



Fossil Molluscs from the Middle Miocene Lower Siwalik Deposits of Jammu, India

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Abstract

Palaeontological field investigations carried out in the Middle Miocene Lower Siwalik beds of Jammu region, India, resulted in the delineation of a fossiliferous horizon that yielded mega and micro remains of fossil molluscs. The molluscan fauna recovered from the Lower Siwalik deposits of Jammu comprises of *Lamellidens* indet., *Parreysia* cf. *Parreysia* (*Parreysia*) *tatrotensis*, *Thiaridae* gen. et sp. indet. and *Mesogastropoda incertae sedis* that are being described for the first time from this area.

Keywords: Molluscs, Middle Miocene, Lower Siwalik, Jammu

Introduction

The Siwalik rocks of the Indian Subcontinent occur in a linear belt all along the Himalayan foothills between river Indus in the west and the Brahmaputra gorge in the east. They represent the last and the southernmost phase of the upliftment of the mighty Himalayas. The Siwalik Group, deposited by large river systems analogues to present day rivers running transverse to Himalayas, had its inception in the Middle Miocene (18.3 Ma) that culminated in the Late Pleistocene (0.22 Ma). The Siwalik belt of Jammu province lies between the Indo-Pakistan border in the northwest and Ravi river in the southeast. Detailed geological mapping by the Geological Survey of India (GSI) revealed the presence of a 7000 m thick, nearly complete sequence of Siwalik rocks from Kamlial to Boulder Conglomerate in the southern limb of the Surin–Mastgarh anticline in the Mansar–Uttarbani section of Jammu province¹. Since most of the type sections of Siwaliks are located in Potwar Plateau, Pakistan, the Mansar–Uttarbani section of Jammu, India that exhibits complete sequence of the Siwalik Group is suggested to be used as the reference section for the Siwalik Group in this part of the Indian subcontinent¹⁻³. The Siwalik deposits of Jammu has been classified into different formations and members¹⁻³ and equated with the standard Siwalik sequence exposed in Pakistan (table 1).

Palaeontological prospecting was carried out in Ramnagar area that lies 38 km northeast of Jammu within the southern limb of Udhampur Syncline (figure–1A). The area exhibits excellent development of Mansar Formation of the Lower Siwalik Subgroup. Collection of megafossil remains in the field as well as bulk sampling of sediments for the recovery of microfossils by screen-washing techniques done from gritty brownish-grey sandstone exposed 8 km southwest of Ramnagar and about 0.5 km northeast of village Dehari (figure–1B) resulted in recovery of a rich fossil assemblage comprising of freshwater fishes,

discoglossid frogs, crocodiles, snakes, tragulids, suids, an insectivore, Soricidae and charophytes in addition to molluscs which form the subject of present paper. Based on rodent biochronology the fossil yielding bed at Dehari has been dated to be 14–13 Ma old⁴⁻⁵.

The report on fossil molluscs from the Siwalik deposits is scanty despite the first discovery made by Lydekker from the Siwalik rocks exposed in Yamuna area. The specimen was a gastropod which was assigned to *Paludina dissimilis*⁶. Thereafter, Wadia (in Pascoe⁷) recovered gastropod opercula from the Kamlial Formation exposed southeast of Soan basin in Pakistan. A gastropod opercula collected by Wadia from Lower Siwalik (Chinji) rocks of Palandri, India was described by Prasad⁸. Subsequently, two new species of Unionidae, *Indonaia mittali* and *Lamellidens jammuensis* from the Upper Siwalik beds near Nagrota (J&K) and few unionidae shells from Upper Siwaliks of Khanpur (J&K), were assigned to genus *Parreysia*⁹. In 1930, lamellibranch, *Lamellidens* sp. indet. cf. *L. jammuensis* from the Lower Siwalik deposits of Chinji and Middle Siwalik of Asnot regions of Pakistan were described¹⁰. Lahri (in Fermor¹¹) reported the occurrence of poorly preserved Unio shells at the boundary of Middle-Upper Siwalik at Nandgram and Lahri (in Fermor¹²) reported the occurrence of another Unio bearing horizon near Bhaddi. Vokes¹³⁻¹⁴ described the fossil Unioidae recovered during the two Yale Peabody Museum expeditions to North India from the Tatrot, Dhok Pathan, and Chinji formations exposed near Padhri, Hasnot, Tatrot, Trail and Chinji villages of Pakistan and Khol Tandu and Ramnagar villages of India. The described taxa comprised of *Lamellidens lewisi*, *L. prashadi*, *Indonaia* sp A, and *Parreysia tatrotensis*. Das Hazra (in West¹⁵) added another Lower Siwalik molluscan locality, Thein (India) by recovering some indeterminate *Lamellidens* shells from here. Bhatia and Khosla¹⁶ while describing ostracodes from the Upper Siwaliks of Chotti Parch near Chandigarh made a passing by reference of the presence of

