



White hole compliments
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PHTHIRAPTERAN INSECT AND LARVAL ACANTHOCEPHALA FROM THE LATE TRIASSIC SEDIMENTS OF THE SATPURA BASIN, INDIA

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ASBTRACT

A fossilized microscopic, wingless ectoparasitic anopluran insect and an endoparasitic larval form of Phylum Acanthocephala have respectively been recorded from the Bagra Formation and the Denwa Formation of the Late Triassic of the Satpura Basin, Madhya Pradesh, India. Both specimens show parasitic habitat, the former parasitising on mammals and the latter occurring in the intestinal region of an arthropod. Taxonomy of Phthiraptera has been discussed.

Key words: Phthiraptera, larval Acanthocephala, Late Triassic, Satpura Basin, India.

INTRODUCTION

The Triassic sediments in the Satpura Basin are divisible into three units, viz. Pachmarhi Sandstone (Lower), Denwa Clays (Middle) and Bagra Conglomerate (Upper) (see Medlicot, 1873). Crookshank (1936) considered the latter two units to represent the youngest units of the Mahadeva Group. The Denwa beds were assigned to the Late Triassic (Keuper) age based on the occurrence of labyrinthodont fossil *Mastodonsaurus indicus* Lydekker (1885) near Jhipra in the Satpura Basin (Crookshank, 1936). However, Krishnan (1982) opined that the presence of *M. indicus* (allied to *Capitosarus* and *Metapias*) indicates Rhaetic age (Late Triassic). Pascoe (1959) considered the Denwa beds and the Bagra conglomerates as equivalent to Muschelkalk to Keuper and Rhaetic or/Rhaetic-Liassic, respectively. On the basis of their position in sequence, Raja Rao (1983) suggested that the Denwa Formation possibly ranges in age from the upper part of Lower Triassic to Middle Triassic and the Bagra Formation possibly is of Rhaetic (?) (Late Triassic) age.

Nandi (1996) assigned the Carnian to Norian age for the subsurface Denwa Formation on the basis of palynological studies. Lately, Kumar (2000) also recorded a rich assemblage of spore-pollen, dinocyst, fungal remains, wood tracheids,

etc. from the Denwa Formation exposed in a well section near Anthoni village and suggested its age as the Norian to Rhactian.

Recently, Kumar and Kumar (1999) recorded ectoparasitic mallophagan insect remains from the Late Triassic sediments in the Satpura Basin. In the same continuation, the present communication reports occurrence of a fossilised, microscopic, wingless ectoparasitic anopluran insect recovered from the yellowish-reddish sandy clay in the Bagra Conglomerates exposed at Khatama Caves, Hoshagnabad District, M.P. (figs. 1-4). See details

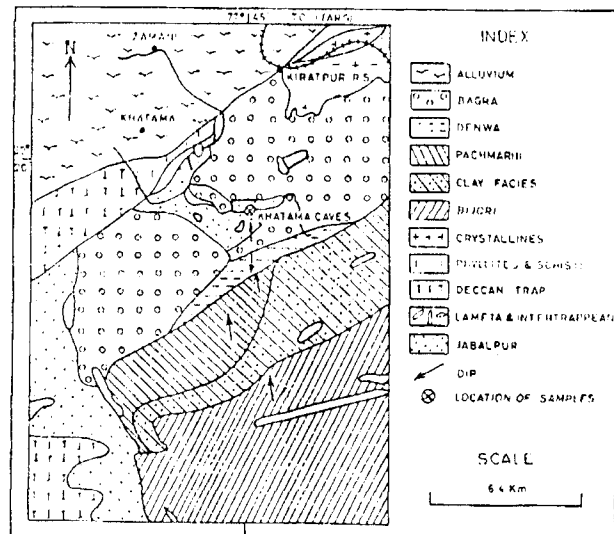


Fig. 1. Geological map of the area showing locations of rock samples near Khatama Caves (after Crookshank, 1936).

