

Dave Green's Great Crested Newt Larval Development



Written and drawn by Dave Green (on the right) in 1984.

Digitised by John Durkin (in the middle) in 2012

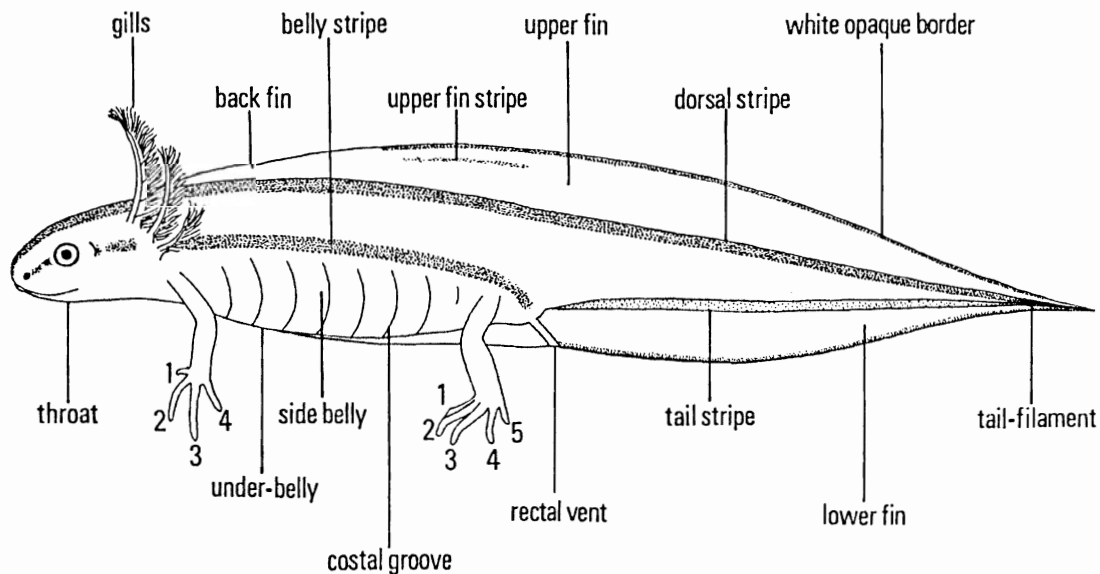
LARVAL DEVELOPMENT- AN INTRODUCTION

The following notes give detailed information on the development of great crested newt larvae over a 12 week period, the time taken for their complete metamorphosis at the indoor temperatures of $15\frac{1}{2}^{\circ}$ - 17°C . It is hoped that the information will not only act as a development guide but will be helpful in determining the ages of individuals caught in the wild.

The natural egg-laying period for this species in Durham is from mid/late March to late July, and the normal development time varies between 18-24 weeks (except for the extended period of between 36-44 weeks needed by overwintering individuals). It therefore follows that the twelve 'Week Stages' outlined will not correspond relatively with the 'natural' stages because of the temperature fluctuations incurred at different months upon the latter. As would be expected, these stages also vary considerably amongst natural larvae, depending on the month of their birth. Whilst the egg stage (Weeks 1-3) may encompass a natural period of over 8 weeks early in the season, such a period may be halved during July; conversely whilst the larvae of the latter develop speedily through until September their development slows dramatically, forcing some individuals to overwinter. It is thought, however, that the strongest case for forming time-relating parallels to the 12 week period is that near the beginning of the laying period, in late April, as such larvae will be amongst the most developed and, being in ponds right through until October, are amongst the most likely encountered during netting. During March many females will not of began laying and those that do lay few eggs per day. The natural 'week stages' are given in brackets in the 'WEEK No.' column of the Synopsis of Larval Development table over-page. Also given in the table are the corresponding natural larvae sizes, though these should only be looked upon as a rough guideline for much variation occurs.