gastropods and bivalves at this locality. In one of the major contribution on molluscs of Siwaliks, fifteen molluscan taxa comprising of bivalves and gastropods from the Pinjor Formation of the Upper Siwalik deposits of Punjab exposed near Chandigarh were described¹⁷.

Several workers¹⁸⁻²¹ listed the presence of fossil molluscs from the Lower and Upper Siwalik deposits of Jammu, India but no description or illustrations were provided by them. *Lamellidens vrendenburgi* and *Scala cf. gajensis* were reported from the Pliocene Tatrot Formation exposed in Saketi, Himachal Pradesh²², whereas five bivalve taxa were reported from the Pinjor Formation, exposed in Haryana²³. From the Churia Group (= Siwalik Group) of Nepal some new forms as well as already known species of bivalves and gastropods were reported²⁴⁻²⁹. Gastropods along with ostracods and charophytes were

recovered from the Pinjor Formation and their palaeobiogeographic and palaeoecologic significance was discussed³⁰. Recently, additional taxa of mollusc from Middle and Upper Siwaliks of Kangra, Ambala, and Ropar was reported and the taxonomic status of the entire Siwalik fossil Mollusca of the Indian subcontinent was revised and compared with the coeval taxa of adjoining areas of Myanmar and Afghanistan in light of modern works on molluscan systematics³¹.

During the course of present work about 20 complete and incomplete shells and several opercula belonging to bivalves and gastropods were recovered from Dehari section, an account of which is presented below. The bivalve shells have been assigned to two different taxa, *Lamellidens* and *Parreysia*, whereas the gastropod shells are identified as those belonging to Thiariidae.

Table-1
Lithostratigraphic Classification of the Siwalik Group in the Jammu region¹⁻³

Sub-Group	Formation	Member	Lithology	Probable equivalents	Age
UPPER SIWALIK	Dughor (76 m)	—	Conglomerate to intermittent layers of friable sandstone and rarely clays, characterized by orange pigment in the matrix	Lower Boulder Conglomerate	Lower Pleistocene
	Uttarbaini (2524 m)	Marikhui (1524 m)	Sandstone and conglomerate with interbeds of clays, laterally grading in to conglomerates	Pinjor	Lower Pleistocene
		Labli (1000 m)	Clay and sandstone alternations with minor conglomerate beds, laterally changing to grey conglomerate, containing lenticular bands of sandstone	Tatrot /Saketi	Upper Pliocene
MIDDLE SIWALIK	Mohargarh (915 m)	—	Predominantly sandstone with minor clay partings	Dhok Pathan	Middle Pliocene
	Dewal (1753 m)	—	Massive, thickly bedded sandstone with subordinate clays	Nagri	Lower Pliocene
LOWER SIWALIK	Mansar (1977 m)	Ramnagar (1498 m)	Clay, mudstone/ claystone, siltstone and sandstone alternations	Chinji	Upper Miocene
		Dodenal (479 m)	Sandstone and siltstone with interbeds of clays and mudstone/ claystone	Kamlial	Middle Miocene

