the pathogen—obviously, a perennial pond from which the water was originally drawn. Although *Trichodina* could not be located in fish specimens including *C. carpio* from the pond, the ciliate did occur occasionally in plankton hauls. It may be recalled *Trichodina* can exist in plankton form[1] and may inhabit the body surface of a variety of aquatic animals besides fish[2].

The infested fry did not present any apparent symptoms. However, earlier observations that the parasite was dangerous under severe infestation[4] and may damage epithelial cells of the skin[1,5] prompted attention towards remedial measures. Bathing the affected fishes in various chemical solutions[5–7] could not be done here. To choose a chemical for direct application in the ponds, trials were conducted in the laboratory on infested fry using the pond water. The observations are presented in Table I.

TABLE I

Chemotherapic trial on fry of C. carpio *infested with* Trichodina

Sl. No.	Treatment	Dose	Observations
1.	Quick lime	5 gm/litre	Fry all alive with infestation of *Trichodina* as before
2.	Common salt	10 gm/litre	do.
3.	Potassium permangnate	1 ppm	do.
4.	Glacial acetic acid	1 :10000	do.
5.	Glacial acetic acid	1 :5000	Fry all dead/No trace of *Trichodina*
6.	Formalin	1 :10000	50% fry dead/living ones free of the infestation
7.	Copper sulphate	0·5 ppm	Fry all alive and free of the infestation
8.	Control	..	Fry all alive and infested with *Trichodina*

Clearly copper sulphate was the most effective of the chemicals tried. At 0·05 ppm *Trichodina* infestation disappeared a day after the application. No adverse effects of copper sulphate treatment were noticed either in the density of plankton or condition of fry which grew satisfactorily. Possibly, alkaline nature of the water helped early removal of the residual copper[8]. It may be noted in this connection that in a study of toxicity, copper is least toxic to *C. mrigala* at pH 8·2[9]. By close of the rearing operations, nearly a lakh and a half fry and fingerlings were distributed from the nurseries, indicating 74% survival from the hatchling stage.

The authors are thankful to Dr. P. S. Prasad, Director of Fisheries, Bihar, for facilities provided and for going through the manuscript; to Dr. A. K. Mandal, Zoologist, Zoological Survey of India, Calcuttta, for confirming the identification of *Trichodina*.

Fisheries Research Station, SHYAM RATAN BANERJI.
Mithapur, Patna, UPENDRA NARAIN SINGH.
November 12, 1977. SHREEKANT TIWARI.

1. Tripathi, Y. R. *Record Ind. Mus.* 1954 52, 221.
2. Sarig, S., *FAO Fisheries Synopsis No. 312.* Rome, 1966, **3**, 12.
3. Hyman, L. H., *The Invertebrates: Protozoa through Ctenophora,* McGraw–Hill Book Co., New York, 1940. p. 199.
4. Sarig, S., *FAO Technical Conference on Aquaculture,* Kyoto, Japan, 1976, R 32, 4.
5. Duijn Jur, C. Van, *Diseases of Fishes,* Ilife Books Ltd. London, 1967, p. 64.
6. Hora, S. L., and Pillay, T. V. R., *FAO Fisheries Biology Technical Paper* 14, Rome 1962, p. 146.
7. Trivathi, Y. R., *Indian Farming,* 1969. 21 (9), 84.
8. Baneriee S. M. and Mitra, E., *Ind. J. Fisheries,* 1954.
9. Bhatia. H. L., *J. Inland Fish. Soc. India,* 1970, 2, 134.

EFFECT OF STARVATION ON THE MID-GUT EPITHELIUM OF THE ADULT *ODONTOPUS VARICORNIS* (DIST.)