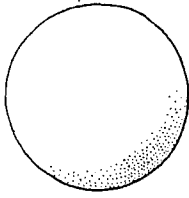
All features given in this account are of perfectly formed specimens and it is important to note this when making comparisons with natural individuals, which, due to fighting or predators, may lack a tail-filament, some limbs/digits and areas of the gills and tail-fins.

The composite illustration below gives the terminology used in the text.

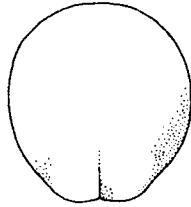


LARVAL TERMINOLOGY

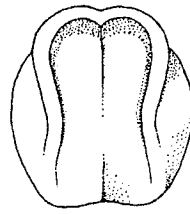
LARVAL DEVELOPMENT (1)



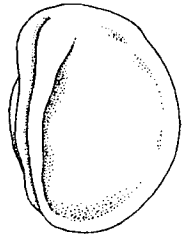
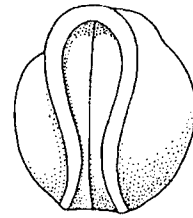
days 1-3



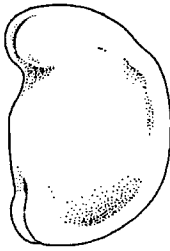
day 4



day 5



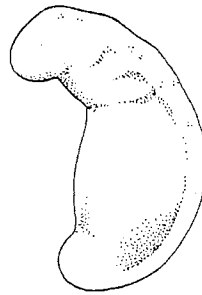
day 6



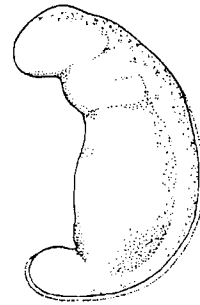
day 7



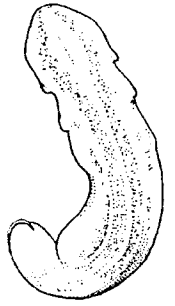
day 8



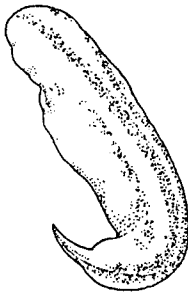
day 9



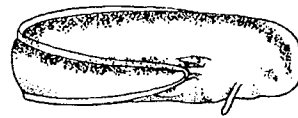
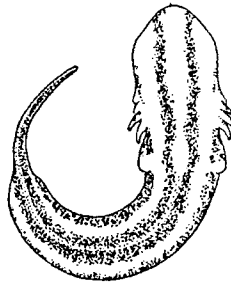
day 11



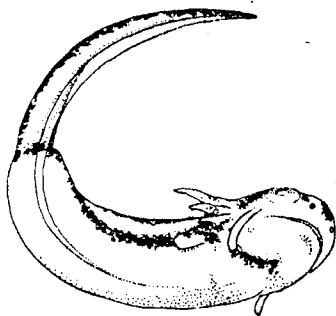
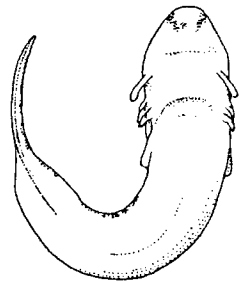
day 12



