Late Pliocene (Piacenzian Stage) Fossil Molluscs from Upper Siwalik Subgroup of Jammu, Jammu and Kashmir, India

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Abstract

Five species of gastropods and two of bivalves are being reported, and described from the mudstone horizon immediately underlying geochronologically dated (2.8±0.56m.y.) bentonitized tuff band exposed at Barakhetar village in a stream cutting section. The reported fauna comprises Gastropods: Gastrocopta sp., Gyraulus sp. indet., Viviparus bengalensis, Viviparus sp., Bellamya celispiralis and Bivalves: Lamellidens lewisi, Oxynaia sp. indet. Stratigraphically, the fossil (gastropod and bivalve) bearing mudstone horizon belongs to the Nagrota Formation of Upper Siwalik Subgroup of Jammu Province, Jammu and Kashmir, India and located about 30km east of Jammu city. A brief account of the age and palaeoecology of the recovered taxa have also been discussed in the present paper.

Keywords: Late Pliocene, Molluscs, Palaeoecology, Age, Nagrota Formation, Upper Siwalik Subgroup, Jammu.

Introduction

Siwalik Group is the southernmost part of the Himalayan foreland basin containing rich assemblage of Neogene fossils. It occurs all along the length of the Himalayan arc from the Indus River in the northwest to Brahmaputra in the east. Most of the type sections of the Siwalik Group occur in Pakistan; a few occur in India and reference sections that yield fossils are known from both India and Nepal. Bhatia and Mathur¹ have reported eleven taxa of bivalves and twenty two of gastropods from the Late Pleistocene of Punjab. Takayasu et al.² recovered freshwater Moicene – Pliocene molluscan fossils from the Churia Group (equivalent to the Siwalik Group) of Nepal. The recovered bivalve fauna comprises Lamellidens arungensis, Lamellidens longiformis, Indonaia narayani, Indonaia jimuriensis, Indonaia tenella, Parreysia baiinaensis, Parreysia zigzagicostata and Physunio chitwanensis. Mathur³ described four taxa of gastropods and six of bivalves from the Middle and Upper Siwalik deposits (Late Miocene-Pleistocene) of Kangra (H.P.), Ambala (Harayana), and Ropar (Punjab) districts. This fauna is represented by Anmicolia (Alocinna) sp., cf. A. (A.) sistanica, Sitala sp. indet. (Upper Siwalik Pinjor Formation) and Hydrobioides avarix and Indoplanorbis exustus from terrace deposits. The bivalves are represented by Parreysia sp., cf. P. edwini (Gupta), P. sp. indet., Lamellidens sp. indet. A, L. sp. indet. B, Oxynaia sp. indet. (Pinjor) and Corbicula sp. from the Boulder Conglomerate Formation (Upper Siwalik). Mathur⁴ made an attempt to synthesise the sporadic records of charophytes from the Siwalik Group and to build up a molluscan biostratigraphy and concluding that the Lamellidens prashadi is of the proposed Lower Zone (Chinji) and L. jammuensis of the proposed Upper Zone (DhokPathan – Pinjor). Within L. jammuensis Zone, L. subparallelus-Parreysia (Parreysia) tatrotensis assemblage represents the Lower Sub Zone (DhokPathan – Tatrot) and Pisidium (Afropisidium) sivalensis represents Upper Sub Zone (Pinjor). Gurung⁵ collected freshwater fossil molluscan fauna from the Siwalik Group of Nepal which is represented by gastropods belonging to the families Viviparidae, Ampullariidae, Bithyniidae, Thiariidae and bivalves belonging to the families Unionidae, Corbiculidae and Pisidiidae. Of these four new species viz. Angulyagra schiddarthaí, Brodiai dobatanesi, Paludomus suraiensis and Parreysia churii have also been described⁶.

The Siwalik succession of Jammu Hills, the eastern extension of Potwar Plateau and lying in a linear belt between the Line of Control and Ravi River, is relatively least studied area from invertebrate and micro- paleontological points of view. No reports have been published on gastropods and bivalves of this area until now except that of Prashad⁷ and Parmar⁸. Prashad⁷ collected two specimens of unionid shells from the Upper Siwalik beds near Nagrota, Jammu and one shell from Nawapet, Hydrabad, and Deccan India. The unionid fauna comprises of Lammellidens jammuensis, Indonaia mittali, and Indonaia parasoei. Parmar⁸ recovered a few species of molluscan fauna comprises of Mesogastropoda incertae sedis, Lammellidens indet., Thiariidae sp. Parreysia tattrotensis from the Lower Siwalik deposits of Jammu region. The present collection of bivalve and gastropod specimens have been recovered from the mudstone horizon immediately underlying the geochronologically dated bentonitized tuff band (2.8±0.56m.y.) exposed at Barakhetar village in the Nagrota Formation, Upper Siwalik Subgroup of Jammu region.