THE mesenteron of Heteropteta has been divided into a number of mid-gut regions on the basis of its morphological characteristics[1] Thus, in the alimentary canal of *Chrysocoris purpureus* four distinct mid-gut regions have been recognized[2]. Studies on these different mid-gut regions have shown that the upper and lower regions are concerned with the function of secretion and absorption respectively. According to Goodchild[3] the first two mid-gut regions of the allimentary canal of cacao capsid bugs have secretory function, while the third mid-gut region seems to perform an absorptive function. The present study aims at finding out the effect of starvation on the mid-gut epithelium of the adult *Odontopus varicornis* with a view to understanding the secretory functions of different mid-gut regions.

Material and Methods

Laboratory colonies of *O. varicornis*, maintained at 28 ± 2° C with RH 80 ± 4 per cent were used for the present study. A batch of twenty speciments was allowed to starve for a maximum period of twenty-four hours to bring the digestive system of these insects into an almost uniform condition, as suggested by Bhaskaran[2]. Of the twenty specimens, ten were allowed to feed on their preferred food, the cotton seeds. The remaining ten specimens were put under starvation for a period of twenty-four hours. These insects, at regular intervals of time of feeding, were vivisected in insect ringer solution. The cut pieces of different regions of the mid-gut of the alimentary canal were, then, fixed in Bouin's fluid. The permanent preparations of the slides were made following the usual procedure of paraffin embedding. Serial sections of 6–8 μ thickness were deparaffinised and stained in Heidenhain's haematoxylin, using eosin as counter stain.

Observation

Marked histological changes have been observed in the mid-gut of adult *O. varicornis* for a prolonged starvation of about 48 hours. The results are presented in Table I.

The epithelium, which is usually folded in the normal insects (Figs. 1, 3, 5 and 7) now appears, under starved conditions, to be almost flattened sheet in all the mid-gut regions excepting the fourth mid-gut of the alimentary canal. The size of the columnar cells is considerably reduced in all the mid-gut regions (Figs. 2, 4, 6 and 8). The cell boundaries have become very thin and are not clearly visible (Fig. 2).

In the first and second mid-gut regions, the cytoplasmic granules are sparsely distributed throughout the cytoplasm of these cells. The nuclei are slightly reduced in their size and are located towards the basal region of these cells (Figs. 2 and 6). In addition to these changes, some of these cells show the presence of cytoplasmic vacuoles (Fig. 4). Similar cytoplasmic granular and nuclear changes are observed with reference to third and fourth mid-gut regions. The lumen of the first, second and third mid-gut regions appears to contain some quantity of secretory products (Fig. 4). Such product is found to be absent in the lumen of the fourth mid-gut region (Fig. 8).

After 12 hours of the commencement of feeding, the mid-gut epithelial cells seem to have regained their normal condition. The epithelium is thrown into a few folds and its cells have become slightly larger in size (Table I). The cytoplasm is intensely stained with eosin and its granules are uniformly distributed over the cells. The nuclei are almost central in their position. The secretory products, which appear to be absent in the lumen of the third and fourth mid-guts, are identified in the lumen of the first and second mid-gut regions.

After 24 hours of the commencement of feeding, the epithelia of the different mid-gut regions are thrown into 'villi' as in the case of normal insects. The mid-gut cells have further increased in their size (Table I), particularly at their apical region due to the accumulation of the cytoplasmic granules and the formation of vacuoles. The cell boundaries have become thick and are clearly discernible.

TABLE I

Morphometric data of the epithelial cells and their nuclei of different mid-gut regions of the adult Odontopus varicornis *under normal and starved conditions*

Mid-gut region	Condition	Mid-gut epithelial cells	
		Length (μ)	Nuclear diameter (μ)
First mid-gut	Normal	14·20±0·18	0·63±0·20
	Starved 48 hours	8·50±0·56	0·43±0·13
	12 hours after feeding	10·75±0·41	0·61±0·20
	24 hours after feeding	14·12±0·21	0·62±0·15
Second mid-gut	Normal	12·35±0·35	0·62±0·01
	Starved 48 hours	9·35±0·24	0·45±0·02
	12 hours after feeding	10·65±0·15	0·58±0·02
	24 hours after feeding	12·10±0·28	0·63±0·02
Third mid-gut	Normal	11·05±0·29	0·67±0·01
	Starved 48 hours	6·70±0·11	0·57±0·02
	12 hours after feeding	8·72±0·32	0·61±0·13
	24 hours after feeding	10·77±0·25	0·63±0·01
Fourth mid-gut	Normal	3·83±0·10	0·67±0·01
	Starved 48 hours	2·27±0·10	0·47±0·02
	12 hours after feeding	3·45±0·08	0·61±0·01
	24 hours after feeding	3·80±0·08	0·65±0·01

