# Fatty Acid Composition of Eggs during Development of the Cotton Leaf-Worm, *Spodoptera littoralis* Boisduval

I. Z. Boctor

Laboratory of Plant Protection, National Research Centre, Dokki, Cairo, Egypt

Z. Naturforsch. **36 c**, 562–563 (1981); received January 2, 1981

Fatty Acids, *Spodoptera littoralis*, Eggs

Gas-liquid chromatographic analysis of egg lipids during development of *Spodoptera littoralis* showed the presence of 13 fatty acids ranging in carbon chain length from caproic (C6:0) to linolenic acid (C18:3). Palmitic, palmitoleic, stearic, oleic and linoleic acids composed over 90% of the total fatty acids. Palmitic acid was always the predominant fatty acid and oleic acid was the second most abundant.

## Introduction

The period of embryogenesis of terrestrial arthropods represents the most dynamic phase of organizational and metabolic activity of their life cycle. During this period most of the rather inert substances of the ova are synthesized into integral tissues and organs while the rest are catabolized to provide respiratory energy. Lipid materials serve as a source of energy during this period. Lipids, particularly triglyceride account exclusively for the decrease of lipid material during embryogenesis [1–3]. The body of available information on general chemical embryology relates mainly to the vertebrate [4, 5], but precise information concerning the metabolism of the invertebrata during embryogenesis is rather scarce, particularly as regards the Hexapoda. Bumgarner and Lambremont [6] determined the fatty acid content of the boll weevil egg. Palmitic acid, oleic acid and linoleic acid composed about 80% of the fatty acids of the triglyceride fraction obtained from the eggs.

The present paper reports the changes in fatty acid composition of the cotton leaf-worm, *Spodoptera littoralis* during embryogenesis.

## Experimental

*Spodoptera littoralis* was reared on castor-oil leaves in the laboratory according to El-Ibrashy and Chenouda [7]. Egg masses deposited on oleander leaves (*Nerium oleander* L.) were collected and allowed to develop for 24, 48 and 70 h. Hatching started at about 72 h after oviposition.

0341-0382/81/0700-0562 $ 01.00/0

Total egg lipids were extracted with chloroform-methanol mixture (2:1) using the procedure of Folch *et al.* [8]. The lipids extracted in chloroform were then washed [9], and evaporated to dryness under a reduced pressure. Flasks containing the purified lipid were desiccated over phosphorus pentoxide to a constant weight. The percentage of lipid was then calculated and the lipids raised to a known volume with chloroform.

Gas-liquid chromatographic analysis of fatty acids was done on methyl esters prepared and purified by the method of Luddy *et al.* [10]. Varian aerograph-440 gas-liquid chromatograph equipped with a hydrogen flame ionization detector was used. The fatty acid methyl esters were analyzed on a column 6 feet × 5 mm stainless steel tubing packed with 10% diethylene glycol succinate on Chromosorb-W (100–200 mesh). Flow of carrier gas: helium, 10 ml/30 sec; hydrogen, 10 ml/30 sec; air, 100 ml/sec and column temperature 190 °C. The fatty acid esters were identified by comparison of their relative retention time with those of known standards. The area of each chromatographic peak determined by the technique of multiplying the peak height by the width at half-height recommended by Horning *et al.* [11] proved very satisfactory.

## Results and Discussion

The lipid content of 24, 48 and 70 h was 6.75, 6.23 and 5.00% of the fresh weight of the eggs respectively. The data show that lipid content decreases during embryonic development of *Spodoptera littoralis*. This agrees with reports by Allais *et al.* [1] and Gilbert and Schneiderman [12] that total lipid content decreased during embryonic development of

Table I. Percentage fatty acid composition from eggs of developing *S. littoralis*. Values represent the average of determinations on three separate egg masses. First number denotes the number of carbon atoms and that after the colon the number of double bonds.

| Fatty acid | Hours of embryonic development | | |
|---|---|---|---|
| | 24 | 48 | 70 |
| 6:0 | 0.40 ± 0.010 | 0.77 ± 0.011 | 0.58 ± 0.011 |
| 8:0 | 0.62 ± 0.013 | 0.60 ± 0.017 | 0.50 ± 0.011 |
| 10:0 | 0.14 ± 0.002 | 0.54 ± 0.010 | 0.25 ± 0.004 |
| 12:0 | 0.50 ± 0.009 | 0.70 ± 0.010 | 0.14 ± 0.002 |
| 14:0 | 0.43 ± 0.008 | 0.84 ± 0.021 | 0.67 ± 0.015 |
| 16:0 | 48.08 ± 2.884 | 42.33 ± 1.905 | 41.85 ± 2.929 |
| 16:1 | 4.97 ± 0.173 | 3.42 ± 0.171 | 2.11 ± 0.052 |
| 16:2 | 2.49 ± 0.045 | 0.89 ± 0.022 | 1.32 ± 0.046 |
| 17:0 | 2.10 ± 0.105 | 0.70 ± 0.025 | 0.86 ± 0.021 |
| 18:0 | 4.99 ± 0.274 | 7.89 ± 0.355 | 9.37 ± 0.356 |
| 18:1 | 29.38 ± 0.881 | 35.45 ± 1.342 | 40.27 ± 2.094 |
| 18:2 | 4.06 ± 0.085 | 4.65 ± 0.130 | 1.34 ± 0.044 |
| 18:3 | 1.84 ± 0.027 | 1.22 ± 0.024 | 0.72 ± 0.016 |

*Locusta migratoria* and *Hyalophora cecropia*. Also, the Japanese beetle *Popilliae japonica* catabolizes 46% of initial egg lipids, and Rothstein [13] reported that the peroid of maximum lipid metabolism corresponds to the peroid of maximum energy requirement by the embryo.

