

THE EFFECT OF TEMPERATURE ON THE FRONS WIDTH IN MALES OF *STOMOXYS CALCITRANS* LINNAEUS (DIPTERA: MUSCIDAE)

B. SUTHERLAND, Veterinary Research Institute, Onderstepoort 0110

ABSTRACT

SUTHERLAND, B., 1979. The effect of temperature on the frons width in males of *Stomoxys calcitrans* Linnaeus (Diptera: Muscidae). *Onderstepoort Journal of Veterinary Research*, 46, 117-119 (1979).

Laboratory experiments established that males of *Stomoxys calcitrans*, raised at a high temperature (30 °C), had frons widths that were very significantly smaller ($P=0,01$) than those of males raised at a lower temperature (20 °C). Thus, although the frons width is apparently controlled genetically, it can also be influenced by temperature. It was also established that temperature acted on the fully-fed 3rd instar larva to affect the adult male frons width.

Résumé

EFFET DE LA TEMPÉRATURE SUR LA LARGEUR DU FRONT CHEZ LES MÂLES DE *STOMOXYS CALCITRANS* LINNAEUS (DIPTERA: MUSCIDAE)

Des expériences de laboratoire ont montré que la largeur du front chez des mâles de *Stomoxys calcitrans* élevés à haute température (30 °C), était inférieure à celle de mâles élevés à basse température (20 °C), la différence étant hautement significative ($P=0,01$). En conséquence, bien que la largeur du front soit apparemment sous contrôle génétique, elle peut aussi être influencée par la température. On a également montré que c'est sur la larve repue du 3e stade que la température agit pour influencer la largeur du front chez le mâle adulte.

INTRODUCTION

The frons ratio is a widely used character in the Cyclorrhapha and is referred to in population studies by Greenham & Hughes (1971), Paterson (1964, 1974) and Monzu (1977). In his taxonomic studies on the adult males of the Stomoxyinae, Zumpt (1973) used the frontal index (i.e. the smallest width of the frons divided by the greatest length of the eye) as one of his distinguishing characters. Hulley (1975, 1978) stated that the male frons width in *Musca domestica calleva* and *M.d. curviforceps* is not only genetically fixed but is also affected by temperature, as it was narrower at higher culturing temperatures.

This study was aimed at measuring the effects of temperature on the male frons width of *Stomoxys calcitrans* and, in addition, determining the developmental stage at which temperature gives rise to differences in male frons widths.

MATERIALS AND METHODS

Eggs were collected less than 1 hour after deposition from the stock colony kept at 27 °C (Sutherland, 1978). Large mixed batches of these eggs were then raised for 1 generation at 20 °C and 30 °C respectively, but in other respects under the same experimental conditions as the stock colony.

Adults emerging from the larval breeding jars in these 2 sub-colonies were subsequently liberated into 0,027 m³ gauze cages when they were less than 2 hours old. Only flies from the same age-group and originating from the same temperature treatment were put together in the same cage for 3 days to harden. One batch of the flies raised at 30 °C was transferred to a temperature of 20 °C for this 3-day hardening period, but 2 similar groups, one of which was also raised at 30 °C and the other at 20 °C, were kept at 27 °C. During the hardening period, all the flies were provided daily with citrated cattle blood and oviposition media (Sutherland, 1978).

After the hardening process, all the flies were killed with diethyl ether and the dead females discarded. The males were pinned and dried for 5 days at room temperature. Forty males were then randomly

selected from each of the 3 experimental groups and pinned for examination on strips of polystyrene at an angle of 45°. On each fly the width of the frons at its narrowest point and that of the head at its widest point were measured, using a stereo-microscope fitted with an eyepiece micrometer.

Eggs were collected from the stock colony as described above for experiments to determine the immature stage at which temperature acts to produce the different frons widths in the males. Mixed batches of these eggs were then transferred with a soft camel-hair brush onto moist filterpaper strips in 60 mm Petri dishes and incubated at 30 °C. In addition, a number of larval breeding jars containing freshly-prepared larval breeding medium were seeded with mixed batches of 300-400 eggs, covered with fine muslin squares, and incubated at 30 °C. Both the eggs in the Petri dishes and the larvae developing in the jars were inspected regularly with a table model magnifier. Immediately after the eggs in the Petri dishes started to hatch, mixed batches of not more than 300 1st instar larvae per jar were transferred to previously prepared larval breeding jars at 20 °C. Similarly, 2nd instar, young 3rd instar and fully-fed 3rd instar larvae were transferred from the breeding jars at 30 °C to separate larval breeding jars at 20 °C, consistent use being made of not more than 300 larvae per jar. All the breeding jars used in this experiment were filled beforehand with freshly prepared larval breeding medium and then kept for at least 5 days at 20 °C prior to use.