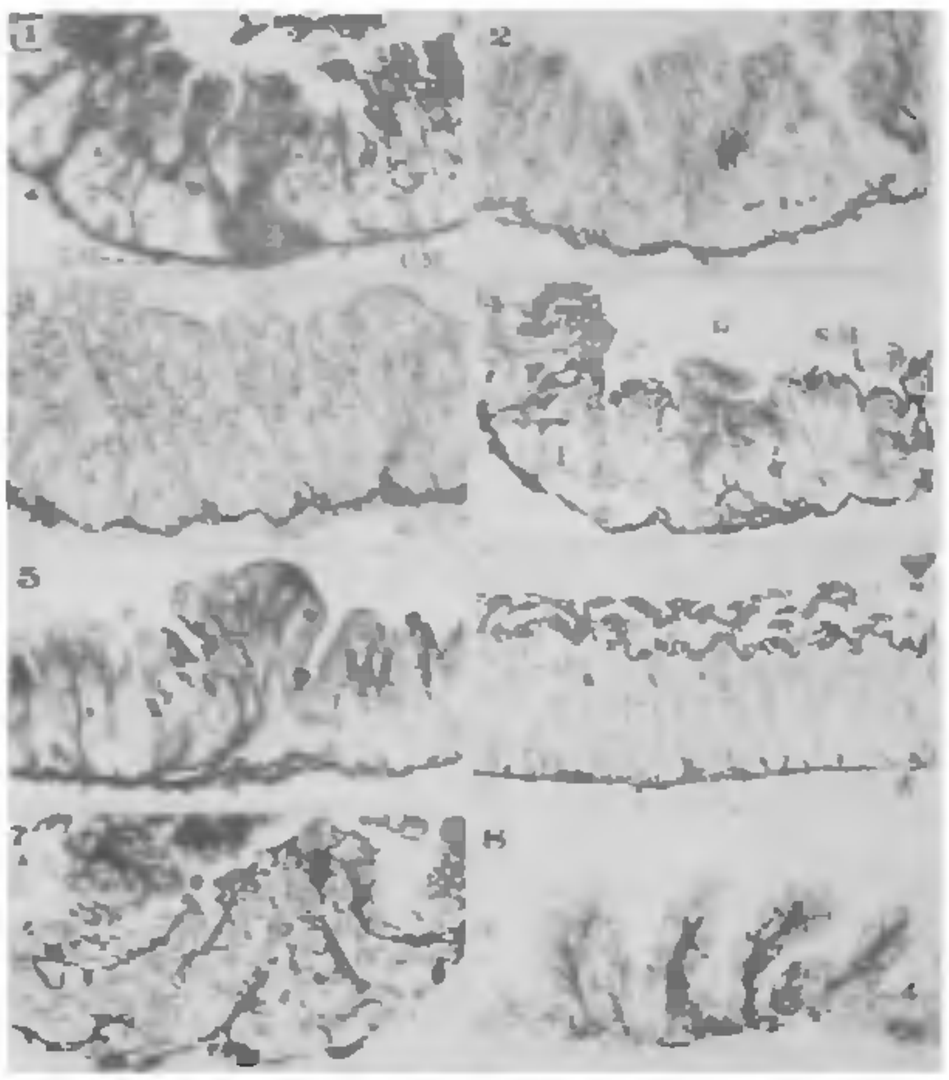
Dr...sion

In *O. taricornis* the mid-gut epithelium has shown certain marked histological changes as a result of the effect of prolonged starvation. These histological changes are the shortening of the epithelial cells, and their reduced secretory activity. Further, it was shown for this insect that normal histological conditions of the epithelium and its secretory activity are restored, 12 to 24 hours after the commencement of feeding. It may be inferred from these observations that the starvation for a prolonged period of 48 hours appears to have no influence over the production of secretory substances (enzymes). These observations are consistent with those of Bhaskaran[2] who has reported for *C. purpureus* that the epithelium of first mid-gut of 48 hours starved insect is completely stretched as a translucent sheet devoid of its normal cytological feature. He has also reported the occurrence of digestive enzymes in the gut of this insect irrespective of the nutritional status. In this insect, starvation for a period of 48 hours appears to have no influence over the production of digestive enzymes. Similarly, in *Trogoderma* all the enzymes identifiable in the mid-gut extract of normal larva are found to be present in the larva starved for a continuous period of 10 days[4].

We are grateful to Dr. P. Govindan, Professor and Head, Department of Zoology, Annamalai University, for providing facilities. Our thanks are also due to Dr. V. Sriramulu, Reader in Zoology, Annamalai University, for his help in photomicrography. Financial assistance by UGC to one of us (S. S.) is gratefully acknowledged.

Department of Zoology, Annamalai University, Annamalainagar, 608 101, India, *December* 15, 1977.

S. SABESAN.
N. RAMALINGAM.