In the present study, gas-liquid chromatographic analysis of egg lipids during development of *Spodoptera littoralis* revealed the presence of 13 fatty acids (Table I). Five principal fatty acids, palmitic acid (C 16:0), palmitoleic acid (C 16:1), stearic acid (C 18:0), oleic acid (C18:1) and linoleic acid (C 18:2) composed over 90% of the total fatty acids present. This distribution is characteristic of the Insecta with the exception of the Coccidae and Diptera, which have a high content of myristic acid (C 14:0) and palmitoleic acid respectively [14]. The results of the present investigation show that palmitic acid was always the predominant saturated fatty acid while oleic acid was the major unsaturated fatty acid. These data agree with that obtained with *Hyalophora cecropia* [15] which showed that palmitic acid is a prominant fatty acid in the eggs. Turunen [16, 17] reported that the egg of *Pieris brassicae* is characterized by relatively high levels of palmitic acid and oleic acid. The high content of these two acids in eggs on all the diets studied may result not merely from passive diffusion but apparently also from active incorporation by the female.

Palmitoleic acid shows a continual decrease throughout development. It contributes from 2.1 to 4.9% of the total fatty acids in *Spodoptera littoralis*, whereas in most other insect eggs, this compound occurs in trace quantities only [18]. The relative per cent of stearic acid increased throughout development of *Spodoptera* to reach a maximum in 70 h (9.3%). The caproic (C 6:0), caprylic (C 8:0), capric (C 10:0), lauric (C 12:0) and myristic (C 14:0) acids were present in minute quantities, less than one per cent.

The higher content of linoleic and linolenic acids in 24, 48 h as compared with 70 h, the increased rate of utilization of linoleic acid near the time of hatching (70 h), and the 41% decrease in linolenic acid near hatching are interesting, since numerous dietary studies [19] have shown that one or both of these acids are necessary for the normal development of insects. The studies of Vanderzant *et al.* [20] suggested that linoleic acid functions in the developmental process and that linolenic acid is essential for uninterrupted eclosion.

[1] J. P. Allais, J. Bergerard, J. Etienne, and J. Polonovski, J. Insect Physiol. **10,** 753 (1964).
[2] J. E. Kinsella and T. Smyth, Jr., Comp. Biochem. Physiol. **17,** 237 (1966).
[3] W. J. Yrukiewicz and J. Oelsner, Comp. Biochem. Physiol. **28,** 955 (1969).
[4] J. Brachet, The Biochemistry of Development. Pergamon Press, London 1960.
[5] J. Needham, Chemical Embryology. Hafner, New York 1964.
[6] J. E. Bumgarner and E. N. Lambremont, Comp. Biochem. Physiol. **18,** 975 (1966).
[7] M. T. El-Ibrashy and M. S. Chenouda, Z. angew. Ent. **65,** 146 (1970).
[8] J. Folch, M. Lees, and G. H. S. Stanley, J. Biol. Chem. **226,** 497 (1957).
[9] R. Nicolaysen and A. P. Nygaard, J. Clin. Lab. Invest. **15,** 79 (1963).
[10] F. E. Luddy, R. A. Barford, and R. W. Riemenschneider, J. Amer. Oil Chemists' Soc. **37,** 447 (1960).
[11] E. C. Horning, E. H. Ahrens, S. R. Lipsky, F. H. Mattson, J. F. Mead, D. A. Turner, and W. H. Goldwater, J. Lipid Res. **5,** 20 (1964).
[12] L. I. Gilbert and H. A. Schneiderman, Gen. Comp. Endocrinol. **1,** 453 (1961).
[13] F. Rothstein, Physiol. Zool. **25,** 171 (1952).
[14] J. S. Barlow, Can. J. Biochem. **42,** 1365 (1964).
[15] W. F. Stephen, Jr. and L. I. Gilbert, J. Insect Physiol. **16,** 851 (1970).
[16] S. Turunen, J. Insect Physiol. **19,** 1999 (1973).
[17] S. Turunen, J. Insect Physiol. **20,** 1257 (1974).
[18] J. E. Kinsella, Comp. Biochem. Physiol. **19,** 291 (1966).
[19] R. H. Dadd, J. Insect. Physiol. **10,** 161 (1964).
[20] E. S. Vanderzant, D. Kerur, R. Keiser, J. Econ. Entomol. **50,** 606 (1957).