

## A STUDY ON THE FEEDING HABITS AND GNATHAL APPENDAGES IN ORIBATID MITES (ACARINA: CRYPTOSTIGMATA)

Alphonsa Xavier<sup>1</sup> and M.A. Haq<sup>2</sup>

<sup>1</sup> Selection Grade Lecturer, Department of Zoology, Government Arts and College, Calicut, Kerala 673018, India

<sup>2</sup> SMIS Dale, Kohinoor, Thenhipalam, Kerala, India

Email: <sup>1</sup> puthusery@sify.com

### ABSTRACT

Gut contents of eight species of oribatid mites collected from the field were analysed employing suitable staining techniques, which showed the presence of bacteria, fungal hyphae and spores, pollen grains, leaf and wood particles in various stages of digestion. Based on this, the species considered could be placed under different 'trophic niches'. The pedipalp, chelicera and rutellum which formed the major grasping and masticating appendages of these mites were subjected to detailed structural analysis which established their functional role in food grasping, collection and mastication.

### KEYWORDS

Decomposition, gnathal appendages, gut contents, macrophytophage, microphytophage, nutrient cycling, oribatid mites, panphytophage

The numerical abundance of oribatid mites makes them the most important quantitative component among the soil mesofauna. Within the soil, they are actively involved in litter decomposition mainly due to their habit of feeding on plant residues (Kevan, 1962; Walwork, 1970; Pelletier & Hill, 1978). The food habits of oribatid mites have been studied by a number of workers (Bhattacharya, 1962; Luxton, 1972; Haq & Prabhoo, 1976; Haq, 1982; Ramani & Haq, 2001). These studies revealed the capacity of the mites to utilize different types of food substances. This in its turn is dependent on the structural adaptation and functional modification of their gnathal appendages which help them to tackle a variety of food substances. The present investigation is both an attempt to study the feeding specificity of a few common oribatid members of Malabar area to categorise them into definite feeding types and to analyse the structural modification of their gnathal appendages.

Based on their food preferences Schuster (1956) divided oribatids into three major types, (i) macrophytophages (feeding on higher plants); (ii) microphytophages (feeding on microflora); (iii) non-specialists - Luxton (1972) revised this classification, coining the term panphytophages for non-specialized feeders and adding (iv) zoophages (feeding on living animal material); (v) necrophages (feeding on carrion); and (vi) coprophages (feeding on faecal material).

### MATERIALS AND METHODS

Soil and litter samples collected from the study areas were extracted in a modified Tullgren funnel apparatus for about 72hr. Mites were collected both in 70% alcohol and in vials containing powdered and moistened leaf obtained from the study area. Eight species of mites obtained from the soil were identified and separated species wise. Mites collected in the preserved condition were used for taxonomic studies and those

collected in live condition were used for gut content analysis. For gut content analysis live mites were washed in distilled water and then transferred on to microscopic slides; 30-35 individuals of each species were dissected to obtain their gut contents. The separated gut contents were fixed in 80% ethyl alcohol, centrifuged and stained with appropriate stains following Haq & Prabhoo (1976). After proper staining, identification of gut contents was carried out following Sass (1959); Foster (1960); Kuhnelt (1976).

Gnathal appendages of each of the eight species of oribatid mites were dissected out in glycerine and kept in slightly warm lactic acid for 20-30min. They were then properly spread out on microslides and mounted in Hoyer's medium. The pedipalp, chelicera and rutellum which formed the major grasping and masticating appendages were subjected to detailed structural analysis for studying their functional role in food grasping, collection and mastication. Sketches were drawn using camera lucida attached to a Leitz Aristoplan microscope.

Oribatid mites for the present study were collected from different parts of the Calicut University Campus in Malappuram District of Kerala (11°35'45" & 75°45'50"), on either side of N.H. 17 at an altitude of 40-60m. The campus is vast, extending over an area of 400ha.

