or microorganism-like particles[5]. It is also interesting to note that an insect which is otherwise a regular symbiote-bearer loses its symbiote under a different geographical condition due to unfavourable climate[6].

Hence a survey was conducted around Annamalainagar to identify insects in which microbial symbiosis exists. The insects were either collected from the fields or from light traps. Live insects were dissected in 0.8% saline. Smears were prepared with mycetomes, alimentary canal, ovary, testes, fat-body, haemolymph etc and stained with Giemsa or cotton blue. Slides were examined under light microscope for the presence of microbes. The type of symbiote was classified as yeasts or bacteria or 'a' symbiote, as the case may be, based on the available descriptions[1,7,8]. The insects examined, the type of symbiotes in them and their location are given in table 1.

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UPPER EXTREME OF TEMPERATURES LIMITING THE DEVELOPMENT OF *TETRASTICHUS PYRILLAE* CRAWFORD WITHIN ITS HOST EGGS

R. P. YADAV* and J. P. CHOUDHARY
Department of Entomology,
Haryana Agricultural University,
Hissar 125 004, India.
**Department of Entomology,*
Tirhut College of Agriculture,
Dholi, Muzaffarpur 848 125, India.

AMONG the natural enemies of the sugarcane leaf hopper (*Pyrilla perpusilla* Walker), the egg parasitoid, *Tetrastichus pyrillae* Crawford (Eulophidae: Hymenoptera) occupies an important place[1–6]. In a laboratory study the present authors found that the fertility of this parasitoid was the maximum when the rearing temperature was kept around 25°C. In the present study, attempts have been made to explore the upper extreme of temperature, hitherto obscure, for the embryonic or post-embryonic development of *T. pyrillae*.

Pure cultures of both the host and the parasitoid were maintained in the laboratory. Freshly emerged parasitoid adults were isolated and released at the rate of 20 pairs per rearing glass tube (10 × 3.75 cm). Five such tubes were prepared and kept at 25 ± 1.5°C in a BOD incubator. The adults in each rearing tube were fed on 10% sucrose in water. About 100 freshly laid host eggs glued on the egg card were subjected to parasitization by the parasitoid females. This method was repeated simultaneously for all the five rearing tubes. The egg cards were replaced every 24 hr until all the females died. The egg cards were then transferred to test temperatures viz. 27.5, 30, 32.5 and 35 ± 1.5°C after 1, 2, 4, 6 and 8 days of parasitization from tubes 1–5, respectively.

In all cases, the number of eggs displaying symptoms of parasitization, duration of life cycle and the number of male and female parasitoids emerged was recorded and the data are summarized in table 1.

The average number of parasitized eggs/female revealed that the host eggs, when transferred from 25 to 35 ± 1.5°C after 1–2 days of parasitization, did not produce any symptom, indicating that the parasitoid died in its embryonic stage. In host eggs shifted to 35 ± 1.5°C after 4 days of parasitization symptoms in the form of black minute spots of microscopic size could develop. In 6–8-day-old parasitized host eggs, the symptoms of parasitization appeared quite clearly but from such host eggs no

Table 1 *Effect of certain high temperatures on the development of Tetrastichus pyrillae Crawford within the eggs of Pyrilla perpusilla Walker (Data based on 20 pairs of parasitoid adults)*

Particulars	Temperature (±1.5°C)	Transfer of host eggs to higher temperature at days after parasitisation					Development at 25.0±1.5°C
		1	2	4	6	8	
(a) Average number of parasitoid eggs/female (on the basis of symptoms)	27.5	24.4	25.4	24.6	27.4	25.2	
	30.0	26.1	24.2	24.4	25.8	25.8	
	32.5	24.8	25.4	26.2	24.8	25.4	26.4
	35.0	0.0	0.0	24.2*	24.6	25.4	
(b) Average duration of life cycle (days)	27.5	11.2	11.4	12.2	12.6	13.2	
	30.0	9.8	10.2	11.4	12.4	15.0	
	32.5	–	–	–	–	–	13.8
	35.0	–	–	–	–	–	
(c) Percentage of adult emergence	27.5	88.4	88.6	90.4	90.6	88.4	
	30.0	69.4	70.2	84.4	84.6	86.8	
	32.5	0.0	0.0	0.0	0.0	0.0	90.4
	35.0	0.0	0.0	0.0	0.0	0.0	
(d) Percentage of females	27.5	80.4	81.6	80.4	82.4	82.6	
	30.0	82.4	81.6	80.6	82.6	81.4	
	32.5	–	–	–	–	–	81.6
	35.0	–	–	–	–	–	

*Only minute black spots were seen through a binocular microscope.

parasitoid could emerge. These observations suggested that the immature stage of *T. pyrillae* was unable to tolerate this temperature i.e. 35°C. At the remaining temperatures viz 27.5 to 32.5 ± 1.5°C, the appearance of a clear symptom in parasitized eggs revealed that the embryonic development of *T. pyrillae* took place in a normal way.

