day or two. Disruption of normal moulting and development in certain insects was reported by Svoboda *et al*[1].

Our results demonstrated that 25-azacoprostane disrupted the normal growth, moulting and reproduction by interfering with the hormone biosynthesis and metabolism in *Dysdercus similis*. This compound can thus be used as a safe insect control chemical.

We acknowledge with thanks the generous gift of 25-azacoprostane by Dr J. A. Svoboda, Insect Physiology Laboratory, USDA, Beltsville, Maryland. The authors thank UGC for financial assistance.

24 February 1986; Revised 5 April 1986

1. Svoboda, J. A., Thomson, M. J. and Robbins, W. E., *Lipids*, 1972, **7**, 553.
2. Chippendale, G. M. and Reddy, G. P. V., *J. Econ. Ent.*, 1973, **66**, 1336.
3. Al-Izzi, M. A. J. and Hopkins, T. L., *J. Insect. Physiol.*, 1982, **28**, 267.
4. Robbins, W. E. and Shortino, T. J., *Nature (London)*, 1962, **194**, 502.
5. Kaplanis, J. N., Robbins, W. E., Monroe, R. E., Shortino, T. J. and Thomson M. J., *J. Insect. Physiol.*, 1965, **11**, 251.
6. Monroe, R. E. Hopkins, T. L. and Valder, S. A., *J. Insect. Physiol.*, 1967, **13**, 219.
7. Svoboda, J. A., Thomson, M. J., Robbins, W. E. and Kaplanis, J. N., *Lipids*, 1978, **13**, 742.

INSECT-FERN INTERACTIONS WITH PARTICULAR REFERENCE TO *HELIOTHRIPS HAEMORRHOIDALIS* (BOUCHE) (THYSANOPTERA: PANCHAETOTHRIPINAE)

A. MOHAN DANIEL and
S. S. CHANDRASEKAR
Entomology Research Institute, Loyola College, Madras 600 034, India.

RESISTANT factors in ferns such as texture[1], toxins[2,3], exogenous ecdysone[4,5], presence of thiaminase[6], cyanogen[7], and poor nutritional composition including aminoacid deficiency[8] have been generally reported to render them unfit to be utilized by insects. Recent work on this aspect however revealed that insects like *Megacopta* (=*Coptosoma*) *siamicum* (Fabr.)[9], *Micromyzodium filicum* David, *Micromyzus nigrum* van der Goot (Aphididae:Homoptera) and *Kolla tigrina* Distant (Cicadellidae:Homoptera) efficiently utilize the fern host for their growth and development[10]. Information presented here on the polyphagous, cosmopolitan thrips, *Heliothrips haemorrhoidalis*, often infesting the fern, *Polypodium phegopteris* in glass houses pertains to utilization of this fern host for their survival and development.

Infestation of *H. haemorrhoidalis* on *P. phegopteris* is mostly resticted to mature fronds where they feed on both the abaxial and adaxial surfaces leaving white silvery patches with numerous minute blackish markings caused by deposition of faecal matter by the larvae. Both sexes occur on the same leaves and mating was also evident in contrast to parthenogenetic reproduction on coffee leaves. The male: female ratio on *P. phegopteris* was 3:25. The duration of life-cycle ranged from 20 to 30 days, both immatures and adults were collected in large numbers on this host from Valparai (Anamalais) and Ooty (Nilgiris). Interestingly this thrips-fern association was observed only at altitudes above 1,900 meters.

To assess the impact of the chemical factors (lipid, phenol, carbohydrate, nitrogen and protein) involved in host selection/preference, ten fern hosts including *P. phegopteris* were analyzed biochemically. Young fronds not preferred by *H. haemorrhoidalis* had only 8 mg/g of lipid whereas the mature fronds which attract the insect had a comparatively high lipid concentration (12 mg/g) and not much variation was evident in carbohydrates, phenols and proteins between the juvenile and mature fronds (figure 2). Further, the different chemical compounds were present in various concentrations in different fern hosts (figure 1). *P. phegopteris* was the preferred host of this thrips because of the higher concentrations of proteins and nitrogen (43 mg/g and 7% respectively). To assess the quantitative changes in the chemical composition of *P. phegopteris*, due to the infestation of *H. haemorrhoidalis*, the host plant at three different stages, i.e. juvenile fronds, mature fronds with sori and the infested fronds were subjected to biochemical analysis. Variations exist between the juvenile and mature fronds with respect to lipid concentration (8 mg/g in juvenile fronds and 12 mg/g in mature fronds), but no quantitative reduction was evident between the uninfested and infested mature fronds. However, quantitative loss in the total carbohydrate, phenols, and nitrogen content was observed in the mature fronds (figure 1) indicating that *H. haemor-*