A different method was used to transfer pupae from a temperature of 30 °C to 20 °C. Small amounts of the larval breeding medium kept at 30 °C and containing fully-fed 3rd instar larvae were transferred to 500 ml non-waxed paper cups, which were then returned to the incubator at 30 °C. These paper cups were regularly inspected at least 4 times a day. At each inspection, all insects that were still in the larval stage were removed, leaving only the young creamy-white pupae behind. The cups containing these young pupae were covered with fine muslin squares secured with elastic bands, and then immediately transferred to a temperature of 20 °C. The media containing these pupae were always kept moist to prevent them from desiccating.

Adults emerging in the different containers at 20 °C were liberated twice a day into separate 0,027 m³ guaze cages, kept for 3 days at 27 °C to harden and then killed. The males were pinned and dried for 5 days at room temperature, after which the frons width of each was measured.

An ordinary analysis of variance was done on the frons widths of 40 randomly selected pinned specimens taken from large groups of specimens from the various temperature regimes.

RESULTS

The mean frons widths of males raised at the high (30 °C) and the low (20 °C) temperature, plus those of males kept initially at 30 °C and then transferred at different stages of their development to 20 °C, are listed in Table 1.

Differences at the 95% probability level ($P=0,05$) will be referred to as 'significant', and those at the 99% probability level ($P=0,01$) as 'very significant'.

TABLE 1 The mean frons width of male *Stomoxys calcitrans* developed from immature stages and cultured at different temperatures

Treatment number	Developmental histories of males (hardened for 3 days at 27 °C)	Mean frons width (μm)
1.....	Egg—adult at 30 °C.....	530,7 4; (5-8)
2*.....	Egg—adult at 30 °C.....	528,0 4; (5-8)
3.....	Egg—pupae at 30 °C, then transferred to 20 °C.....	528,3 4; (5-8)
4.....	Egg—fully-fed 3rd instar larvae at 30 °C, then transferred to 20 °C.....	555,3 (1-3)
5.....	Egg—young 3rd instar larvae at 30 °C, then transferred to 20 °C.....	572,0 (1-3)
6.....	Egg—2nd instar larvae at 30 °C, then transferred to 20 °C.....	570,0 (1-3)
7.....	Egg—1st instar larvae at 30 °C, then transferred to 20 °C.....	565,3 (1-3)
8.....	Egg—adult at 20 °C.....	569,3 (1-3)

* Males hardened for 3 days at 20 °C

Comparisons between the various treatments are indicated by numbers below the relevant results, in bold type, referring back to numbers 1-8 in Column 1

Significant differences ($P=0,05$) are indicated simply by the numbers of the treatments that are different

Very significant differences ($P=0,01$) are indicated by the treatment numbers in brackets.

The head widths of the males from the various batches varied considerably and were in no way related to the temperature regimes to which they had been exposed.

The frons widths of males raised at a high temperature (30 °C) were very significantly smaller than those of males raised at a low temperature (20 °C). No significant differences existed in the frons widths of 2

groups of males, both raised at 30 °C, but hardened for 3 days at 27 °C in one group and at 20 °C in the other. Males emerging from pupae that were raised to the pupal stage at 30 °C and then transferred as young pupae to 20 °C, had the same frons widths as those males that were raised throughout at 30 °C.

All the males from 3 groups of flies raised initially at 30 °C and then transferred as either 1st, 2nd or 3rd instar feeding larvae to 20 °C, had the same frons widths as those raised at 20 °C. These widths differed very significantly, however, from those of males that were raised throughout at 30 °C.

Males obtained from larvae that were raised to the fully-fed 3rd instar at 30 °C and then transferred to 20 °C, had the same frons widths as those that completed their life cycles at 20 °C. Their frons widths differed significantly, though, from those raised to the pupal or adult stages at 30 °C.