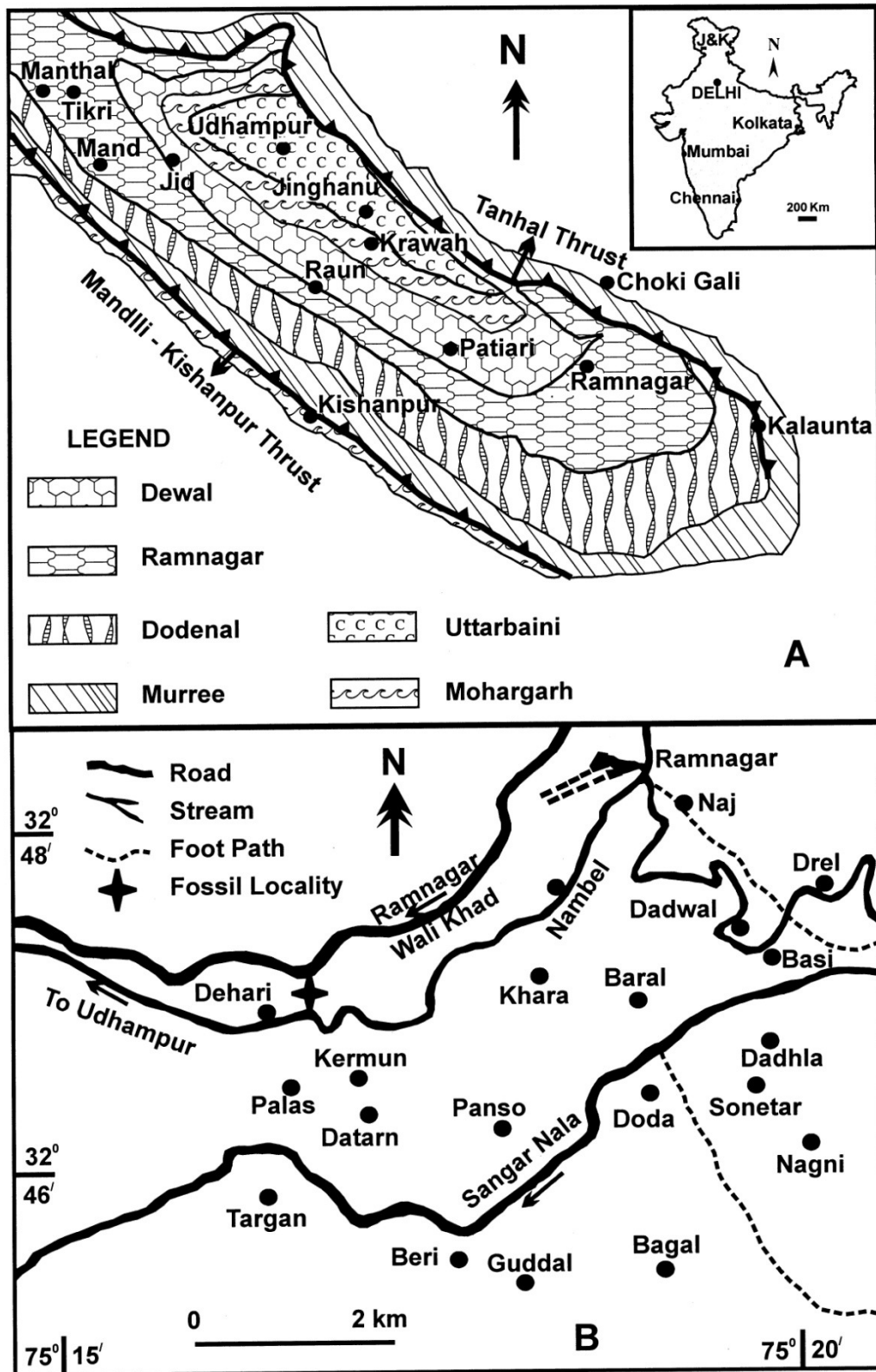


Figure-1

Geological map of Udhampur Syncline (after Gupta & Shali, 1989; Gupta, 2000). B. Location map of the fossil yielding site

Systematic Descriptions

The unionid bivalves are described in accordance with the systematic description of Unionacea followed in the Treatise on Invertebrate Paleontology, Part N, Volume 1, Mollusca 6, Bivalvia, whereas gastropods are described following Bentham³², Wenz (in Schindewolf³³⁻³⁵) and Knight *et al.* (in Moore³⁶).

