

has shown that some of the shrunken eggs can survive without adverse effect.

I thank Mr Arthur Lutz for constructing the apparatus and Mrs Joan Florence and Mr D. R. Akers for technical assistance. This work was supported by a US Public Health Service grant.

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Received July 21; revised August 17, 1967.

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Melanin in an Insect, *Lucilia cuprina* (Wied.)

MELANINS, although somewhat ill defined, are dark pigments which occur in animals and plants and they are usually bound to protein. Thomson¹ in a review has pointed out that there are no satisfactory histochemical tests for the identification of melanin. Alkali solubility and reversible reduction merely indicate acidic and quinonoid properties—properties common to many different types of pigments. Mammalian and cephalopod melanins in particular have been extensively studied and some have been isolated and examined chemically. Melanins are formed by the action of a phenolase on a phenolic substrate, but their structure is not known. Those derived from tyrosine, however, are considered to be built up from indolyl units. Nicolaus *et al.*² classified melanins as “indole” or “catechol” types, depending on the degradation products formed on alkali fusion and permanganate oxidation. All melanins so far examined from animal sources are of the indole type, as are the melanins prepared by the oxidation of tyrosine and dopa.

In insects, except for one investigation³, identification of melanin has relied on inadequate histochemical tests. Sometimes a search has been made for an accompanying phenolase system, but this is usually of little value because of the phenolase activated process of sclerotization which occurs in insects. Nevertheless, sclerotization and blackening (said to be melanin) have been shown to be independent processes in a few insects (for a review, see Hackman⁴).

I have a laboratory strain of the blowfly *Lucilia cuprina* (Wied.) in culture which is homozygous for three recessive mutants carrying yellow eyes, rusty body and a black puparium (the puparium of the normal wild strain is brown). Electron microscopy shows a layer of fine black granules at the inner surface of the epicuticle of the puparium. When empty puparia, from which pupal cuticles, other residues and lipids have been removed, are hydrolysed (6 normal hydrochloric acid) thin insoluble membranes remain which are “ghosts” of the original puparia. In the normal wild strain these membranes are colourless, but in the mutant they are an intense black and thicker.

When radioactive tyrosine⁵ was injected into fully grown last instar larvae of the mutant, 79 per cent of the radioactivity was recovered from the puparia and 49 per cent of this was in the black membrane remaining after hydrolysis. With the normal wild strain these percentages were 59 and 16, respectively.

The black pigment was extracted (10 per cent aqueous sodium hydroxide) from the insoluble membranes remaining after acidic hydrolysis of puparia of the mutant and recovered by acidifying the extract and yielded 4.6 per cent on weight of puparia taken. The pigment was again subjected to acidic hydrolysis (6 normal hydrochloric acid) for 24 h. In alkaline solution the pigment showed only general absorption in the ultraviolet and visible regions of the spectrum. The pigment was subjected to alkali fusion² and 5,6-dihydroxyindole and 5,6-dihydroxyindole-2-carboxylic acid were identified among the degradation products. Permanganate oxidation⁶ of the pigment gave pyrrole-2,3,5-tricarboxylic acid as the principal product together with smaller amounts of pyrrole-2,3-dicarboxylic acid and pyrrole-2,3,4,5-tetracarboxylic acid. These degradation products are the same as those obtained by Nicolaus and his collaborators^{2,3} from invertebrate melanins (from squid, cuttlefish and octopus inks and from *Drosophila melanogaster* tumours and *Tropinota glabra* elytra) and from melanin prepared by oxidation of dopa.

The black pigment in the puparia of the *L. cuprina* mutant has the physical properties of a melanin and gives degradation products characteristic of melanins of animal origin. This pigment is therefore classified as an indole melanin. Experiments with radioactive tyrosine show it to be formed from tyrosine, which is confirmed by the nature of the degradation products.

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Received July 24, 1967.

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Retraction of the Claim that Host Pregnancy affects Pupal Production by the Tsetse Fly

DURING the first two seasons of an investigation into the effect of host pregnancy on female *Glossina austeni* we claimed that the performance of the flies fed on pregnant goats was significantly better than that of those fed on non-pregnant goats¹⁻³. We must now retract this claim. The combined results for season 2 are given in Table 1, followed by the figures for the first experiment in season 3 in which there was a complete reversal.

Table 1. SURVIVAL AND PUPAL PRODUCTION BY FEMALE *G. austeni* WHEN FED ON PREGNANT AND NON-PREGNANT GOATS

No. of experiment	Age of flies (weeks)	No. of survivors		No. of pupae deposited	
		Pregnant goats	Control (male and female)	Pregnant goats	Control (male and female)
Season 2 (all experiments combined)	0	1,048	1,044	0	0
	9	639	406	2,865	1,852
Season 3 Expt. 1	0	600	600	0	0
	9	163	367	1,032	1,766
Expt. 2A	0	Female goats (non-pregnant)	Male goats	Female goats (non-pregnant)	Male goats
	9	300	300	0	0
Expt. 2B (same goats as in 2A)	0	211	210	1,067	1,053
	9	(Pregnant)	(Pregnant)	(Pregnant)	(Pregnant)
	0	600	600	0	0
	9	424	441	2,038	2,104
	20	129	145	4,078	4,048

Before this investigation began, attempts had been made to test goats for individual variation in attractiveness to fertilized female tsetse, but they failed as a result of concealment of the blood meal by the larva. After checking that the blood picture was normal for the three pregnant goats used in experiment 1, we devised a test for the suitability of the host using unfed 2 day old male flies as the test organism. The proportion of such flies which have fed after application for 15 min is referred to as the "host suitability index"; indices were obtained for all goats. There is no evidence that certain goats are basically unattractive, but a few become exceedingly unsuitable because of skin thickening caused by excessive feeding by the flies or by susceptibility to tsetse saliva. Of forty goats tested, four had very low indices. By chance two of these four were in the team of three pregnant goats used in experiment 1; furthermore, all four had been included in the control herds used in seasons 1 and 2, where their presence would have lowered the control values and given rise to apparently better results from the pregnant goats.