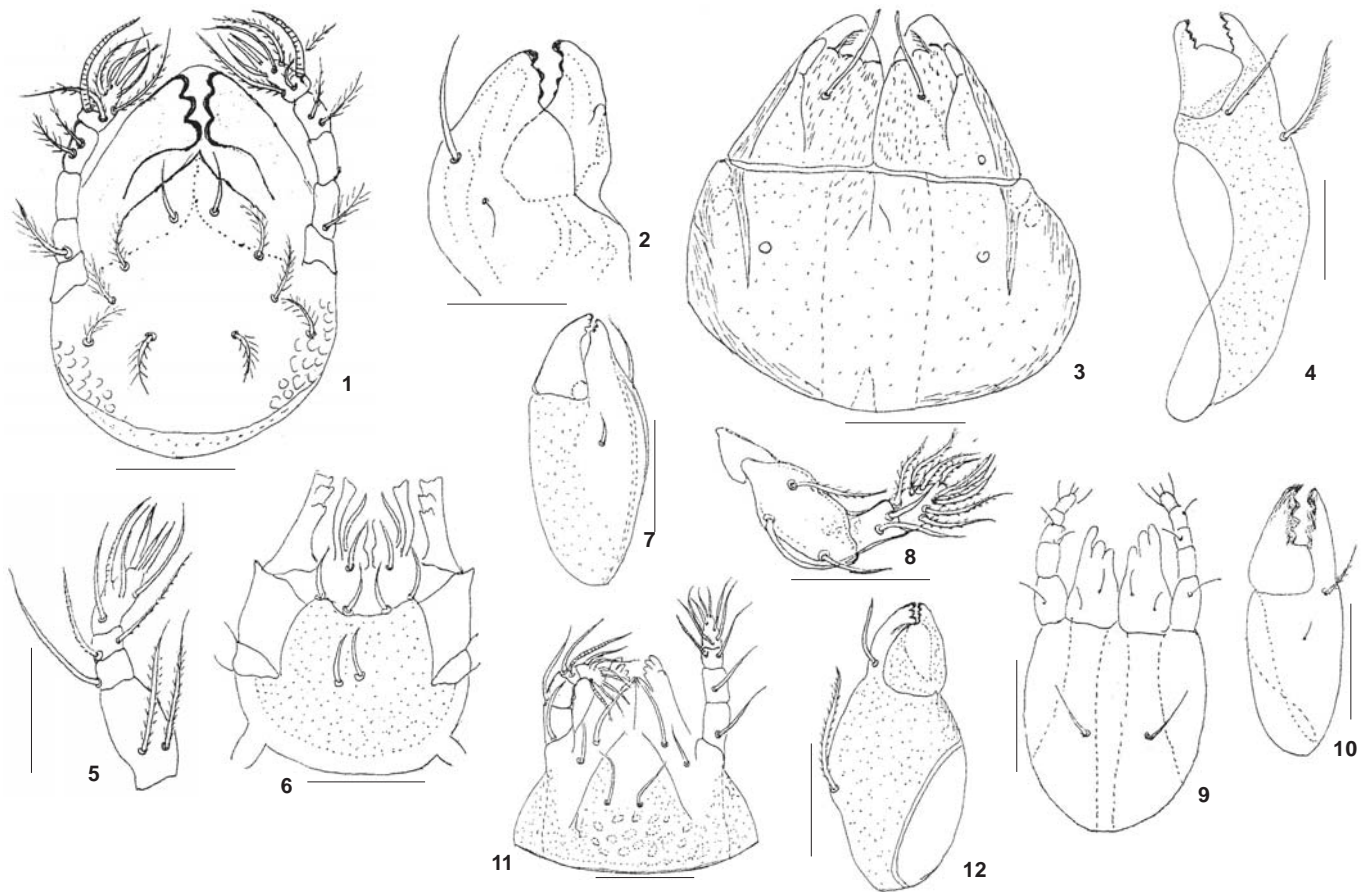
### RESULTS

Results of the analysis of the gut contents of eight species of oribatid mites collected from the field are presented in Table 1. The occurrence of parts of vascular bundles of higher plants in the gut contents was indication of wood feeding habit while that of parenchymatous elements and leaf lamina indicated leaf feeding. Presence of fungal hyphae and spores indicated fungus feeding nature. These results were also used to categorise the mites into three feeding groups. Mites whose gut contents revealed the presence of higher plant materials were regarded as macrophytophages, those with fungi as microphytophages and those with both as panphytophages.

Detailed analysis of gnathal appendages in the eight species showed considerable variation in the structure of rutella and chelicerae. Chelicera in *Cryptacarus dendrisetosus* (Fig. 1 & 2) were found to be broad and stout with denticulated body. Chelae were well developed and sclerotised. Movable digit had four and fixed digit had three teeth. Rutella had a broad distal end with a concave vestibule dorsally and narrow proximal end bearing three strongly sclerotised, round notches distally.