DISCUSSION

As Hulley (1975, 1978) found in *M.d. curviforceps* and *M.d. calleva*, the male frons width in *S. calcitrans* was directly related to the temperature at which the immature stages were cultured, whereas there was a great variation in the head width of the males. He suggested that it was essential therefore to take the effect of temperature into consideration when using the male frons width of *S. calcitrans* in any population or taxonomic study, since the width of this sclerite is liable to decrease when the culturing temperature rises, and vice versa. It is thus obvious that the male frons width of *S. calcitrans* is not a genetically controlled character.

It was very clearly demonstrated in this study that temperature, acting on the fully-fed 3rd instar larvae of *S. calcitrans*, gave rise to differing frons widths in the males. It was also found that, within the range tested, temperature had no effect, as far as the male frons width was concerned, either on any other immature stage or on the newly-emerged adults.

When determining the developmental stage at which temperature acted on the male frons width in *M. domestica*, Hulley (1975) divided mature larvae of a cross between *M.d. calleva* and *M.d. curviforceps* reared at 25 °C into 2 groups, one of which was transferred to 15 °C and the other to 30 °C to complete their development. He found significant differences between the frons widths of the 2 groups of males that emerged. He concluded, however, that 'temperature has a direct effect on frons width, and that this very probably operates during development within the puparium'. Subsequently, Hulley (1978) stated that, in the *M. domestica* subspecies he investigated, 'the response to temperature seems to be strongest around the time of puparium formation'. In similar experiments, Greenham & Hughes (1971) transferred the prepupal larvae of *M. vetustissima* to different temperatures but although they also found significant differences in the frons widths of the resulting males, they could not establish any differences when they transferred puparia that showed the characteristic pigmentation of flies about to emerge. Despite this, the latter authors also concluded 'that the response is mainly during development within the puparium'. It seems more likely, though, that temperature also acts on the mature larvae of *M. domestica* and *M. vetustissima*, rather than on the pupae, to affect the male frons width.

ACKNOWLEDGEMENTS

The author is indebted to Prof. H. Paterson, University of the Witwatersrand, Dr I. G. Horak, University of Pretoria, Dr P. E. Hulley, University of Rhodesia and Dr C. J. Howell, Onderstepoort, for valuable criticism of the manuscript. A sincere word of thanks is due to Miss Jane B. Walker and Dr Anna Verster for editing the manuscript and to Prof. K. R. Solomon, University of Guelph, Canada, for assisting in the statistical analyses.

REFERENCES

- GREENHAM, P. M. & HUGHES, R. D., 1971. Investigation of a morphometric cline in bushfly populations from north to south Australia. *Journal of the Australian Entomological Society*, 10, 261-264.
- HULLEY, P. E., 1975. Studies on the ecological genetics of the sympatric subspecies *Musca domestica calleva* Walker and *M.d. curviforceps* Sacca and Rivosecchi (Diptera: Muscidae). Ph. D. Thesis, University of London, London.
- HULLEY, P. E., 1978. The effect of temperature on male frons width in *Musca domestica calleva* Walker and *M.d. curviforceps* Sacca and Rivosecchi (Diptera: Muscidae). *Journal of the Entomological Society of South Africa*, 41, 265-274.
- MONZU, N., 1977. Coexistence of carrion breeding Calliphoridae (Diptera) in Western Australia. Ph.D. Thesis, University of Western Australia, Perth.
- PATERSON, H. E., 1964. Population genetic studies in areas of overlap of two subspecies of *Musca domestica* L. In: Davis, D. H. S. (Ed.), *Ecological studies in Southern Africa*, pp. 244-254. *Monographiae Biologicae*, 14. The Hague, W. Junk.
- PATERSON, H. E., 1974. The *Musca domestica* complex in Sri Lanka. *Journal of Entomology* (B), 43, 247-259.
- SUTHERLAND, B., 1978. Nutritional values of different blood diets expressed as reproductive potentials in adult *Stomoxys calcitrans* L. (Diptera: Muscidae). *Onderstepoort Journal of Veterinary Research*, 45, 209-212.
- ZUMPT, F., 1973. *The stomoxiine biting flies of the world*. Stuttgart: Gustav Fischer Verlag.