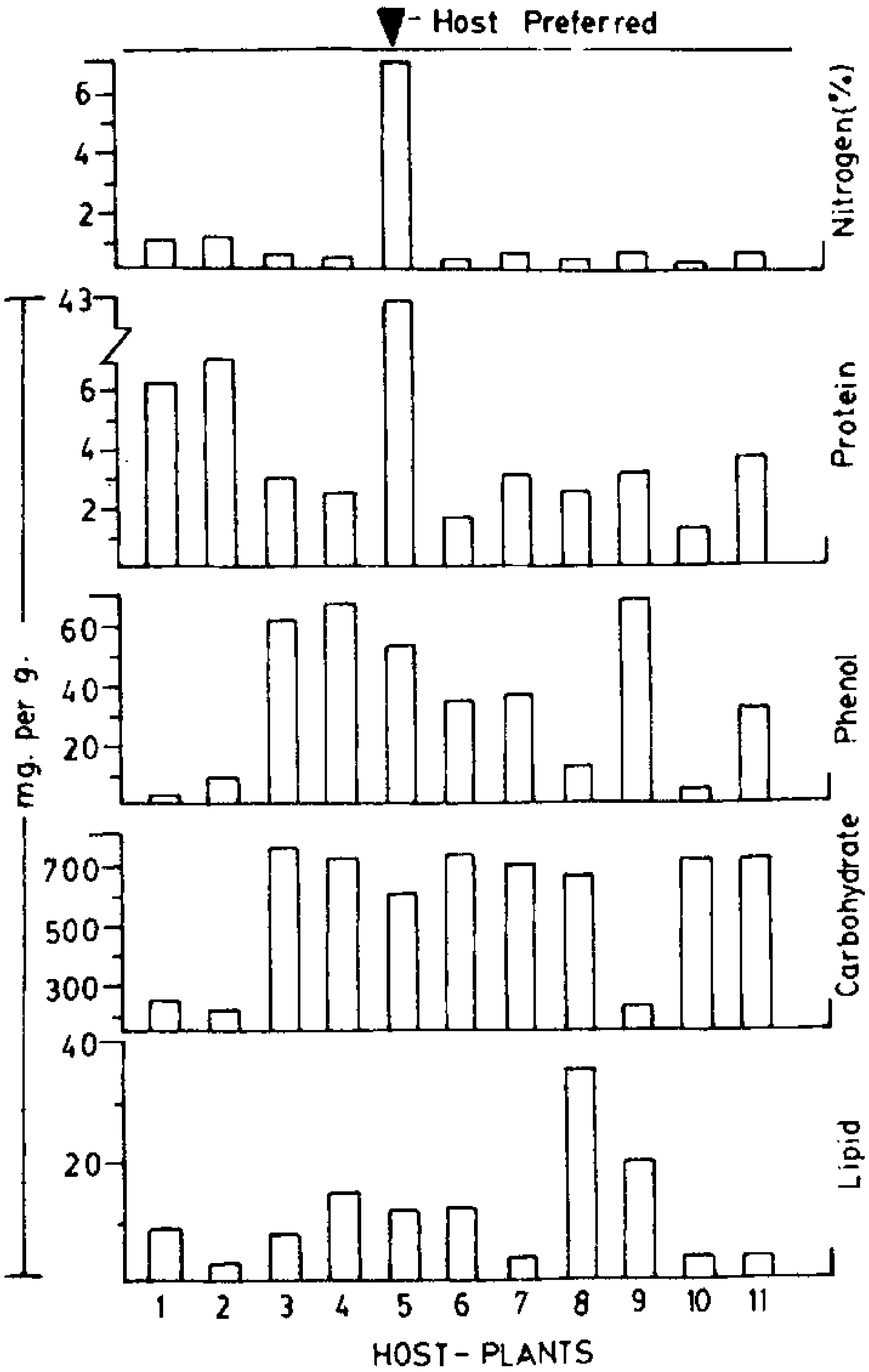


Figure 1. Analyses of chemical compounds in different fern hosts. 1. *Pteris quadriaurita*. 2. *Pteris quadriaurita argyrarea*. 3. *Blechnum orientale*. 4. *Blechnum braziliensis*. 5. *Polypodium phegopteris*. 6. *Lomaria gibba*. 7. *Diplazium lasiopteris*. 8. *Mycrolepia* sp. 9. *Tectoria macrodonta*. 10. *Cyrtomium falcatum*. 11. *Gleichenia* sp.

rhoidalis utilizes these substances for their growth and development. Considerable depletion of lipids by the infestation was not evident, possibly due to the feeding of the insect on the palisade parenchyma cells of the fronds, resulting in the appearance of silvery white patches on the mature fronds.