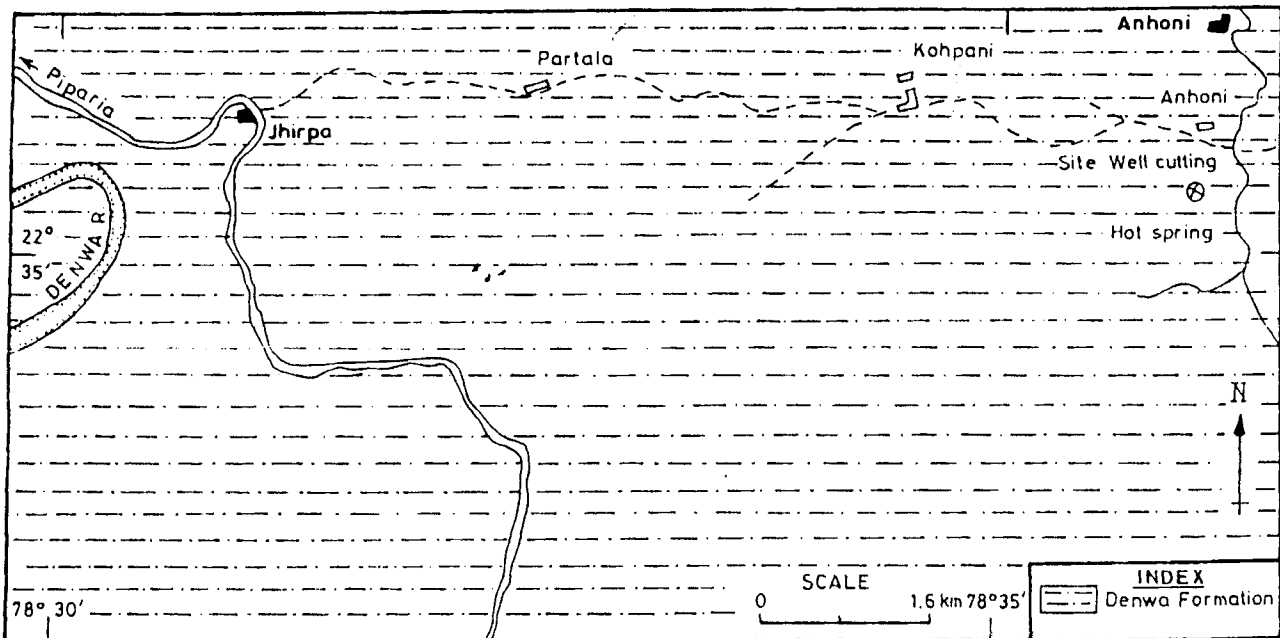


Fig. 2. Geological map of the Anthoni area showing the site of a well-cutting (after Raja Rao, 1983).

in Kumar and Kumar 1999, fig. 2, fig. 3- sample no. 1. The endoparasitic larval form of *Acanthocephala* is also being reported from the Khaki Shale of the Denwa Formation subcropping in an artisan well-cutting at the village Anthoni in Chhindwara District, M.P. See details in Kumar and Kumar 1999, fig. 4, fig. 5 - sample no. 7.

DESCRIPTION OF INSECT

The present specimen (Pl. I, fig. 1) is a complete fossilised insect of the Order Phthiraptera and Suborder Anoplura (sucking lice). It has three distinct body regions of atypical insect; head (a), thorax (b) and abdomen (c). It is delicate, small and has a dorsoventrally flattened body. It measures 600 μm in length. More or less triangular head, 137.00 x 100.00 μm in size, narrower than thorax,

narrowing towards the front side where it becomes pointed and containing piercing and sucking type of mouth parts in a trophic sac within the head capsule (Pl. I, fig. 2 A). The mouth parts are unique as they invaginate into head except when insect is feeding, otherwise retractile in nature when not in use and are completely withdrawn into the head of louse. In front of head is a small tube (Pl. I, fig. 2) haustellum that is believed to be formed from labium (Buxton, 1946). This tube is soft, reversible and armed with small minute teeth. One can easily observe externally a fringe of minute teeth at the foremost part of the head of the louse (Pl. I, fig. 1, 2 A). Anoplurans are haematophagous (sanguivorous) due to their piercing and sucking type of mouth parts. They exclusively feed on blood of the mammalian hosts, hence, blood