*Pelokylla malabarica* (Figs. 3-5) and *Apoplophora pantotrema* (Figs. 6-8) possessed narrow, compressed and more or less

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**Figures 1-18. Gnathal appendages in Oribatid Mites. Scale = 2.5cm**

**1 - Infracapitulum of *C. dendrisetosus*; 2 - Chelicera of *C. dendrisetosus*; 3 - Infracapitulum of *P. malabarica*; 4 - Chelicera of *P. malabarica*; 5 - Pedipalp of *P. malabarica*; 6 - Infracapitulum of *A. pantotrema*; 7 - Chelicera of *A. pantotrema*; 8 - Pedipalp of *A. pantotrema*; 9 - Infracapitulum of *A. giganticus*; 10 - Chelicera of *A. giganticus*; 11 - Infracapitulum of *A. longisetosus*; 12 - Chelicera of *A. longisetosus***

triangular rutella, carrying 3-4 sharp notches distally. Chelicera was narrow and elongated. The movable and fixed digits carried 3-4 small but sharp teeth. *Allonothrus giganticus* (Figs. 9-10) possessed a narrow rutellum with three blunt notches distally. Chelicera was remarkably long and thin. Movable digit carried four conical and widely separated teeth while fixed digit had three teeth. In the case of *Archegozetes longisetosus* (Figs. 11-12) rutellum was rectangular and narrow with three distinct notches. Chelicera was broad and short. Digitus mobilis and digitus fixus carried three teeth each. In *Schelorbates decarinatus* (Figs. 13-14) and *Xylobates seminudus* (Figs. 15-16) rutellum was broad and sclerotised into three indistinct notches. Rutellum possessed a rutellar brush with fine setae on either side. Chelicera was strong and well developed. Digitus mobilis carried 3-4 teeth and digitus fixus 2-3. Rutellum in *Galumna flabellifera* (Figs. 17-18) was thin and somewhat pointed. Chelicera was long, thin, strong and well sclerotised. Both digits carried two well sclerotised teeth.

## DISCUSSION

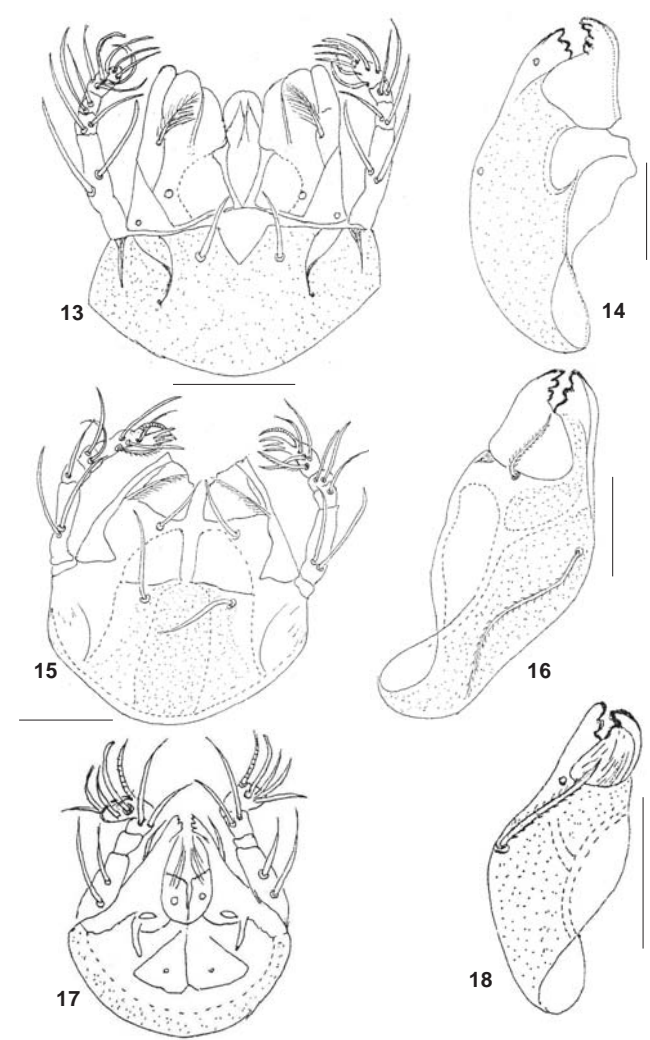
Data collected in the present work on gut content analysis permitted to assign the eight species studied into three feeding