Recently two teams of goats with equally high suitability indices were used. The performance of female tsetse flies was remarkably similar when fed on a team of non-pregnant female goats or on a team of castrated male goats (experiment 2A). Using the same goats, the experiment was repeated when the females were pregnant; again, fly performance was similar with the two types of host (experiment 2B). It should be noted that the superiority of these results over those of season 2 resulted from the introduction of a new type of cage².

The error in the interpretation of our earlier results is extremely unfortunate. On the other hand, by culling any unsuitable animals, excellent yields of pupae can be obtained without having to use pregnant goats which are only seasonally available.

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Received July 28; revised September 4, 1967.

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Algebraic Model of the Lactation Curve in Cattle

MANY factors may influence the total milk yield of a single lactation, but the general shape of the curve, defined by the locus of weekly yield, remains substantially unchanged. Economically, the configuration of the curve is important, for the animal which produces milk at a moderate level steadily throughout her lactation is to be preferred to one which produces a great deal of milk at her peak but little thereafter (see Cersovsky¹ for a review of the literature).

Some attention has been paid to the problem and many workers, chiefly in Europe, have noted changes in the shape of the curve as a result of season of calving², age³ and fertility⁴, although the phenomenon appears to remain relatively unaffected by changes in management. The British Milk Marketing Board⁵ has presented diagrams showing the effect of season of calving and parity on average lactation curves, and Makela^{6,7} has studied in detail the position and duration of peak yield, and has pointed out its importance to the milk yield of the lactation as a whole.

Little new has in fact emerged since Johanssen⁸ reviewed the subject in 1961, when he described Gaines formula $y = ae^{-Kt}$ (y is the yield in week t , e is the base of natural

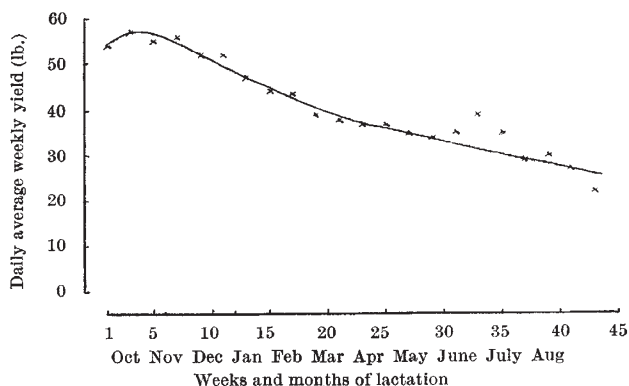


Fig. 1. Regression curve $y = 56.62 n^{0.03996} \exp(-0.00942 n)$ fitted to a single Friesian lactation.

logarithms, a and K are constants) which, however, does not give a very good fit. More recently, Nelder⁹ described an inverse polynomial which might furnish a rather better description, but at the same time our own studies have developed along slightly different lines.

The curve of lactation increases rapidly from calving to peak a few weeks later, followed by a more or less gradual decline until the animal goes dry in about 10 months. This is essentially a gamma-type curve, and may be expressed generally by the function

$$y_n = a n^b \exp(-cn) \quad (1)$$

where y_n is the average daily yield in the n th week and a , b and c are constants.

The total yield is then

$$y = \frac{a}{cb+1} \Gamma(b+1) \quad (2)$$

and yield to week t is given by

$$y_t = a \int_0^t n^b \exp(-cn) dn \quad (3)$$

which may be evaluated, for example, by using tables of the incomplete gamma function.

Peak yield occurs therefore where $n = b/c$ and is itself $y_{\max} = a(b/c)^b e^{-b}$.

Other properties of the model may be deduced immediately.

The exponent, b , must be less than unity, otherwise we are faced with an ever increasing weekly yield. $\Gamma(b+1)$, is therefore close to unity, and total yield

$$y \approx \frac{a}{cb+1} \quad (\text{from equation 2})$$

Hence $cb+1 < 1.0$, and so $c < 1.0$.

But the constant a is a general scaling factor associated with the average daily yield at the start of the lactation, because $y_n = a$ when $n^b \exp(-cn) = 1$. Hence, for lactations starting at the same level, total yield, y , is a function of $c^{-(b+1)}$, which is therefore a measure of "persistence" or the extent to which peak yield is maintained. Putting $S = c^{-(b+1)}$, the relationship between persistency, total yield and level of production is given by

$$\ln(y) = \ln(a) + \ln(S) + \ln(\Gamma(b+1))$$

For given a or S therefore variations in y depend almost entirely on variations in S or a , respectively.

The constants may be determined uniquely for any lactation by least squares methods. Equation (1) converts to

$$\ln(y_n) = \ln(a) + b \ln(n) - cn \quad (4)$$

a straightforward linear regression model.

Evaluation of a single Friesian lactation chosen at random gave the following values, calculated from the 24 h production of one day in each week for the first 44 weeks of lactation: $a = 56.62$; $b = 0.03996$; $c = 0.00942$; from which $y_{\max} = 57.6$ lb./day, $n_{\max} = 4.25$ weeks.

The observed yield over 305 days was 12,215 lb., which