Phylum Mollusca, Class Bivalvia, Subclass Palaeoheterodonta, Order Unionoida, Superfamily Unionacea, Family Unionidae, Subfamily Unioninae, Genus *Lamellidens* Simpson, 1900, *Lamellidens* indet., (figure–2A-C)

Referred Material: VPL/JU/SB/1-3, three almost completely preserved shells and several fragmentary shells.

Stratigraphic Position: Ramnagar Member of the Mansar Formation, Lower Siwalik Subgroup.

Locality: Near Dehari village, District Udhampur, Jammu and Kashmir State, India.

Description: The shell is elongate, elliptical to subtrapezoidal in shape. It is moderately - sized and equivalve. The umbos are low, weakly inflated, lacking umbonal sculpture. The dorsal margin of the shell is straight medially which continues anteriorly into an anterodorsal notch and grades regularly into a rounded broad anterior margin. Posteriorly, the dorsal margin slopes gently as a sharply rounded narrow posterior margin. The ventral margin is nearly straight to gently arch such that the dorsal and ventral margins of the shell are almost parallel to each other. Prominent growth lines are present on the ventrolateral surface of the shell. The dorsoposterior wing is not prominent and the ridge is low and insignificant.

Specimen	Length	Maximum Height
VPL/JU/SB/1	58 mm	27mm
VPL/JU/SB/2	-	29 mm
VPL/JU/SB/3	57 mm	-

Remarks: The genus *Lamellidens* is characterized by an elongate elliptical shell, medium to large size, anterior margin broadly rounded, posterior margin narrowly so, umbos with not so prominent curved radiating ridges, a well developed dorsoposterior wing, which may be delimited ventrally by a shallow groove or ridge³¹. VPL/JU/SB/1-3 corresponds well to the genus *Lamellidens* in these characters and can be confidently assigned to this genus. However, the morphological characters displayed by the shells recovered from the Ramnagar member of the Mansar Formation (=Lower Siwalik) of Dehari area, Jammu as described above do not agree in totality to those of any of the known *Lamellidens* species. VPL/JU/SB/1-3 is distinguished from *L. lewisi* by its smaller size, straight dorsal margin and presence of anterodorsal notch³¹. *L. proctori* differs from VPL/JU/SB/1-3 on account of possessing prominent dorsal

wing, whereas *L. jammuensis* in addition to the presence of prominent dorsal wing has moderately high ridge and shallow groove³¹. *L. vredenburgi* has broad anterior and posterior margins with a centrally placed umbo³¹ unlike VPL/JU/SB/1-3, which has broader anterior and narrower posterior margins and the umbo is anteriorly placed. VPL/JU/SB/1-3 differs from *L. arungensis* as the shell of the later has larger size, broadly rounded umbos and long and narrow posterior wing²⁷. VPL/JU/SB/1-3 also differs from *L. longiformis*, which is a larger shell with anterior end narrower than posterior end, well developed, high, long, and round-topped posterior ridge, long and narrow posterior wing and a distinct groove separating the wing and the ridge²⁷. The present specimens though closely resemble *L. subparallelus* in most of the characters they differ from the latter in lacking a steeply sloping dorsal margin³¹.

Genus Parreysia: *Parreysia* cf. *Parreysia* (*Parreysia*) *tatrotensis* Vokes, 1936, (figure–2D-F)

Referred Material: VPL/JU/SB/4-5, two almost completely preserved shells and several fragmentary shells.

Stratigraphic Position: Ramnagar Member of the Mansar Formation, Lower Siwalik Subgroup.

Locality: Near Dehari village, District Udhampur, Jammu and Kashmir State, India

Description: The shell is elongate, elliptical or subtrapezoidal and moderately - sized. The umbos are subcentral, little anterior to the middle, moderately inflated with a depression and no umbonal sculpture. The dorsal margin of the shell is slightly convex. Anteriorly the dorsal margin forms anterodorsal angulations and then curves anteriorly to form the anterior margin. The anterior margin is narrow. Posteriorly, the dorsal margin slopes gently in to a broad rounded posterior margin. The ventral margin is arched. Prominent growth lines are present on the entire surface of the shell. The dorsoposterior wing is insignificant and the ridge inconspicuous. The valves are moderately convex.