Repository: The recovered specimens have been lodged in the Department of Geology, Paleontology Laboratory, Jammu University under catalogue numbers DG/PL/JU/1-8.
Stratigraphy: From a long time many geoscientists have classified the Siwalik Group of rocks on the basis of one or more of lithology, fauna and flora, magnetostratigraphy and satellite imagery analysis. But the standard stratigraphy of the Siwalik rocks was provided by Pilgrim on the basis of the fauna recovered from Siwalik Hills. He divided the “Siwalik Series” into three units which could have subdivided into seven stages. i.e. Lower Siwalik (Kamlial Stage, Chinji Stage), Middle Siwalik (Nagri Stage, Dhok Pathan Stage) and Upper Siwalik (Tatrot Stage, Pinjor Stage and Boulder Conglomerate Stage) and these assigned an age ranging from Middle Miocene to Lower Pleistocene for the Siwalik Series. This classification is more or less followed till date. All these above stages are named on the basis of type sections in undivided India, but after the division of India most of the stages occur in different localities in Pakistan, except Pinjor and Boulder Conglomerate, which occur in India.

The Siwalik Group of Jammu division is exposed in outcrops that occupy an intermediate position between the type sections on the west and Siwalik Hills of Chandpur in east having type localities Pinjor and Boulder Conglomerate. Various lithostratigraphic units starting from Chinji Formation to Boulder Conglomerate Formation have been delineated in this area. The Upper Siwalik Subgroup of rocks of Jammu region has been divided into Parmandal Sandstone, Nagrota Formation, and Boulder Conglomerate. Adopted these stratigraphic divisions and subdivided Nagrota Formation into three members i.e. Nagrota-A, Nagrota-B, and Nagrota-C. Gupta and Verma classified the Siwalik Group of Jammu into Mansar Formation (Lower Siwalik Subgroup); Dewal Formation (=Nagri), Mohargarh Formation (=Dhok Pathan) (Middle Siwalik Subgroup); and Uttarbehani Formation, Dughor Formation (=Boulder Conglomerate) (Upper Siwalik Subgroup). Gupta further modified the latter classification and divided the Mansar Formation into Dodenal Member and Ramnagar Member and Uttarbehani Formation into Labli Member (=Tatrot) and Marikhui Member (=Pinjore). The comparative classification of Siwalik group of Jammu is given by various workers is reproduced in the table-1.

**Systematic Description**

- **Phylum**: Mollusca
- **Class**: Gastropoda
- **Order**: Caenogastropoda
- **Family**: Viviparidae
- **Genus**: Viviparus

**Viviparus bengalensis**: Referred Material: DG/PL/JU/01, one shell. Stratigraphic Position: Mudstone horizon immediately underlying the geochronologically dated (2.8 ±0.56 m.y.)
Pleistocene deposits of Narmada valley
Viviparus bengalensis, cannot be seen because of the breakage of the specimens.
From above. Large apical part can be observed but a dapical part specimen. Description: Shell small in size, 2-4 mm in diameter,
Remarks: The specimen under study compares well with Bellamya celsipiralis:
Bentonitized tuff band exposed at BaraKhetar, Jammu. Locality: In a stream cutting, 0.375 km northwest of Barakhetar village,
Jammu district, Jammu and Kashmir, India. Description: Shell short and broad, conical spire, four whorls, whorls swollen,
dextrally coiled increase in size gradually and evenly, body whorl larger than the spire, suture linear and impressed, surface
of whorls convexly flattened, aperture subspHERAL, ventral surface of the body whorl convex, surface smooth.
Remarks: The present forms approach the morphology of Viviparus bengalensis, which has so far been recorded from the
Pleistocene deposits of Narmada Valley and Pinjor Formation near Chandigarh and Saketi. It has also been documented
from the freshwater lakes of Jammu region and has a wide spread occurrence in the Indian subcontinent.
Viviparus sp.: Referred Material: DG/PL/JU/02, one shell. Description: Shell small, medium-sized, slightly inflated, short
conical, apex blunt, three whorls, whors increase in size gradually and evenly, body whorl larger than spire, whors moderately
convex, sutures linear and depressed, aperture ovoidal in shape, ventral surface of body whorl convex, dextrally coiled, a low prominent ridge along the basa
l periphery of ultimate whorl, surface with fine longitudinal striae.
Remarks: The specimens under discussion differ from those of V. bengalensis in having adpressed sutures, less inflated whors,
and ovoidal aperatura. Although in general appearance, the present specimen resembles Sitala sp. indet. from Pinjor
Formation near Chandigarh, is elongate conical and the number of whors are 5 ½, the spire is relatively high and the
apical angle is low.