FIGS. 1–8: Fig. 1 Cross section of the first mid-gut of normal insect showing the folded columnar epithelium (CE), Longitudinal (LM) and Circular (CM) layer of muscles. × Ca 500. Fig. 2 C. S. of the first mid-gut of starved insect showing the sparse distribution of the cytoplasmic granules. × Ca 500. Fig. 3 C. S. of the second mid-gut of normal insect showing columnar epithelium. × Ca 500. Fig. 4 C. S. of the second mid-gut of starved insect showing cytoplasmic vacuoles (V), less amount of secretory materials (SM) in the lumen (L) and the reduction in the size of the columnar cells × Ca 500. Fig. 5 C. S. of the third mid-gut of normal insect showing a large epithelial fold. × Ca 500. Fig. 6 C. S. of the third mid-gut of starved insect. Note the flattened surface of the epithelium. × Ca 500. Fig. 7 C. S. of the fourth mid-gut of normal insect showing epithelial folds. × Ca 500. Fig. 8 C. S. of the fourth mid-gut of starved insect. Note the reduction in the size of the columnar cells. × Ca 500.

1. Imms, A. D., A General Text Book of Entomology. Methuen & Co., Ltd., London, 1957, p. 123.
2. Bhaskaran, K. K., *Ph. D. thesis*, Annamalai University, 1970.
3. Goodchild, A. J. P., *Proc. Zool. Soc. Lond.*, 1952, 122, 543.
4. Krishna, S. S., *J. Zool. Soc. India*, 1955, 7, 170.

CHANGES IN LEVEL OF KETO ACIDS DURING PERITHECIAL DEVELOPMENT OF *CHAETOMIUM GLOBOSUM* KUNZE

KETO acids play a vital role in fungal metabolism and provide the carbon skeleton for the synthesis of amino acids and proteins[1-2]. In the present communication an attempt has been made to study the changes in the production of keto acids in the culture filtrate during perithecial development of *Chaetomium globosum* Kunze.

Seven days old culture of *C. globosum* Kunze was inoculated to Asthana-Hawker's broth and incubated at ± 250° C. Fungal mats of 4, 8 and 12 days old cultures were harvested and the culture filtrates were analysed for total quantity of keto acids[3]. Perithecial production at different stages was recorded.

Quantity of keto acids produced at different stages of fruiting body formation are recorded in the following table.

Records show that there is a direct correlation between the quantity of keto acids and stage of perithecial development. Higher accumulation of keto acids in fully mature culture reflects that its requirement dimi-