Specimen	Length	Maximum Height
VPL/JU/SB/4	38 mm	26 mm
VPL/JU/SB/5	32 mm	24 mm

Remarks: The genus *Parreysia* is characterized by a medium to small - sized sub rhomboidal shell, narrow anterior margin, broad posterior margin, umbo with prominent zigzag ribs which usually extend all over the surface and the shell often possessing anterior dorsal and/or posterior dorsal alation³¹. The subgenus *Parreysia* is distinguished by swollen midventral region and strong umbonal structure characterized by ‘V’ shaped central ridges joining at lower points³¹. VPL/JU/SB/4-5 corresponds well to genus *Parreysia* in most of the characters except the absence of ribs on umbo in VPL/JU/SB/4-5. This could be so, since the shells recovered from the Lower Siwalik deposits of

Jammu are poorly preserved. However, VPL/JU/SB/4-5 shells lack characteristic features of subgenus *Parreysia*, viz. absence of swollen midventral region and 'V' shaped ridges. The comparative study of the new material (VPL/JU/SB/4-5) shows it close affinity to *Parreysia (Parreysia) tatrotensis*³¹. VPL/JU/SB/4-5 and *P. (P) tatrotensis* both have same shell dimensions, subtrapezoidal shaped shells with subcentral umbo placed little anterior to midline, narrow anterior margin and broader posterior margin. VPL/JU/SB/4-5 differs from *P. (P) tatrotensis* in lacking umbonal sculpture which can be accounted due to preservation bias, convex dorsal margin rather than straight, presence of only one alation i.e., anterodorsal angulation in VPL/JU/SB/4-5 rather than two i.e. anterodorsal and posterodorsal as in *P. (P) tatrotensis* and in lacking sharply defined ridge in VPL/JU/SB/4-5. *P. (P) edwini* differs from VPL/JU/SB/4-5 as it has 'V' shaped umbonal sculpture, steeply sloping anterior and posterior margins and a prominent ridge³¹. VPL/JU/SB/4-5 differs from *P. (P) chureii* as the later has rounded sub triangular shell, anterior margin broadly rounded and posterior margin nearly vertical²⁹. *P. binaiensis* has a subtrigonal shell, large umbo, regularly rounded anterior margin, nearly straight and short posterior margin and prominent posterior ridge²⁷, which differentiates it from the presently described material. VPL/JU/SB/4-5 differs from *P. zigzagicostata* as the later has rounded trigonal shell, broadly rounded dorsal margin, subtruncated posterior margin and a prominent posterior ridge with wide and slightly concave posterior slope²⁷. Due to poor preservation and paucity of bivalve shells (about 30 complete and incomplete shells representing both species) recovered from the field, specific designation at this juncture would not be justifiable. However, on account of the characters possessed by the two forms, as described above they can be confidently placed as *Lamellidens* indet. (VPL/JU/SB/1-3) and *Parreysia* cf. *Parreysia (Parreysia) tatrotensis* (VPL/JU/SB/4-5), respectively.

Class Gastropoda, Subclass Prosobranchia, Order Mesogastropoda, Family Thiaridae Troschel, 1857, Gen. et sp. indet., (figure-2G-H)

Referred Material: VPL/JU/SG/1-4, four incompletely preserved shells.

Stratigraphic Position: Ramnagar Member of the Mansar Formation, Lower Siwalik Subgroup.