Bellamya celsipiralis: Referred Material: DG/PL/JU/03, one specimen. Description: Shell elongated turbinate in shape,
moderately solid, spire elevated, long, equal or slightly larger than the body whorl. Shell consisting of four whors, gradually
and regularly increase in size. The whors are rounded and separated by impressed suture. Aperture partially preserved,
body whorl not greatly enlarged in size. Shell surface marked with coarse and fine striate or growth lines. Aperture broadly
ovate, small, thinly lipped, inner lip is thicker than the outer lip.
Remarks: The specimen under study compares well with Bellamya celsipiralis described by Gurung from the Churia
(Siwalik) Group of Tinau (Nepal).

Gyralus sp. indet.: Referred Material: DG/PL/JU/05, one specimen. Description: Shell small in size, 2-4 mm in diameter,
discoidal, thin and dextrally coiled; all the whors are visible from above. Large apical part can be observed but adapical part
cannot be seen because of the breakage of the specimens. Whors increasing in diameter rapidly and consist of two and
half whors. Body whorl larger and a little expanded around the aperture.
Remarks: The specimens under study campare with those of Gyralus reported by Bhatia from the Karewa deposits of Kashmir. However, breakage of the specimens from adapical side made their identification at species level difficult.

Gastrocopta sp.: Referred Material: DG/PL/JU/06, one specimen. Description: Shell elongated cylindrical in outline, five
whors, whors increase in size gradually and evenly, and moderately convex, spire higher than body whorl or nearly equal to it, apex blunt, sutures linear and impressed, aperture sub-quadrate in outline, ventral surface of body whorl convex, surface with fine longitudinal striae, apertural folds are indistinct due to matrix filling.
Remarks: Gastrocopta is known by Gastrocopta kashmirensis from the Karewa Formation of Kashmir, Gastrocopta naidui and Gastrocopta (Gastrocopta) prashadi from the terrace deposits near Chandigarh. More recently, Mathur described additional molluscan fauna and revised earlier described ones from the Siwalik Group and terrace deposits of Himachal Pradesh, Haryana, and Punjab and provided a comprehensive account of apertural characters that can be successfully used in taxonomic classification. In overall appearance, the specimen from the Upper Siwalik beds of Jammu is comparable to Gastrocopta kashmirensis. Because of the indistinct nature of apertural characteristics and paucity of material, assignment of present material to G. kashmirensis is avoided.

Oxynaia sp. indet.: Referred Material: DG/PL/JU/07, single specimen with both valve. Description: The specimen is
transversely ovate in outline, anterior margin broadly rounded with an antero-dorsal notch, posteriorly cuneate, dorsal
gradually sloping, ventral feebly arched, convex, broadly rounded anterior end, nearly acutely pointed posterior end,
antero-dorsal notch, shell moderately inflated, umbo slightly inflated, strongly inequilateral, umbo sculpture indistinct.
Dimensions: Length = 7 mm, Width = 4 mm.
Remarks: The present specimen is comparable to Oxynaia sp. indet. earlier described by Mathur from the Chhoti Parch, near
Chandigarh, Pinjor Formation. This species is restricted to the Pinjor Formation.

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**Lamellidens lewisi:** Referred Material: DG/PL/JU/08, single specimen with both valve. Description: The specimen under study is transversely elongate, elliptical in shape, shell is large, surface with distinct concentric growth lines, anterior margin broad, regularly arched, posterior narrow, sharply rounded, dorsal margin gently sloping, ventral margin nearly straight, umbo broad, low, and not much inflated, with a depression, no umbonal sculpture.

Dimensions: Length = 62 mm, Width = 22 mm

Remarks: This specimen resembles *L. lewisi* described by Vokes\(^2\) from the Tatrot Formation near Tatrot (Pakistan) and Pinjor Formation near Khol Tandu (section A vi), Chandigarh. Mathur\(^3\) reported similar specimens from west of Chandigarh (Pinjor Formation).

**Figure-2**

Figure 3

Age and palaeoecology

A very few workers39-35 were carried out work on age, palaeoecology, palaeocommunity structure and Depositional environment of Upper Siwalik Subgroup of Jammu region on the basis of recovered microfossil, micro vertebrates, flora charophyte and bentonitized tuff band.