Though leucine, threonine and phenylalanine are in very low concentrations with the marked absence of tryptophan[8] in ferns, *P. phegopteris* showed low concentration of threonine and a trace of tryptophan. With the fronds attaining maturity, leucine and phenylalanine increased in concentration to a moderate level along with an increase in concentration of tryptophan.

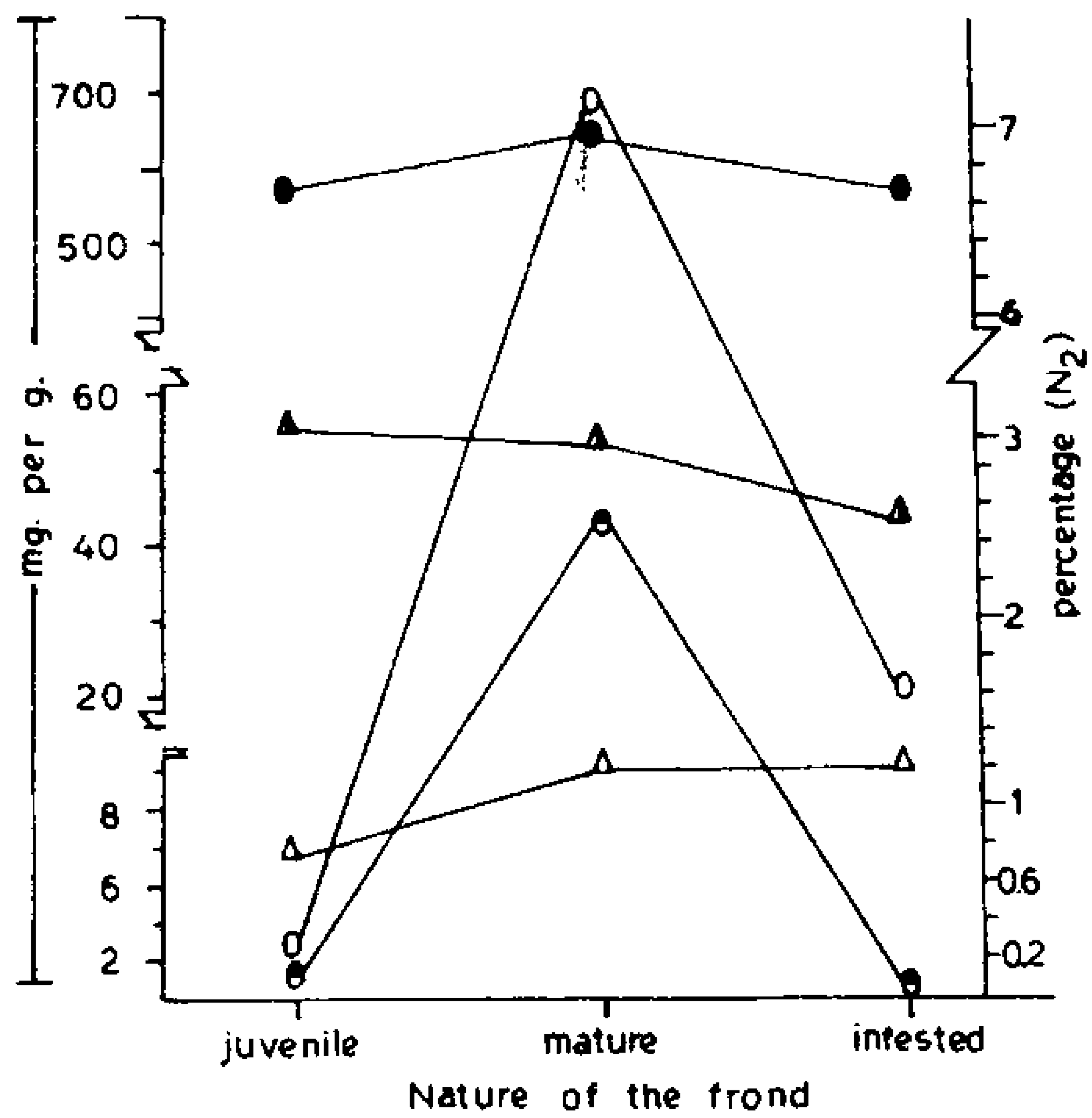


Figure 2. Analyses of chemical compounds in the juvenile, mature and infested fronds of *Polypodium phegopteris*. (● – Carbohydrate; ⊖ – Protein; o – Nitrogen (%); ▲ – Phenol; Δ – lipid).