Locality: Near Dehari village, District Udampur, Jammu and Kashmir State, India

Description: The shell is small in size, turreted, with mostly abapical whorls preserved, except in one (VPL/JU/SG/2) which has the apex preserved. In rest of the specimens, the early whorls including the apex are missing, as is the body whorl except in one specimen, VPL/JU/SG/1, which has the body whorl, the shell is dextral (figure-2G-H). The total number of whorls preserved in this specimen is three. Another specimen

VPL/JU/SG/2 has four whorls preserved, but the body whorl is missing. The whorls are oblique and increase in diameter regularly with the body whorl being larger and rounded. The sutures between whorls are shallow but distinct. The whorls are strongly sculptured by thick, vertical axial ribs, more so in the later whorls, especially the body whorl. The aperture is preserved in just one shell (VPL/JU/SG/1). It is medium - sized, elongated, oval in outline with a thin outer lip. The periphery of the shell lacks spines unlike in other Siwalik forms.

Remarks: Thiaridae is a worldwide distributed family and the variability among its genera and species is extremely great. From the Siwalik deposits of the Indian Subcontinent the family has been reported from the Middle and Upper Siwalik deposits of both India and Nepal (Churia Group) represented by three genera. From the Indian Siwaliks the presence of the family Thiaridae during Middle and Upper Siwalik times represented by *Melanoides tuberculata* has been documented by^{17,31}. In the Nepalese Siwalik deposits the family is better represented. The Thiaridae taxa recovered are *Melanoides* cf. *tuberculata*, *Brotia palaeocostula*, *Brotia* sp. indet. A, *Brotia* sp. indet. B, and *Brotia* sp. indet. C²⁸ and *Melanoides* cf. *tuberculata*, *Brotia dobataensis*, and *Paludomus suraiensis*²⁹. VPL/JU/SG/1-4 differs from all these forms. *Melanoides* shell whorls increase in diameter gradually and the body whorl is small. The whorls are sculptured with spiral ridges and obtuse ribs. In the later whorls, the ribs are formed into rows of tubercles^{17, 28-29,31}. All these features are absent in VPL/JU/SG/1-4. The shell of *Brotia* in turn has banded, belt like suture marked with spiral and axial ridges. In the later whorls of the genus the axial ridges bear blunt spines just above the periphery²⁸⁻²⁹. VPL/JU/SG/1-4 lacks all these characters. VPL/JU/SG/1-4 differs from *Paludomus*, as the shell surface of *Paludomus* bears regular, fine spiral grooves with prominent subsutural spiral groove below shallow suture, with much of the shell being smooth²⁹. Moreover, the shells recovered from the Lower Siwalik deposits of Jammu are smaller in size than all the known Siwalik forms of Thiaridae. Since the new material from Jammu display considerable differences from the known Thiaridae taxa reported from Siwaliks, their referral to any of these genera or species will be incorrect. Even proposing a new genus or species for this material would be premature as the shells recovered are few in number, (only four) and incompletely and poorly preserved. However, based on the shell characters as discussed above VPL/JU/SG/1-4 can be confidently placed in the family Thiaridae.

Order Mesogastropoda Thiele, 1929, Family indet., Gen. et sp. indet, (figure-2I-N).

Referred Material: Several uncatalogued fragmentary and poorly preserved gastropod shells and several well preserved opercula.

Stratigraphic Position: Ramnagar Member of the Mansar Formation, Lower Siwalik Subgroup.

Locality: Near Dehari village, District Udhampur, Jammu and Kashmir State, India

Description: The gastropod shells (figure– 2I-J) recovered from the Dehari section are poorly preserved and incomplete. On the contrary the opercula (figure–2K-N) are well preserved. Some of the shells are long, cylindrical with a blunt apex. Others are small, ovoid conical, with whorls increasing gradually in width and comparatively less so in height. All the opercula are similar in morphology, having an elongate ovoid shape with the lower margin of the opercula regularly rounded and the upper margin narrowly rounded. The nucleus is large, subcentral, situated towards the inner margin of the opercula and is surrounded by concentric growth lines. The outer surface of the opercula is convex medially with its margin flat, thick and broad peripherally.