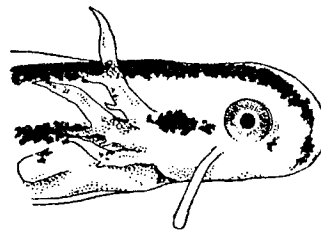
day 13



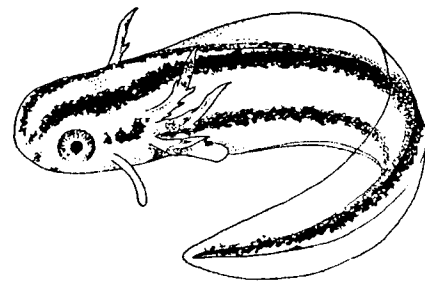
day 14



day 17



day 21

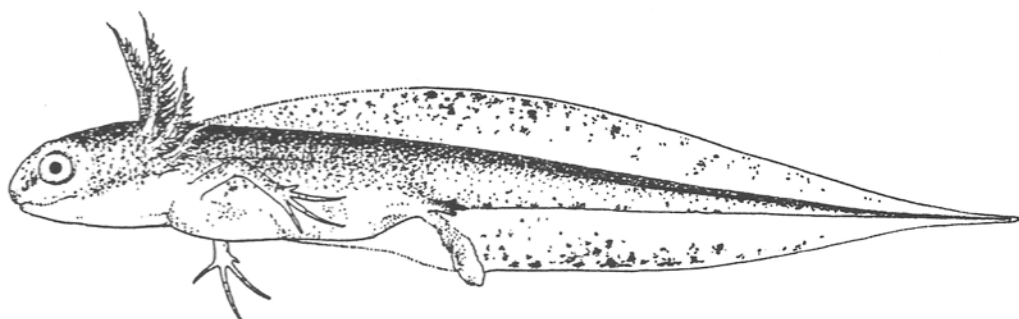


D. Green

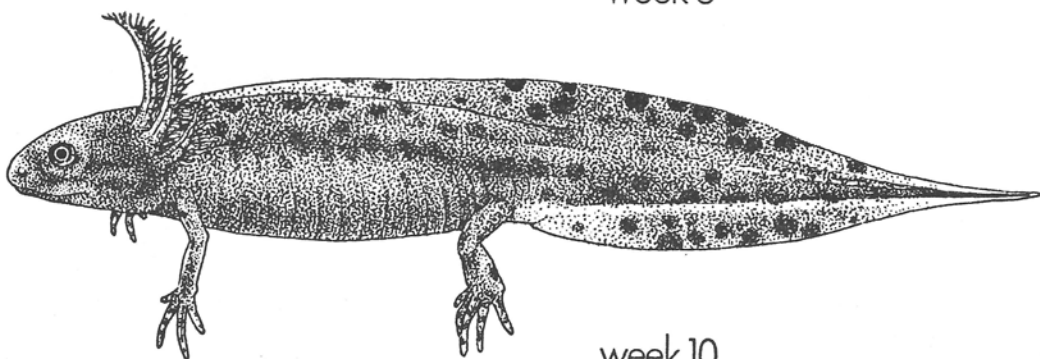
LARVAL DEVELOPMENT (2)



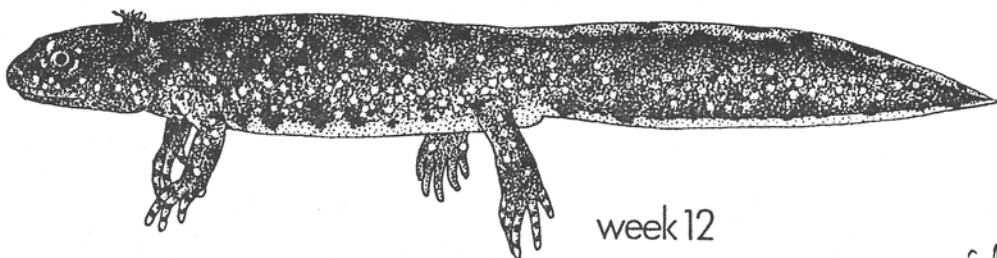
week 4



week 6



week 10



week 12

K. Jones

A SYNOPSIS OF LARVAL DEVELOPMENT

This table summarises the development of great crested newt larvae. The numbers in brackets in the 'WEEK No.' & 'SIZES' columns refer to the corresponding natural stages, as based on eggs laid in late April.