categories. Since the gut contents of *C. dendrisetosus* consisted of leafy and woody material, it was categorized as a macrophytophage. Gut contents *P. malabarica* and *A. pantotrema* revealed only fungal hyphae and spores and hence categorized as microphytophages. Gut contents of five species viz., *A. giganticus*, *A. longisetosus*, *S. decarinatus*, *X. seminudus*, and *Galumna flabellifera* consisted of both higher and lower plant elements which helped to categorise them as panphytophages. Of the eight species studied, 12.5% appeared to be macrophytophage, 62.5% panphytophage and 25% microphytophage. This observation was very close to that made by Behan & Hill (1978) who reported percentages of macrophytophages, panphytophages and microphytophages as 12, 56 and 32, but differs greatly from that of Haq (1996) who reported the percentage of occurrence of this as 37, 52 and 11. The above figures show that demarcation between different nutritional strategies is arbitrary than definite. However, in all the three studies, the percentage of panphytophages was more than 50%, showing the predominance of this group of mites in most natural habitats. This is evidenced by their wider food choice. They could subsist on food items ranging from lower plants to higher plants. This type of feeding habit is ecologically of

Table 1. Gut content analysis of oribatid mites collected from the field

S.No	Species Studied	Types of food identified			Remark
		Leaf	Wood	Fungal hyphae/spores	
1.	<i>Apoplophora pantotrema</i> Berlese, 1913	-	-	++	Microphytophage
2.	<i>Cryptacarus dendrisetosus</i> Bhattacharya et al., 1974	++	+	-	Macrophytophage
3.	<i>Allonothrus giganticus</i> Haq, 1978	+	-	+	Panphytopahage
4.	<i>Archegozetes longisetosus</i> Aoki, 1965	++	-	+	Panphytopahage
5.	<i>Pelokylla malabarica</i> Clement and Haq, 1982	-	-	+++	Microphytophage
6.	<i>Schelorbates decarinatus</i> Aoki, 1984	++	-	++	Panphytopahage
7.	<i>Xylobates seminudus</i> Hammer, 1972	+	++	++	Panphytopahage
8.	<i>Galumna flabellifera</i> Aoki, 1965	+	-	++	Panphytopahage

+ low amount; ++ high amount; +++ very high amount; - absence



Figures 13-18. Gnathal appendages in Oribatid Mites.  
Scale = 2.5cm  
13 - Infracapitulum of *S. decarinatus*; 14 - Chelicera of *S. decarinatus*; 15 - Infracapitulum of *X. seminudus*; 16 - Chelicera of *X. seminudus*; 17 - Infracapitulum of *G. flabellifera*; 18 - Chelicera of *G. flabellifera*

great advantage to the species possessing it. As a result of this eurytypic feeding habit, population of a particular species may be able to survive in a wide variety of habitats. (Luxton, 1972; Harding & Stuttard, 1974; Pelletier & Hill, 1978).

An examination of structural organization of mouth parts in relation to functional significance in feeding, revealed the influence of rutella and chelicera in the mastication of food materials. Pedipalp appeared to have a chemosensory function. The general organization of the gnathal structures remained the same in all the species studied, but individual variation depending as the nature of food consumed was quite resident. The chelicera of macrophytophagous species was thick, strong and sclerotised with prominent teeth capable of cutting hard wood particle as well as rough leaf particles. Their rutellum was unique in having a concave vestibule. As Dinsdale (1974) reported, active feeding involved the diversion of rutellae of both sides allowing the chelicerae to protrude between them one at a time. In the next stage, muscular activity retracts chelicerae and rutellae on the food particles, scraping it systematically using the stout denticles. The scraped food particles collected into the concave vestibule got further masticated by the chelicerae. The gnathal appendages of *C. dendrisetosus* fitted this explanation completely. In the microphytophagous species like *P. malabarica* and *A. puntotrema*, narrow compressed and triangular rutella and the elongated and narrow chelicerae with small sharp teeth were suitable for nibbling fungal cushions and other small food items which at the same time prevented them from consuming bigger food particles. The panphytophagous oribatid mites possessed an intermediate type of rutella and chelicera. Chelicere was strong and stout with well sclerotised chelae, and sharp and highly developed teeth. Rutellum also was well sclerotised with strong and stout denticles. The rutellar brush directed the food particles to the rutellar gap. These modified gnathal appendages were of high value to the species in utilizing a wide range of food items including leafy and woody matter, fungal elements and spores.