The molluscs fauna recovered from the Barakhetar locality of Nagrota Formation comprises of gastropods: Gastrocopta sp., Gyraulus sp. indet., Viviparus bengalensis, Viviparus sp., Bellamya celispiralis and bivalves: Lamellidens lewisi, Oxynaia sp. indet.

Bellamya celispiralis is characteristic of Pleistocene-Recent sediments. Viviparus is represented in the present collection by Viviparus bengalensis and Viviparus sp. Viviparus bengalensis was recovered from the Pleistocene of Narmada valley21. Bhatia and Mathur1 recorded this species from the Pinjor Formation (Upper Siwalik) near Chhoti Parch (section A). Mathur3 also reported this species from the same locality. Gastrocopta kashmirensis was reported from Plioocene-Pleistocene sediments of the Karewas of Kashmir.26, 27. This species was also reported from Kishanpur terrace deposits3. Gyraulus sp. was reported from the Terrace T3 deposits of Sirsa, Kishanpur near Nalagarh (H.P.)27. Tokuoka36 recovered this species from the Churia Group of Nepal. This species has also been reported from the Pinjor Formation near Chandigarh. Bellamya celispiralis was reported from the Pleistocene Churia Group, West-Central Nepal.

The bivalve shells belong to Lamellidens lewisi and Oxynaia sp. indet. Lamellidens lewisi, originally described as an indeterminate species of genus Lamellidens from Asnot area (now in Pakistan)37 and was later described under the trivial name L. lewisi from the Tatrot Formation near Tatrot (in Pakistan) and the Pinjor Formation near Khol Tandu (section A VI), near Chandigarh38. This species is known to be restricted to

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Table-1
Comparison of lithostratigraphic classification of the siwalik group of Jammu region given by different workers (modified after Prasad et al., 2005)
the Upper Siwalik (Tatrot and Pinjor formations)\textsuperscript{28}. \textit{L. lewisi} also reported from the Pinjor Formation near Khol Tandu, near Chandigarh\textsuperscript{1} and \textit{Oxyaina} sp. indet. was recovered from Chhoti Parch, near Chandigarh\textsuperscript{1}. This species is so far known only from the Pinjor Formation. Raghavan\textsuperscript{38} reported this species from the Pinjor Formation of Panchkhulla (Haryana, India) area.

As far as palaeoecology is concerned, majority of the taxa recovered from the Upper Siwalik strata of the studied area have living representatives or closely related forms in the living fauna. The extant molluscs are known from marine, freshwater, brakish water and terrestrial environments. They are vagrant and bottom dwellers. A few of them are burrowers in sand or mud. Most of the aquatic molluscs are preserved in situ. Contrary to this, the terrestrial fossils are commonly preserved far from their habitat. Therefore aquatic moll scan should be better indicators of aquatic ecological conditions prevailing at any time. Similarly, if changes in the type and distribution of moll scans in time and space can be evaluated, ecological variation due to changes in climate as well as topography can also be understood.

The fossil evidence for the palaeoecological inferences is derived from recovered gastropods and bivalves. Bivalves include \textit{Lamellidens lewisi} and \textit{Oxyaina} sp. indet. in the present collection that have wide geographical and geological distribution. The living forms are exclusively aquatic which have a range of adaptability to depth. Gastropods of the present collection include \textit{Gastrocopta} sp., \textit{Gyraulus} sp., \textit{Viviparus} sp., \textit{Viviparus bengalensis}, and \textit{Bellamya celispirals}. Most of these taxa are commonly known to live in low energy environment ranging from ponds, lakes to margin of slow flowing river, but generally avoiding fast flowing waters. The exclusive occurrence of gastropods opercula indicates predominance of current action, which was not only responsible for abundant vegetative matter but also in separating the opercula from the shell and depositing them in a different part of the basin. In general, the molluscan fauna of the study area indicates freshwater, shallow lacustrine environment of deposition.

**Conclusion**

On the basis of gastropods and bivalves fauna in association with microfossil (ostracodes, charophytes, fishes, frogs, rodents) recovered from the mudstone horizon just below geochronologically dated bentonitized tuff band (2.8±0.56 m.y.) from Barakhetar locality, Upper Siwalik Subgroup of Jammu province, it is concluded that gastropods and bivalves bearing mudstone horizons have been deposited during Late Pliocene (Piacenzian Stage) under fresh water shallow lacustrine conditions.

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