WEEK No.	SIZES	COLOURATION	LIMBS	TAIL-FINS	OTHER COMMENTS
DEVELOPMENT WITHIN THE EGG	<u>1</u> (1-3) 2 $\frac{1}{4}$ -2 $\frac{3}{4}$ mmms (2-2 $\frac{3}{4}$ mmms)	Cream-white	Absent	Absent	Whilst the head, body & vertebral column are distinct the tail-bud is poorly developed.
	<u>2</u> (4-6) 5-6 $\frac{1}{2}$ mmms (3 $\frac{1}{2}$ -6mmms)	Cream-white suffused with yellow. Grey dorsal & belly stripes develop.	The fore-limb buds are present	Clear tail-fins are present.	The balancers & gills have now formed. The larva is capable of slow movement.
	<u>3</u> (7-9) 8 $\frac{1}{2}$ -12 $\frac{1}{2}$ mmms (8 $\frac{1}{4}$ -10 $\frac{1}{2}$ mmms)	Yellow with black dorsal & belly stripes. The belly is cream-white.			The eyes & gill filaments develop, though this is a time of rapid tail growth. The larva moves quickly within the egg.
<u>4</u> (10-12) 14-17mmms (13 $\frac{1}{2}$ -18mmms)	Yellow with distinct black dorsal & belly stripes. The belly is pink.	The fore-limbs show 2 digits.	Fine black speckles develop.	Poor swimmer	
<u>5</u> (13-14) 21-25mmms (17 $\frac{1}{2}$ -22mmms)	Dull yellow with black dorsal stripes though fragmented belly stripes.	The fore-limbs show 3 digits, the middle one being by far the longest. The hind-limbs show as tiny buds.	The fine black speckles increase.	Whilst the tail-filament develops the balancers are absorbed. Good swimmer.	
<u>6</u> (15-16) 30-34mmms (21-29mmms)	Grey-yellow. The dorsal stripes begin to fragment whilst a groove shows in place of the belly stripes. Dark blotches show along the lower margin of the tail.	The fore-limbs show 4 digits, the 2nd remaining slightly longer than the 3rd whilst the newly developed 4th is the smallest. The hind-limbs remain small but show 3 digits the middle one being longest.	Black blotches develop on both fins, though are essentially confined to the margins of the middle third portions.	The gills now show their characteristic form of curving both forwards & outwards.	

7(17)	40-45mms (33-39mms)	The underlying vertebral column now shows in place of the fragmented dorsal stripes. Small dark blotches appear on the upper areas of the body, tail & limbs. The blotches on the lower margin of the tail are now black. The top portion of the pink side belly darkens.	The fore-limbs are now fully formed- the 2nd digit remains the longest whilst the 2 outermost ones are the shortest. Annulations show as light coloured bands. The hind-limbs show 4 digits, the 2nd remaining the longest.	Due to increased speckling their general colouration is a clouded grey. The black blotches increase in number & size.	The costal grooves now show.
8(18)	50-57mms (40-48mms)	The vertebral column becomes somewhat obscure except on the tail. The side belly colour is golden-pink, the under-belly light yellow.	The hind-limbs now show all 5 digits, & annulations are present upon them.	The lower fin becomes tinged with ochre on both sides of the rectal vent.	
9(19)	55-65mms (48-55mms)	Grey. The vertebral column is now indistinct. The side belly darkens.	The hind-limb digits become fully formed, the middle (3rd) being slightly longer than the 2nd, whilst the 2 outermost remain the shortest. The digits & limbs thicken.		
10(20)	70-75mms (50-59mms)	The body blotches are now black & spread onto the light grey side belly. The throat shows grey speckling on its anterior margin.	A pair of off-white warts develop on the inner side of each limb, above the outermost digits.	The lower fin recedes past the rectal vent & thus frees the cloaca.	The skin becomes very finely textured.
11(21)	76-83mms (57-64mms)	Dark grey. Off-white speckles appear mainly on the lower areas of the head, body & tail. The tail stripe develops & becomes a bright yellow, as does the under-belly, which now sports black spots between the fore-limbs.	Whilst the annulations & inner sides of the limbs become bright yellow, the outer digit warts become white.	Both fins are slightly absorbed.	The skin becomes roughly textured. The tail-filament & gills show signs of absorption.
12(22)	78-82mms (58-67mms)	The off-white speckles become white. The throat becomes fully covered with speckles. The black spots between the fore-limbs may spread $\frac{1}{3}$ of the way back along the belly.	The hind-limbs grow to the same size as the fore. The limbs & digits are strongly built.	The upper fin is absorbed along the back & for much of its height along the tail, whilst the lower fin is absorbed to the tail stripe.	The skin becomes warty. The larva thins particularly in the head & side belly regions. The tail-filament & gills are totally absorbed. Poor swimmer.