CONCLUSION

The gut content analysis revealed the presence of a variety of food items in various stages of digestion in the gut of the three different feeding categories of oribatid mites considered. This has great significance in natural ecosystem, where decomposition of accumulated plant litter from a major aspect of nutrient cycling. Macrophytophagous oribatid mites through their feeding activities affect rates of litter decomposition through their role as secondary decomposers. Such action makes organic debris more suitable for attack by primary decomposers, namely the microflora (Luxton, 1979). On the other hand,



microphytophagous species feeding on lower plant elements like fungal cushions, help in disseminating their spores in different soil layers (Haq, 1996). Effect of feeding by panphytophagous species appeared to be a combination of the above two as they assisted biodegradation by direct feeding on plant litter and indirectly by microbial activation. Luxton (1972) noted panphytophages as twice active as macrophytophages in processing dead organic material. Therefore, it can be concluded that combined activity of these three different feeding categories accelerated decomposition rate of organic litter.

Macrophytophagous oribatid mites were equipped with gnathal appendages which enabled effective trituration of large and hard food particles. Arrangement of gnathal appendages in microphytophagous species allowed only small particles to be consumed while panphytophagous species possessed an intermediate organization of gnathal appendages.

## REFERENCES

- Pelletier, V.M.B. & S.B. Hill (1978). Feeding habits and spore dispersal of oribatid mites in North American arctic. *Revue D'Ecologie Et De Biologie Du Sol* 15(4): 497-516.
- Bhattacharya, S.K. (1962). Laboratory studies on the feeding and life cycles of soil inhabiting mites. *Pedobiologia* 1: 291-298.
- Dinsdale, D. (1974). Feeding activity of a *Phthiracarid* mite (Arachnida: Acari). *Journal of Zoology, London* 174: 15-21.
- Foster, A.S. (1960). *Practical Plant Anatomy*. 2<sup>nd</sup> ed., Van Nostrand, 228pp.
- Haq, M.A. (1982). Feeding habits of ten species of oribatid mites (Acari: Oribatei) from Malabar, South India. *Indian Journal of Acarology* 6: 39-50.
- Haq, M.A. (1996). Nutritional diversity of oribatid mites in relation to soil fertility. *Journal of the Karnataka University, Science Special Issue*: 76-91.
- Haq, M.A. & N.R. Prabhu. (1976). Observations on the feeding habits of mites from the soils of Kerala (Acarina: Cryptostigmata), Panphytophages. *Entomon* 1(2):133-137.
- Harding, D.J.L. & R.A. Stuttard (1974). Microarthropods, pp.489-532. In: *Biology of plant litter decomposition* Vol.2. Dickinson, G.H. and C.J.P. Pough (eds.). Academic Press, London.
- Kevan, D.K. Mc E. (1962). *Soil Animals*. London, Witherby Ltd. XV, 237pp.
- Kuhnelt, W. (1976). *Soil Biology with special reference to the animal kingdom*. Walker. N. Gaber, London, 397pp.
- Luxton, M. (1972). Studies on the oribatid mites of Danish beech wood soil. *Pedobiologia* 12(5): 434-463.
- Luxton, M. (1979). Food and energy processing by oribatid mites. *Revue D'Ecologie Et De Biologie Du Sol* 16:103-111.
- Ramani, N. & M.A. Haq (2001). Feeding habits of the Indian oribatid mite *Hoplophthiracarus rimosus* (Phthiracaridae) and *Lohmannia* n.sp. (*Lohmanniidae*) and their role in decomposition. *Acarology proceedings of the 10<sup>th</sup> International Congress*: pp.262-265.
- Sass, J.E. (1959). *Botanical microtechnique*, 3<sup>rd</sup> Ed. Constable & Co., London, 228pp.
- Schuster, R. (1956). Der Anteil der Oribatiden an den Zergetzungsorganismen in Boden. *Zool Morphologische Zoologie. Tiere* 45: 1-33.
- Walwork, J.A. (1970). *Ecology of soil animals*. Mc. Graw Hill, London, New York, 283pp.



