similar work by a similar subject could be predicted to the first degree of approximation from

$$E\left(\frac{\text{Kcal}}{\text{min.}}\right) = 0{\cdot}074\ W\ \text{kg.}$$

Mahadeva *et al.* (1953) obtained a relation between gross weight and energy cost for walking on a horizontal plane ($E = 0{\cdot}047\ W + 1{\cdot}02$) and for step test ($E = 0{\cdot}066\ W$), with which the present equation bears comparison. The constant of multiplication in the present case is higher since stairclimbing is far more strenuous than walking.

The gross mechanical efficiency of physical work defined as,

$$100 \times \frac{\text{External work in kilogram meters} \times \text{Factor for conversion to Kcal.}}{\text{Internal energy expenditure in Kilocalories}}$$

$$= \frac{\text{Weight carried (kg)} \times \text{Vertical height (m.)} \times 0{\cdot}234}{\text{E (Kcal./min.)} \times \text{Time of work (min.)}}$$

was computed in each case. The mechanical efficiency was found to have a mean value of 24·17% (range 20·0 to 28·6%). This gross mechanical efficiency of ascending stairs with loads upto 30 kg. may be taken as fairly constant. The efficiency values in the present study are quite compatible with such values reported for Occidentals for different muscular exercises (20–28%) (Bobbert, 1960) and for Indians climbing hills with a load 22·94% (Das and Saha, 1966).

Experimental studies on the same lines for establishing the relation between gross weight and energy cost and the constancy of mechanical efficiency under different conditions of work stress, rate and mode of carrying are in progress.

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HARMONIA ARCUATA FABRICIUS (COCCINELLIDAE)—PREDATORY ON THE RICE PLANT HOPPERS *SOGATELLA FURCIFERA* HORVATH AND *NILAPARVATA LUGENS* STÅL

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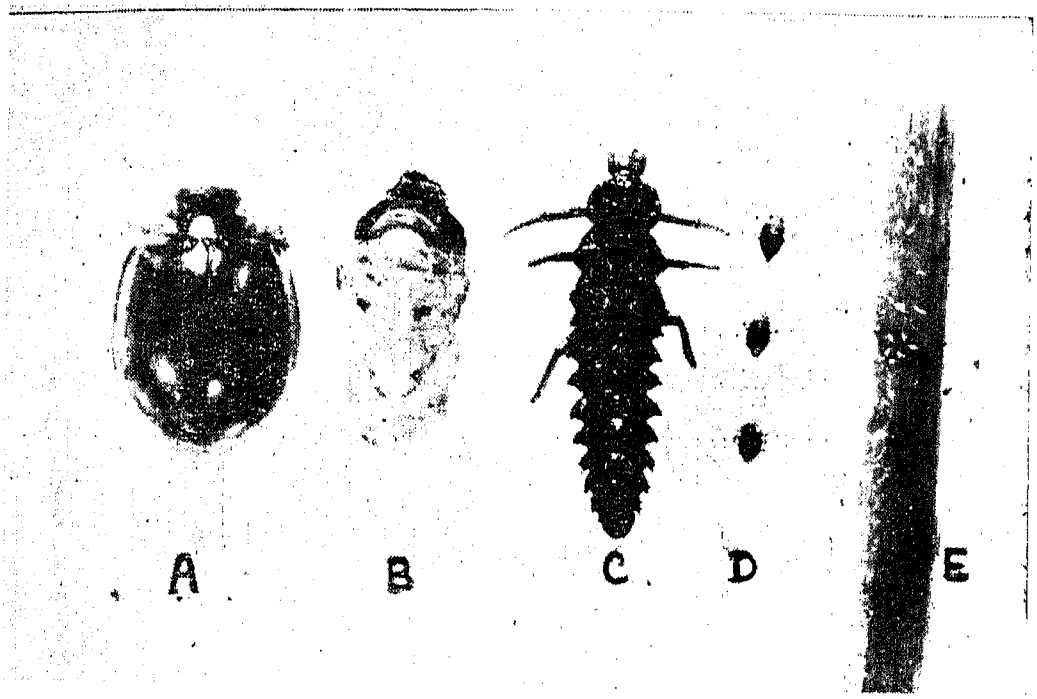
TWO species of delphacid plant hoppers, *viz.*, *Sogatella furcifera* Horvath, the white back plant hopper and *Nilaparvata lugens* Stål, the brown plant hopper have assumed major pest status in paddy with the intensive cultivation of high yielding rice varieties under high fertility levels. In addition to direct damage by sucking the sap and injecting toxins into the rice plant, their role as vectors of rice virus diseases has also been recognised recently in many parts of the world.

In the course of routine field observations on the parasites and predators of rice pests at the Central Rice Research Institute, Cuttack, during 1966 and 1967, the authors observed a coccinellid beetle as a predator on the two rice delphacids, *viz.*, *S. furcifera* and *N. lugens*. This has been identified as *Harmonia arcuata*

Fabricius and is the first record of its predacious habit on the two rice delphacids. "Normally this beetle has a number of black spots on its pronotum as well as the elytra. The elytral black spots tend to become confluent on the shoulder, in the middle and in the apical regions. In many cases, however, there is a reduction of spots both on the pronotum and the elytra. In the specimens (sent for identification) the reduction has gone to an extreme" (Kapur, 1967).

There was a severe incidence of white back plant hopper and the brown plant hopper in the standing *Kharif* (July-December) rice crops, particularly in the high yielding varieties during August and September in 1966 and 967. Preliminary field observations during ese two years indicated that the build-up of e plant hopper population in the rice fields is closely followed by a very rapid multiplii ion of this predacious beetle during mid- ugust to end of September. Besides, rice crops heavily infested with the above two hopper species invariably contained very large numbers of the beetle at all stages of development. The grubs and adults of this beetle appeared to check very effectively the hoppers' biotic potential by its predacious habit. The hopper population thus became gradually less by end of October after which the population of beetles also dwindled considerably. In view of its voracious feeding habit, it may prove to be an effective predator in the biological control of the rice plant hoppers.

Laboratory observations confirmed that the grubs as well as adults of this beetle readily fed on the nymphs as well as adults of *S. furcifera* and *N. lugens*, leaving behind portions of legs and wings. The eggs of *H. arcuata* were laid in clusters on rice leaves. The grub and pupal stages (Fig. 1) lasted for 16 to 20 and 4 to 5 days respectively and the adults lived for 10 to 12 days in the laboratory.



F . . 1. *Harmonia ar.uata* Fabr (A) Adult ; (B) Empty pupal skin ; (C) Full-grown grub ; (D) Newly hatched grubs ; (E) Eggs on rice leaf.

Detailed studies on its life-history and its population dynamics in relation to rice plant hoppers are in progress.

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