EXPLANATION OF PLATE I

1. Complete male fossil Anopluran insect showing three parts of dorsoventrally flattened body — Head (A), Thorax (B) and Abdomen (C). BSIP Slide No. 12350 (SC 23 x 107.8).
- 2.A, Piercing and sucking mouth parts, haustellum, outer rim;
- B, ocular part as simple eyes; C, Original space of Antennae.
- 3.A, showing impressions of the presence of 3 pairs of legs;
- B, showing paratergal plates; C, showing alimentary canal;

- D, showing anus at the posterior end of the abdomen; and E, sexual orifice to upper surface.
- 4.A, showing spiracle-like structure on both the lateral sides of abdomen (enlarged 2.6 times of the fig. 3. E).
5. Larval form of *Acanthocephala* showing hooks (A) on anteriormost part of the larval body, P, proboscis, N, neck and BP-body proper (ca x 500). BSIP Sl. No. 12257 (SC' 45.5 x 100.5).



suckers. The head of the specimen shows prominent ocular part in the form of simple eye (Pl. I, fig. 2B). Antennae are not visible but their presence can be differentiated (Pl. I, fig. 2C). Thorax almost sunken into the abdomen (Pl. I, fig. 1B) is $125.00 \times 100.00 \mu\text{m}$ in size. It can be clearly distinguished into pro-, meso- and metathorax, but usually in modern anopluran insects thorax is not clearly demarcated. Therefore, this specimen is in pre-adaptive stage. It shows impressions of the presence of three pairs of legs (Pl. I, fig. 3A).

The longest part of the body is the abdomen without cerci, a characteristic feature of anopluran insect; it measures $338.00 \times 160.00 \mu\text{m}$ in size. It does not show segmentation but presence of paratergal plates can be recognised (Pl. I, fig. 3B) which may represent beginning of segmentation. It is also an evidence of its pre-adaptive stage. It is a male louse as its posterior abdominal end is rounded and ventral surface is curving upwards so as to become anus (Pl. I, fig. 3D) and sexual orifice (Pl. I, fig. 3E) to upper surface. In the case of female louse, the posterior abdominal end terminates into two large lobes which appear as a bilobed structure.

Locus typicus: Khatama Caves, Hoshangabad District, M.P., India

Stratum typicum: Bagra Formation, Mahadeva Group, Satpura Basin, M.P., BSIP Slide No. 12350.

DESCRIPTION OF THE LARVAL FORM

The fossil larval form of the Phylum Acanthocephala (Pl. I, fig 5) shows presence of hooks situated on the anteriormost part of the body. The most characteristic feature of this phylum is the organ of attachment, the hooks (spines) on a retractile proboscis (Pl. I, fig. 5P) forming the anterior end of the body. Behind the proboscis is a short neck region (Pl. I, fig. 5N) and then body proper (Pl. I, fig. 5BP) which is roughly cylindrical. It lacks a digestive tract.