N.B. If no reference is made to an area/organ after previously being mentioned, it should be taken that no change has occurred.

WEEKS 1-3

When first laid the protective, clear egg-jelly measures on average $4\frac{1}{2}$ mms x $3\frac{1}{4}$ mms. Within this, though not attached to it, is the almost spherical cream-white embryo or vitellus, averaging $2\frac{1}{4}$ mms x 2 mms. During the first week it lengthens to $2\frac{3}{4}$ mms and its colouration is tinged with pink, except for the cream-white yolk-sac which is situated on the belly. The head, body and vertebral column clearly show though the tail-bud is but poorly developed. In the second week the pinkish colouration of the $6\frac{1}{2}$ mm long larva becomes impregnated with yellow whilst two pairs of grey body stripes develop, the dorsals being the most pronounced. The balancers, gills, fore-limb buds and tail-fins develop. The larva also shows the first signs of movement- a slow deliberate curling of the head or tail or a slow twist around within its protective cover. By the third week the yellow pigmentation becomes more prominent and the body stripes become black. An inverted v-shaped area of dark speckling is also present on the underside, at the border of the throat and belly. This period is essentially one of tail growth though the eyes usually show clearly for the first time and filaments develop on the growing gills. The larva is now capable, due to lightening reflexes of the curled tail, of changing its position within the egg in a fraction of a second. Interludes between such movements however, may be as long as three-quarters of an hour or more. At three weeks the larva measures between $8\frac{1}{2}$ mms- $12\frac{1}{2}$ mms long and is ready to leave the strong three-layered egg-jelly, which has had to stretch to an average of 6 mms x $4\frac{1}{2}$ mms to accommodate it. A few days beforehand the egg-leaf, which has served as protection, unfolds so as not to hinder the larva's departure.

WEEK 4

The larva, having digested the egg-jelly emerges either head or tail-first, this being achieved by tail-flicking bursts with quiet periods between. Once free it either hangs motionless to the egg-leaf by its balancers, or swims frantically though aimlessly away. Only late in the week does it swim more purposefully and takes to open water in short spells, occasionally surfacing to take atmospheric oxygen. By this time the larva may of reached between 14 mms- 17 mms. Its colouration remains yellow though its belly turns from opaque cream-white to a delicate pink. It is a fine model for microscopic study as its semi-transparent body shows clearly such structures as the heart, lungs, digestive system and blood circulation. The black dorsal stripes run the full length of the larva, beginning at a central position on the underside of the head, below the eyes. At this point they diverge and pass over the head parallel to one another until behind the gills whereupon they merge together to follow the path of the vertebral column to the tail-tip where they broaden slightly. The black belly stripes also originate on the head, just behind the nostrils. They continue as somewhat broken lines through the eyes but come to an abrupt halt in front of the gills. They re-appear on and clearly mark the belly perimeter, terminating at the rectal vent. During the course of the week the gills develop further filaments, four pairs being present on the largest set and, due to black speckling, they darken. The thin, transparent balancers, positioned just below and behind the eyes, are large and well developed at birth. They are adhesive organs and play a major roll in the larva's early life, being used to hold on to water plants or any other object which happens to be in its path. The fore-limbs gradually increase in size and by mid-week show the 1st and 2nd digits. The tail-fins are clear at first, except for some very fine black speckling and a patch of yellow on the back fin, that continues somewhat sparingly as a thin, broken line above the dorsal stripes, almost to the tail-tip. Within a few days, however, a fine white opaque border develops, only remaining absent from the back fin and between the belly and rectal vent of the lower fin. Both upper and lower fins originate at points just behind the head. Whilst the upper fin rises sharply over the back the lower is shallow along the belly and only shows the depth of the upper after it has passed onto the tail, and then, like the latter gently curves down to the tail-tip.