## BALANTIDIUM AND TOXOCARA INFECTION IN LION (*PANTHERA LEO*) - A CASE REPORT

Hase, P.B.<sup>1,2</sup>, S.U. Digraskar<sup>1</sup>, G.R. Gangane<sup>1</sup>, B.W. Narladakar<sup>1</sup> and S.V. Razawi<sup>3</sup>

<sup>1</sup> College of Veterinary and Animal Sciences, MAFSU, Parbhani, Maharashtra 431402, India

<sup>3</sup> Director, Siddharth Municipal Council Zoo Garden, Aurangabad, Maharashtra, India

Email: <sup>2</sup>pankaj\_hase@rediffmail.com

An 18-year old male lion "Amar" belonging to Siddharth Municipal Council Zoo Garden, Aurangabad (Maharashtra) was reported ill by the zoo authority. Clinical examination revealed dullness, depressed appetite, lethargy, epiphora, and loose faeces since three days. On clinical evaluation, the lion showed normal body temperature (102°F), tachycardia (heart rate 85/min.) and mild dehydration. The lion was secured in a squeeze cage and faecal and urine samples were collected for laboratory examination; blood sample from the coccygeal vein.

The coprological examination indicated heavy infection of intestinal protozoa - *Balantidium coli* and *Toxocara* sp. and mild strongyles infestations. Urine analysis revealed turbid appearance, positive for reducing sugar and presence of very large number of lipid droplets - Lipuria (adiposuria) on microscopic examination (Sastri, 2001). Haemogram indicated significant neutrophilia and eosinophilia.

The lion was treated with an antiprotozoan drug Metronidazole (Inj. Metrogyl) @ 20mg/kg b.w., b.i.d., i/v, Fenbendazole (Tab. Fentas) @ 40mg/kg b.w., orally, Dextrose (20%) and electrolyte rich infusion (Inj. Rintose) - 500ml i/v, an antibiotic Ampicillin - Cloxacillin (Inj. AC - Vet) 2gm i/m, Inj. Soda-bi-carb (7.5%) - 20ml i/v, Vit. B1, B6 & B12 (Inj. Tribivet) - 8ml i/m and Antihistamine (Inj. Anistamin) 8ml i/m. The therapeutic regimen was continued for three consecutive days. The lion recovered on the fifth day of therapy and resumed normal appetite and physical activity.

Presence of parasites in the faeces and considering the success of antiparasitic treatment it can be concluded that the lion was suffering with clinical parasitosis. Zoo animals, especially canids, felids and ursids do not develop immunity and may become reinfected for the ascarids as compared to wild carnivores (Abdel-Rasoul & Fowler, 1980). Canines and felines are prone to nephro- and hepatopathy as compared to other animals (Fowler, 1993). Abnormal constituents in urine, particularly lipuria could be attributed to improper fat metabolism consequent to hepatopathy and nephropathy triggered by chronic parasitism. *Balantidium* with concurrent infection of *Toxocara* sp. resulted in the clinical illness.

## REFERENCES

- Abdel-Rasoul, K.S. & M. Fowler (1980). An epidemiologic approach to the control of ascariasis in zoo carnivores. *Proceedings of the international symposium on diseases of zoo animals*, Arnhem, Netherlands, 273pp.
- Belding, D.L. (1965). *Textbook of Parasitology*. 3<sup>rd</sup> Edition: Appleton-Century-Crofts, New York, 1374pp.
- Fowler, M.E. (1993). *Zoo & Wild Animal Medicine Current Therapy* 3. W.B. Saunders Company Philadelphia, 360-380pp.
- Sastri, G.A. & P.R. Rao (2001). *Veterinary Pathology*, 7<sup>th</sup> Edition. CBS publication & Distributors, New Delhi.
- Patel, P.V., A.I. Patel, R.H. Sabapara, R.K. Sahu & R. Vyas (2002). Helminthic infection in wild canids in zoological gardens of Gujarat. *Zoos' Print Journal* 18(4): 1084.
- Ruprah, N.S. (1985). *A Textbook of Clinical Protozoology*. Oxonian Press Pvt. Ltd. New Delhi, 356-362pp.



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