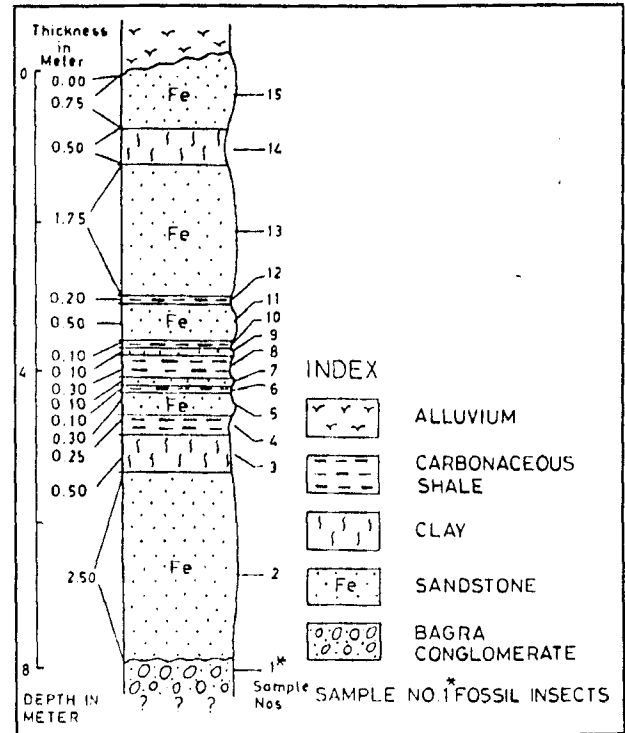


Fig. 3. Stratigraphical sequence exposed in Zamani Nala near Khatama caves, Hoshangabad district, M.P.

Acanthocephala means spiny headed organism which is endoparasitic of peculiar structure and function that lives as adults in the intestine of vertebrates and as a larva in the intestine of arthropods (see Prasad, 1958). The worm clings to intestinal lining of its host by spiny proboscis. Adult acanthocephalans bear rows of stout recurved hooks but larval form bears only three pairs of hooks. As this specimen shows only one complete hook and impressions of other hooks, it is considered to be a larval form. The posterior end of this specimen seems to be broken, hence its is not given here but its maximum width in the middle region measures $56 \mu\text{m}$.

Locus typicus: Anthoni Village, Chhindwar District, M.P., India.

Stratum typicum: Denwa Formation, Mahadeva Group, Satpura Basin, M.P.; BSIP Slide No. 12257.

