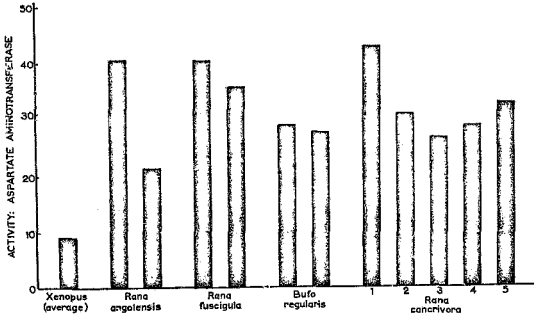
ACTIVITY: ASPARTATE AMINOTRANSFERASE
50
40
30
20
10
0
Xenopus (average)
Rana angolensis
Rana fuscigula
Bufo regularis
1
2
3
4
5
Rana cancrivora

FIG. 14

FIGURE 15

Comparative activities per unit wet weight of G.P.T. in the livers of various species of Amphibia.

Experimental conditions - see opposite Figure 14.

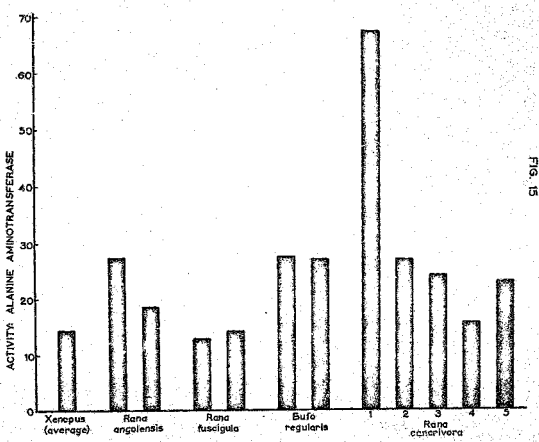
ACTIVITY: ALANINE AMINOTRANSFERASE
70
60
50
40
30
20
10
0
Xenopus (average)
Rana angolensis
Rana fusciguia
Bufo regularis
1
2
3
4
5
Rana canorivora

FIG. 15

FIGURE 16

Comparative specific activities of G.O.T. in the livers of various species of Amphibia.

Experimental conditions:

Xenopus: The results given represent an average of 4 animals per day for 10 days. The frogs were kept in fresh water and starved.

Rana angolensis: The results given are from two lots of four frogs used at different times after capture, the second lot having been in captivity longer and hence starved for longer.

Rana fuscigula: As for Rana angolensis.

Bufo regularis: The results are from animals obtained from two different s[illegible]s. Each result is a mean from 4 toads.

SPECIFIC ACTIVITY: ASPARTATE AMINOTRANSFERASE
1·0
0·8
0·6
0·4
0·2
Rana angolensis
Rana fusciguls
Bufo regularis

FIG. 16

FIGURE 17

Comparative specific activities of G.P.T. in the livers of various species of Amphibia.

Experimental conditions - see opposite Figure 16.

SPECIFIC ACTIVITY ALANINE A TRANSFERASE
1.0
0.8
0.4
0.2
0
Xenopus (average)
Rana angolensis
Rana fusc.gula
Bufo regularis

FIG. 17

FIGURE 18

Comparative ratios of specific activities of G.O.T./G.P.T. in the livers of various species of Amphibia.

Experimental conditions - see opposite Figure 14.

Note: in Rana cancrivora the ratio was calculated from the activities per unit wet weight of the two enzymes.

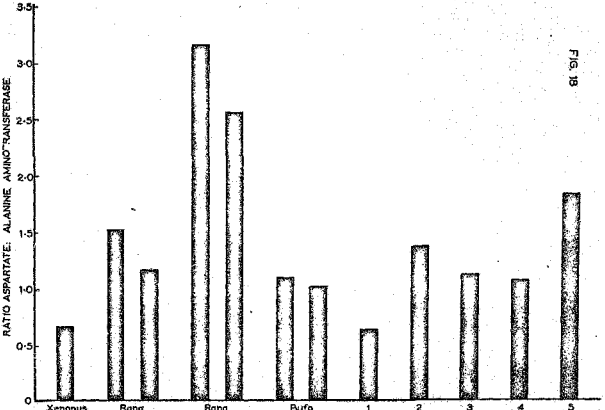
RATIO ASPARTATE: ALANINE AMINOTRANSFERASE
3·5
3·0
2·5
2·0
1·5
1·0
0·5
0
Xenopus (average)
Rana argotensis
Rana fusciguta
Bufo regularis
1
2
3
Rana cancrivora
4
5