WEEK 7

The larva now reaches a length of between 40mms-45mms long. Its colouration continues to darken as does the top area of the protruding, pinkish side belly, which now shows the costal grooves. Small, indistinct dark blotches appear on the upper part of the body and tail, limbs and sometimes the head, though their number and positioning does vary considerably from one individual to another. The only constant blotches are those which are sited along the lower margin of the tail, which have become black. The dorsal stripes are now indistinct, and it is the underlying vertebral column that shows as a somewhat lower 'stripe' (due to skin development) along the back and tail. The beautifully curved gills grow comparatively to the larva's size, the largest set approximating to the length of the head. The covers often become flecked with gold whilst the numerous filaments are of a delicate pink. The digits of the fore-limbs are now fully formed with the 2nd remaining longer than the 3rd and the two smaller outermost ones of comparable length. Annulations show as light bands upon the base colour of the digits. The hind-limbs, only half the length of the fore, show four digits, of which the 2nd remains the longest and the newly emerged 4th the shortest. The heavily speckled tail-fins tend now to have a somewhat clouded, grey appearance, or dull ochre in the case of the back fin, whilst the area by the tail-tip remains relatively clear. Their black blotches grow in number and size though do not show any great expansion in area and the white opaque borders continue to remain intact.

WEEK 8

By the close of this period the grey-yellow larva achieves a length of between 50mms-57mms. The vertebral column can now only be clearly seen along the tail, the black filament of which is upto 7mms in length. The side belly colouration becomes a delicate golden-pink whilst that of the underside is a light yellow. The mid-line of the latter shows a thread-like depression from the fore-limbs to the hind, the previous attachment area of the lower fin. All five digits are present on the hind-limbs and are of comparable size to those of the fore. The 2nd and 3rd are slightly the longest, whilst the two outermost are the shortest. Annulations show on all digits. The black blotches of the fins increase, but continue to be confined to the margins and usually remain absent on the ochre back fin and the posterior quarter of both. The lower fin, having receded almost to the hind limbs, becomes tinged with ochre on both sides of the rectal vent.

WEEKS 9 & 10

Within this fortnight the larva attains a length of between 70mms-75mms, and is now coloured grey. Whilst some features such as the nostrils, mouth outline and costal grooves show more clearly due to this, others such as the dark stripe between nostril and eye, and the vertebral column along the tail become ill-defined and eventually lost. However, with regards to the latter, a ridge now shows in its place, though usually confined to the anterior quarter of the tail. A line of small whitish hyphen marks may also show on the upper tail, though are mainly confined to its posterior, and mark the original upper edge. The variable blotches of the body, upper tail and limbs continue to develop both in size and number and spread onto the side belly, which has darkened considerably. During the 10th Week they become black. The colouration of the under-belly remains light yellow. The throat loses its flesh colour (and its semi-transparency) to become light grey, and may show the first signs of grey-brown speckling on its anterior margin. The gills are now at their longest, the first set reaching 10mms, the 2nds 5 $\frac{1}{2}$ mms and the smallest set 3mms. All five digits of the hind-limbs become fully formed and begin to thicken in the 9th Week, the 3rd being slightly the longest and the 1st and 5th the shortest, though these limbs still remain smaller than the fore. A pair of off-white warts develop on the inner side of each limb, above the two outermost digits. The tail-fins are absorbed very slightly during this period, the effect of which is the loss of the white opaque borders. The lower fin recedes past the rectal vent in the 10th Week and thus frees the developing cloaca. The posterior quarter of the fins, previously quite clear, now show many speckles and some blotches, though the thin strip along the margin of the lower tail remains intact.