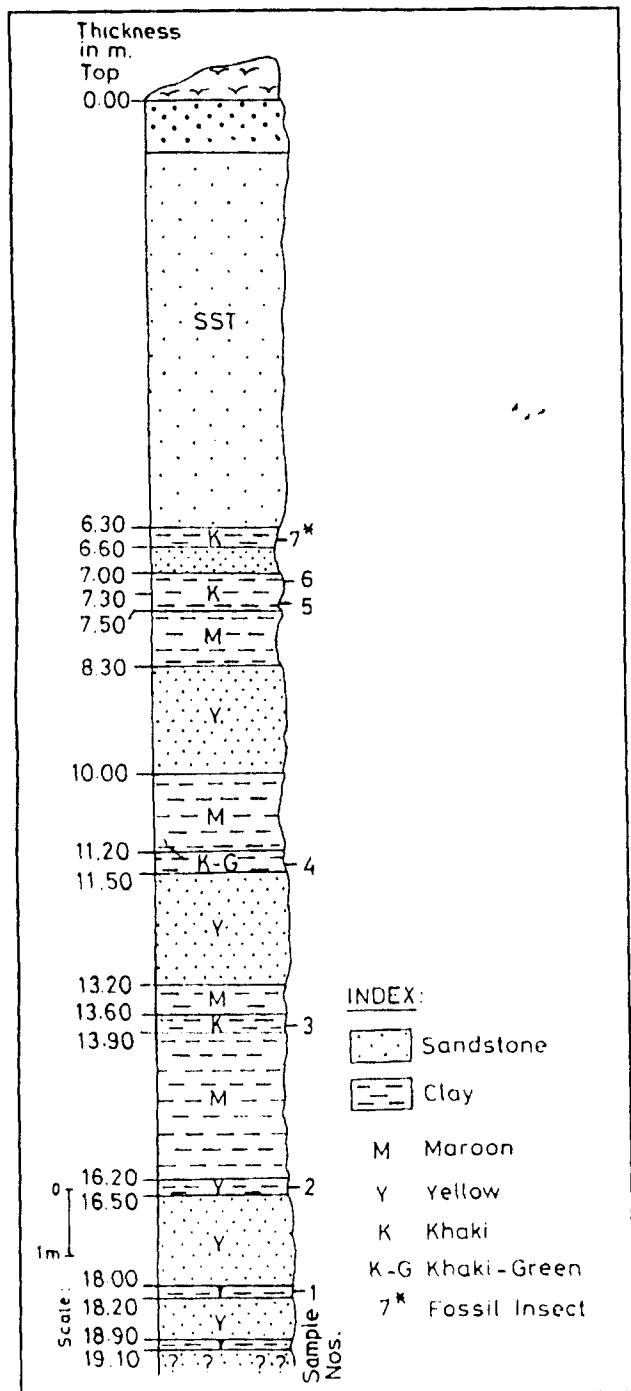


Fig. 4. Stratigraphical sequence exposed in a well-cutting at Anhani, Chhindwara district, M.P.

DISCUSSION

The suborders Anoplura (sucking lice), Mallophaga (biting lice) and Rhyncophthirina (elephant lice) together constitute the Order Phthiraptera (Mani, 1982). The present specimen

of insect may belong to Suborder Anoplura, sucking lice (Leach, 1815) as it shows mouth parts adapted to sucking blood from its host. All members belonging to this suborder are wingless, dorsoventrally flattened and have abdomen without cerci. There are no fossil record of Anoplura but it is believed that they are a monophyletic group which made a major change in their feeding habits when they began to ingest blood during Late Cretaceous - early Palaeocene (Kim and Ludwig, 1982). Anoplura must have existed in the Mid. Cretaceous (Hopkins, 1949). A phylogeny of Anoplura was constructed on the basis of the study of evolution of mammalian hosts (Kim and Ludwig, 1978). The present specimen seems to be Protoanoplura (see Price and Graham, 1997) as its outer rim of mouth parts is clearly seen to form a fringe which is a characteristic feature of the mouth parts of anopluran type (Pl. I, figs. 1 & 2A). The remains of early mammals were recorded from the Tiki Formation (Late Triassic) in the neighbouring South Rewa Basin by Dutta and Das (1996). Hence, the presence of anopluran insects ectoparasitising on mammals during Triassic cannot be ruled out.

Modifications are not necessarily adaptive and if they are not, they may portend demise of species, since any change statistically is more likely to make animal less competitive. An exception would be a modification that proved to be pre-adaptive. Pre-adaptations are fortuitous modifications that enable descendentants to enter new niches or to cope with conditions not existing at the time of modifications (Kent, 1973).

Kumar and Kumar (1999) reported the remains from the Late Triassic sediments of the Satpura Basin, India. These are closely related to bird lice (Mallophaga) and are with unsegmented abdomen. The development of parasitic habit by Mallophaga and Anoplura (Phthiraptera) was explained by Osborn (1991) as having been a progression from the free-living state to semi-parasitic form which sometimes fed on plants and

vertebrate hosts of modern parasite (Price and Graham, 1997). Ancestors of Mallophaga and Anoplura were all free living species before Triassic Period and did not parasitise the skin of ancient reptiles (Rozsa, 1991). Rozsa (1993) further reported the speciation patterns of ectoparasites. Lice tend to be highly host-specific (Kim and Ludwig, 1978; Emerson and Price, 1985). During Triassic Period, there were most extraordinary animals that world has ever seen, as diversified in form and size as are living animals (Ross, 1965, p. 419). Kim and Ludwig (1978) hypothesised that the primitive ancestors of parasitic lice of today invaded new habitats such as animal skin and deposits of skin debris in geologic times and gradually adapted to a parasitic existence.