The concentration of threonine however decreased with the aging of the fronds (figure 2).

As compared to the other fern hosts, higher concentration of protein and nitrogen content in *P. phegopteris* appeared to attract and enhance the survival and growth of *H. haemorrhoidalis*. The higher concentration of nitrogen has been known to play a vital role in host selection among homopterans particularly jassids, where nitrogen plays a significant synergetic role with the other chemical compounds[11] thereby acting as attractants. Higher concentration of nitrogen is also an important factor for the better survival and growth in aphids[12]. Such a condition in the mature fronds of *P. phegopteris* appears to play a significant individual or synergetic role with other chemical compounds in acting as an attractant for *H. haemorrhoidalis*. The phenomenon of "aminoacid deficiency"[8] does not appear to affect the normal growth and survival of *H. haemorrhoidalis* on *P. phegopteris* in view of their presence in low concentration.

The authors are grateful to Professor T. N. Ananthakrishnan, Principal Investigator, under whose guidance this work was carried out during the tenure of a UGC Project, for which thanks are due.

20 January 1986; Revised 29 March 1986

1. Soo Hoo, C. and Fraenkel, G., *Ann. Entomol. Soc. Am.*, 1964, **57**, 778.
2. Muenscher, W. C., *Poisonous plants of the United States*, The Macmillan Co., New York, 1939, pp. 266.
3. Weswig, P. H., Freed, A. M. and Haag, J. R., *J. Biol. Chem.*, 1946, **165**, 737.
4. Karlson, P. and Bode, P., *J. Insect Physiol.*, 1969, **15**, 111.
5. Jones, C. G. and Firn, R. D., *J. Chem. Ecol.*, 1978, **4**, 117.
6. Somogyi, J., *Int. Z. vitaminforschi*, 1949, **21**, 341.
7. Lawton, J. H., *Bot. J. Linn. Soc.*, 1976, **73**, 187.
8. Smith, A. M. and Agiza, A. H., *J. Sci. Food Agr.*, 1951, **2**, 503.
9. Mohan Daniel, A., *J. Ent. Res.*, 1986, (in press)
10. Mohan Daniel, A. and Chandrasekar, S. S., *Curr. Sci.*, 1986, **55**, 370.
11. Jayaraj, S., *Indian J. Exp. Biol.*, 1967, **5**, 156.
12. van Emden, H. F., *Biochemical aspects of plant and animal coevolution*, (ed.) J. B. Harborne, Academic Press, London, 1978, p.309.