During this period the heavily-built larva reaches a length of 78mmms-82mmms. This apparent cessation of growth is due to the absorption of the 8mm long tail-filament, which begins late in the 11th Week, it also being responsible for making the larva's combined head and body length greater than that of the tail, for the first time since the 4th Week. The larva's colouration including the side belly is now composed of various shades of dark grey with some brown. A mottled pattern, the result of the fragmentation of the ground colour by an increase in size and number of blotches, is present in most areas. Side belly blotches increase and show for the first time along the lower edges, some bleeding onto the under-belly. The darkening skin becomes textured and during the 12th Week shows prominent warts. These tend to obscure a number of features including the costal grooves, belly groove, the tail ridge and whitish hyphen marks, if previously present. The larva also thins during this time and the side belly, the most affected area, loses a full $1\frac{3}{4}$ mmms of its width. Off-white speckles appear in the 11th Week between the black blotches of the side belly, the lower regions of the head and tail, and to a lesser extent on the body and limbs. They intensify with age to a pure white. The throat, typically light grey, though sometimes yellow, shows increased grey-brown or black speckling. Whilst at first confined to the anterior margins of the mouth, they spread and totally cover the throat by the close of this period, though remain least numerous at its posterior. During the 11th Week the under-belly and inner sides of the limbs become a bright yellow. Black spots develop on and between the fore-limbs and increase both in size and number. By the time the larva becomes an eft they may have spread two-thirds of the way back along the belly, though remain most numerous by the fore-limbs. The limbs and digits thicken and are strong in build by the close of the 12th Week. The hind-limbs grow to the same size as the fore. The digit annulations become yellow and thus very conspicuous. The pair of warts above the outermost digits on each limb are now strongly developed and are coloured white. The tail-fins continue to darken and blotches increase and often appear on the murky ochre back fin and around the cloaca, now coloured yellow. A $1\frac{3}{4}$ mm deep, cream-yellow stripe develops on the relatively clear area of the lower fin along the margin of the tail. It is often irregular in development and usually shows first at the anterior, then the posterior of the tail before forming along the centre. It becomes a bright yellow at the same time as other yellow areas, i.e. late in the 11th Week.

Absorbitions

The larva is now ready for the final changes to occur for it to become a land-dwelling eft. These take place essentially in the final week though the first signs may occur earlier with the absorption of the tail-filament and the slight recession of the gills and tail-fins. The first indications of gill absorption is their untidy appearance, due to the atrophying filaments. The largest set reduce at a rate of approximately 1mm per day whilst the smaller sets reduce relatively to this. They eventually become wizened stumps and curl inwards to the sides of the head before finally being covered by skin. Within a few days of the 12th Week the lower fin has receded to the origins of the yellow tail stripe. Its absorption occurs quickly and evenly along its length. The upper fin begins to withdraw at the same time though at a much slower pace. It appears to recede from the anterior, though in actuality its shape remains relative to its original form. It is never fully absorbed along the tail. With complete fin absorption along the back a $\frac{2}{3}$ mm wide central depression shows. This area is usually coloured dull ochre. Due to the absorption of its swimming aids the eft becomes a poor swimmer and tends to keep to the shallows. During this period it often sheds its skin a number of times, the skin splitting at the mouth, whose upper lip does not now overhang the lower jaw. It is worked over the back and limbs by a series of contortions and by the larva rubbing up against stones and plants. After a period of upto 20 hours the slough, rarely in one piece, is finally removed and usually eaten, a process which takes up a further half hour. The eft generally takes its first tentative steps onto land on warm, wet evenings. Efts and well developed larvae, although their colouration is that of the female, may show their true sex by making adult movements such as the sperm deposition posture of the male or the egg-laying posture of the female.