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REFERENCES

- Buxton, P.A. 1946. *The louse : An account of the lice which infest man, their medical importance and control*. Edward Arnold & Co.
- Crookshank, H. 1936. Geology of the northern slopes of Satpura between Morand and the Sher rivers. *Mem. Geol. Surv. India*, **66** (2) : 242-272.
- Datta, P.M. and Das, D. P. 1996. Discovery of the oldest fossil mammal from India. *Ind Min.* **50**(3) : 217-222.
- Emerson, K.C. and Price, R.D. 1985. Evolution of Mallophaga on mammals, p. 233-255. In : Ed. Kim, K.C., *Coevolution of parasitic arthropods and mammal*. John Wiley & Sons, New York.
- Hopkins, G.H.E. 1949. The host associations of the lice of mammals. *Proc. Zool. Soc. London*, **119** : 387-604.
- Kent, G.C. 1973. *Comparative anatomy of the vertebrates*. C.V. Mosby Co. Saint Louis.
- Kim, K.C. and Ludwig, H.D. 1978. Phylogenetic relationships of parasitic Psocodea and taxonomic position of Anoplura. *Ann. Entomol. Soc. America*, **71** : 810-922.
- Kim, K.C. and Ludwig, H.D. 1982. Parallel evolution, cladistics and classification of parasitic Psocodea. *Ann. Entomol. Soc. America*, **75** : 537-548.
- Krishnan, M.S. 1982. *Geology of India and Burma*. CBS Publ. & Distrib., India, 6th ed.
- Kumar, Pramod 2000. Palynodating of Denwa Formation, Satpura Basin, India, p. 9-18 In: *Plant Cell Biology and Development* (Ed. Kedves, M.) (11).
- Kumar, Pramod and Kumar, Prabhat 1999. Insect remains from Upper Triassic sediments of Satpura Basin, India. *Curr. Sci.* **76** (12) : 1539-1541.
- Leach, W.E. 1815. Entomology. In : Brewster's Edinburgh *Encyclopedia* **1** : 57-172.
- Mani, M.S. 1982. *General Entomology*. Oxford & IBH Publ. Co., New Delhi.
- Medlicot, H.B. 1973. Notes on the Satpura coal basin. *Mem. Geol. Surv. India*, **10** (2) : 133-188.
- Nandi, A. 1996. Palynodating of carbonaceous shales from Denwa Formation, Satpura Basin, M.P., India, p. 79-87. In: *Gondwana Nine, Proc. 9th Int. Gondw. Symp.* 1994., India. Oxford & IBH Publ. Co. Pvt. Ltd. Calcutta 1.
- Osborn, H. 1991. Origin and development of the parasitic habit in Mallophaga and Pediculidae. *U.S. Department of Agriculture, Insect Life*, **4** : 187-191.
- Pascoe, H. 1959. *A Manual of Geology of India and Burma*. Calcutta.
- Prasad, S.N. 1958. *A Text Book of Intermediate Zoology*. Kitab Mahal, Allahabad, Bombay, Delhi.
- Price, M.A. and Graham, O.H. 1997. Chewing and sucking lice as parasites of mammals and birds. *U.S. Department of Agriculture Research Service Technical Bulletin*, **1849** : 1-257.
- Raja Rao, C.S. 1983. Coal Resources of Madhya Pradesh, Jammua and Kasmir. *Bull. Geol. Surv. India, Ser. A, No. 45, Coalfields of India*, **III** : 1-204.
- Ross, H.H. 1965. *A text book of Entomology*. Wiley Int. Ed., John Wiley & Sons Inc., New York.
- Rozsa, L. 1991. Points in question. Flammig lice contravene Fahrenholz. *Ints. Jl. Parasitol.* **21** : 151-152.
- Rozsa, L. 1993. Speciation patterns of ectoparasites and "stragglings" lice. *Int. Jl. Parasitol.* **23** : 859-864.

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