FIG. 18

FIGURE 19

Activity per unit wet weight of C.O.T. in the livers of metamorphosing Xenopus laevis tadpoles.

Experimental conditions:

For all the tadpole stages, 16 tadpoles were used per result.

Each result for the young froglet stage represents a mean of 4 frogs.

ACTIVITY, ASPARTATE AMINOTRANSFERASE
30
20
10
0
STAGES OF METAMORPHOSIS

FIG. 19

FIGURE 20

Activity per unit wet weight of G.P.T. in the livers of [illegible] developing *Xenopus laevis* tadpoles.

Experimental conditions - see opposite Figure 10.

ACTIVITY ALANINE AMINOTRANSFERASE
30
20
10
0
STAGES OF METAMORPHOSIS

FIG 20

FIGURE 21

Specific activity of G.O.T. in the livers of metamorphosing Xenopus laevis tadpoles.

Experimental conditions - see opposite Figure 19.

SPECIFIC ACTIVITY
ASPARTATE AMINOTRANSFERASE
0
0.2
0.4
0.6
STAGES OF METAMORPHOSIS

FIG 12

FIGURE 22

Specific activity of G.P.T. in the livers of metamorphosing *Xenopus laevis* tadpoles.

Experimental conditions - see opposite Figure 19.

SPECIFIC ACTIVITY,
ALANINE AMINOTRANSFERASE
0·6
0·4
0·2
0
STAGES OF METAMORPHOSIS

FIG. 22

FIGURE 23

Ratio of the specific activities of G.O.T./G.P.T. in the livers of metamorphosing tadpoles.

_____ Xenopus laevis tadpoles.

------- Rana tadpoles.

Experimental conditions:

16 Xenopus tadpoles were used per result, while each result for the young froglet stage represents a mean of 4 frogs.

4 Rana tadpoles were used per result.

1·6
1·4
1·2
1·0
0·8
0·6
RATIO ASPARTATE: ALANINE AMINOTRANSFERASE
STAGES OF METAMORPHOSIS

FIG. 23

FIGURE 24

Activity per unit wet weight of G.O.T. in the livers of metamorphosing Rana tadpoles.

Experimental conditions:

4 tadpoles were used per experiment.

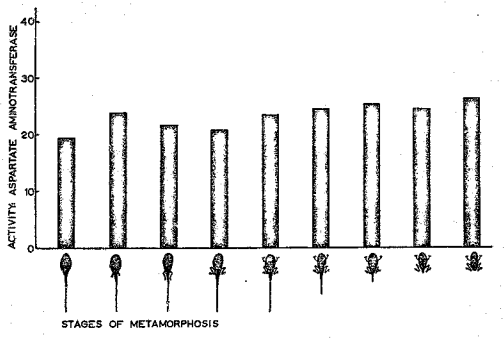
ACTIVITY ASPARTATE AMINOTRANSFERASE
40
30
20
10
0
STAGES OF METAMORPHOSIS

FIG. 24

FIGURE 25

Activity per unit wet weight of G.P.T. in the livers of metamorphosing Rana tadpoles.

Experimental conditions - see opposite Figure 24.

ACTIVITY, ALANINE AMINOTRANSFERASE
40
30
20
10
0
STAGES OF METAMORPHOSIS

FIG. 25

FIGURE 26

Specific activity of G.O.T. in the livers of metamorphosing Rana tadpoles.

Experimental conditions - see opposite Figure 24.

SPECIFIC ACTIVITY
ASPARTATE AMINOTRANSFERASE
0·6
0·4
0·2
0
STAGES OF METAMORPHOSIS

FIG. 26