As regards the effect of high temperature on the rate of development the earlier transfer of the parasitized host eggs resulted in a corresponding reduction in the developmental duration. When one-day-old parasitized host eggs were shifted to 25.5 and 30 ± 1.5°C, the total duration of life cycle was reduced by about 2.5 and 4 days respectively as compared with the same at 25 ± 1.5°C. This finding might be of practical significance in the sense that the maximum fertility and the rapid development of *T. pyrillae* could be obtained at two different temperatures viz 25 and 27.5 ± 1.5°C, respectively.

Non-emergence of parasitoid adults both at 32.5 and 35 ± 1.5°C revealed that this parasitoid in its immature stages, was unable to withstand a temperature at or above 32.5°C. On further examination of the data, it could be inferred that the development of *T. pyrillae* at 32.5 ± 1.5°C proceeded up to pupal stage only while no development could take place at 35 ± 1.5°C. Transfer of parasitized eggs from 25 to 27.5 ± 1.5°C, did not produce any remarkable difference in the rate of adult emergence but the same from 25 to 30 ± 1.5°C resulted in a remarkable reduction in the percentage of adult emergence. Furthermore, the rate of reduction in the percentage of adult emergence increased with the earlier shifting of the parasitized host eggs. This observation indicates that the younger stages of this parasitoid, during post-embryonic development, were more susceptible to a higher temperature than the older ones. The relative proportion of the two sexes in a total adult emergence (in terms of the percentage of females) at various test temperatures did not seem to differ from that recorded at the normal rearing temperature i.e. 25 ± 1.5°C indicating that a temperature higher than the normal one caused mortality in immature parasitoid irrespective of its sexes.

From the above, it could be concluded that none of the developing stages in the life cycle of *T. pyrillae* tolerated the exposure to a temperature at or above 35°C. Its development could proceed up to pupal stage only when the rearing temperature was

kept around 32.5°C. Parasitized eggs of *Pyrilla perpusilla* Walker, when shifted from 25 to 27.5 ± 1.5°C, resulted in faster development and earlier emergence of *T. pyrillae*. For the development and emergence of the parasitoid, the upper limit of the temperature was found to be around 30 ± 1.5°C.

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NEWS

LIGHT SEPARATION FOR ISOTOPES

Lasers have become an invaluable tool in academic and industrial R&D—and today this market accounts for almost a quarter of the $400 m total commercial sales. A traditional application of lasers in chemistry has been in spectroscopy. A more recent development is their use in isotope seperation.

Isotopes are difficult to distinguish spectroscopically because their characteristic frequencies are close together. Early work in the infrared region showed that large vibrational shifts in absorption features of particular isotopes could be matched to the output of the laser. Monochromaticity or pure colour ensures that the effects produced are specific; there are no unwanted interactions with other isotopes. Despite further developments, a mismatch remained between efficient laser output in the infrared and molecular absorption, limiting the versatility of this approach.

In contrast, isotope shifts in electronic spectra of atomic species are smaller and often obscured by Doppler broadening.

However, as Dr Mark Humphries of Coherent (UK), Cambridge, told *Chemistry in Britain*, by generating atoms in a molecular beam, these problems were overcome and spectrally distinct absorption features could be resolved for each isotope. One method of generating the atoms is by laser vaporisation.

Once the sample has been vapourised and entrained in a molecular beam, isotopic seperation is achieved using photoionisation in the visible region. For example, an ion laser or a copper vapour laser in the visible region is used to excite a dye (e.g. rhodamine 6G) in a tunable dye laser. The narrow bandwidth dye laser, using either pulsed or continuous waves (CW), produces photons of specific energy, exciting a particular isotope to an intermediate state, which then absorbs further photons of the same or higher energy leading to ionisation. Once selective ionisation is achieved, separation of isotopes follows. The whole process is called atomic vapour laser isotope separation (AVLIS).

A CW ring dye laser, with absolute frequency calibration and narrow bandwidth, provides detailed knowledge of the atomic spectroscopy of the particular element to optimise the ionisation efficiency. The continuous tunability of such lasers means that a vast number of intermediate states for most elements are accesssible, making isotope separation for many elements possible. This has a wide range of uses in the nuclear industry.

The US Department of Energy has recently backed the AVLIS process for uranium isotope seperation as a future method for generating reactor fuel.

As Dr Humphries says 'this truly is an example where the laser has virtually revolutionised a whole industry and will make a variety of isotopically enriched elements available for a vast number of applications'. (*Chemistry in Britain*, May 1987, p. 411; Published by the Royal Society of Chemistry, (CET) Burlington House, London WIV OBN, England.)