SEQUENTIAL DEGENERATION OF THE LARVAL MUSCLES IN THE LEMON-BUTTERFLY *PAPILIO DEMOLEUS* L AND ITS POSSIBLE SIGNIFICANCE

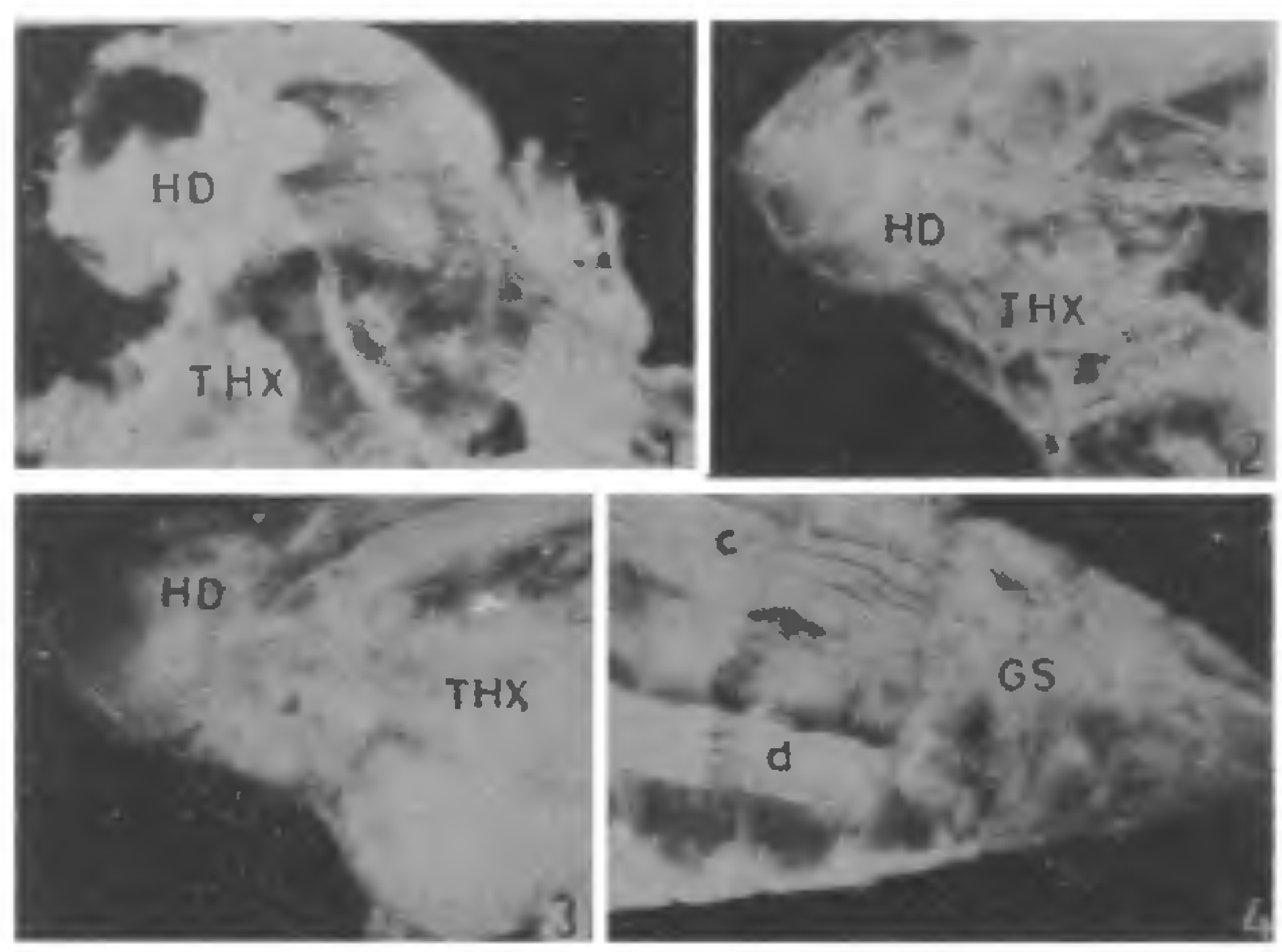
K. P. SRIVASTAVA, P. KUMAR
and J. N. TIWARI
Department of Zoology, Banaras Hindu University, Varanasi 221 005, India.

SEQUENTIAL degeneration of the larval muscles during metamorphosis was discovered by Hufnagel[1] and later rediscovered by several other workers[2-5]. However, its significance has not so far been explained. In this note we have attempted to do this.

The ultimate (fifth) instar larvae of the lemon-butterfly were sorted out from the laboratory colonies and their muscle loss was followed during the larva-pupal-adult transformation up to 1-day-old adult. The muscle degeneration was recognized by the loss of its fibrillar appearance and acquisition of a flaky one.

Degeneration of the larval muscles does not occur simultaneously in all the body segments but follows a definite sequence. For convenience, we have grouped the muscles as segmental and spiracular. Amongst the segmental muscles, the first to be lost are the cranial muscles between the prepupal (figure 1) and zero hr (newly ecdysed) pupal (figure 2) stages, next are the thoracic muscles (figure 3) and muscles of the posterior abdominal or future genital segments (figure 4) between 0 and 36 hr pupal stage followed by the muscles of the anterior abdominal or pregenital segments between 0 and 48 hr pupal stage except muscles a-e (figure 5, muscles c and d, also seen in figure 4) which survive metamorphosis and are lost in 1 day old adult. Amongst the spiracular muscles, the ventral spiracular dilator, f (figure 6) is lost in the pupal stage, the dorsal spiracular dilator, g in 1-day-old adult and the spiracular occlusor, h is not lost at all but persists throughout the adult life.

A selective or sequential muscle degeneration is probably an universal phenomenon throughout the pterygote insects[6]. However, earlier workers do not seem to have explained or speculated upon the possible significance of this phenomenon. Although, direct experimental evidence to explain it will need techniques to block or allow muscle degeneration at will and since such techniques are not immediately available, we have



Figures 1–4. 1. Sagittal section of the early prepupal head and thorax prior to commencement of muscle degeneration. Note the fibrous (undegenerated) nature of the muscles. **2.** Same in zero hr pupa showing degeneration of the cranial muscles as indicated by their flaky appearance. Thoracic muscles are still fibrous. **3.** Same in 36 hr pupa showing degeneration of the thoracic muscles. **4.** Sagittal section of the abdomen of 36 hr pupa showing degeneration of the muscles of the genital (VIII–X) segments and the intact condition of those of the pregenital (I–VII) segments.