Remarks: The characters of the shell as described above have resemblances to genus *Gulella* and *Gastrocopta* described and illustrated by Bhatia and Mathur¹⁷ from terrace deposits of Punjab, India. However, due to incomplete nature of the shells their assignment even at familial level cannot be stated

confidently. The opercula on the other hand though better preserved and abundant are not of great significance in establishing genera or species. Three reports dealing with opercula from the Siwalik deposits of the Indian subcontinent exist in literature. Prasad⁸ described a gastropod operculum from the Lower Siwalik, Chinji Formation of Palandri area and erected a new species, *Pachylabra prisca*, based on the opercula. The operculum of *Pachylabra prisca* is concentric, patelliform with a pyriform shape and is large and differs from opercula recovered from Lower Siwalik deposits of Dehari in all these features. Opercula of *Pila* sp. indet. and *Bithynia* sp. indet. in brief has been described from Nepalese Siwaliks²⁸⁻²⁹. The operculum of *Pila* sp. indet. is pyriform in shape with a small nucleus and a slightly thickened rim²⁸⁻²⁹, whereas the opercula of *Bithynia* sp. indet. is ovoidal in shape, concentric with large subcentral nucleus and a flattened border on the outer margin with raised rim²⁸. The opercula discussed in the present work differ from those of *Pila* and *Bithynia* in their morphology. As stated above taxonomic identification of fauna based upon opercula is not reliable, hence the opercula are simply referred to the order Mesogastropoda.

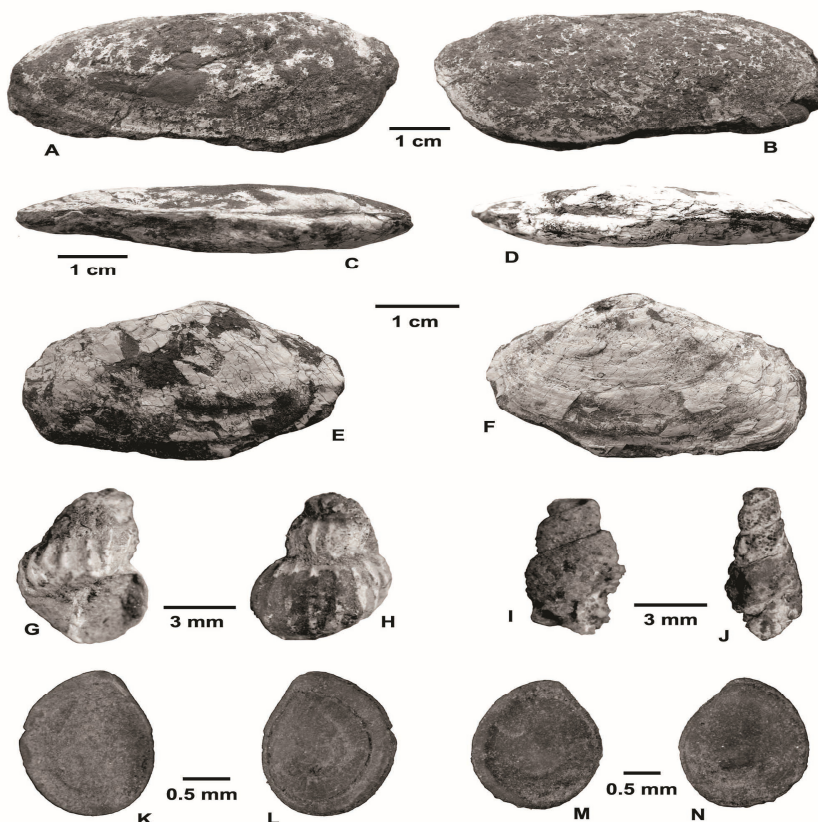


Figure 2

A-C. Shells of *Lamellidens* indet. **A-B.** VPL/JU/SB/1 **A.** Right valve. **B.** Left valve. Scale bar same for figures A-B. **C.** VPL/JU/SB/3 Dorsal view. **D-F.** Shells of *Parreysia* cf. *Parreysia* (*Parreysia*) *tatrotensis* VPL/JU/SB/4 **D.** Dorsal view. **E.** Right valve. **F.** Left valve. Scale bar same for figures D-F. **G-H.** Shells of Thiariidae indet. VPL/JU/SG/1 **G.** Apertural view. **H.** Adapertural view. Scale bar same for figures G-H. **I-J.** Shells of Mesogastropoda in side view. Scale bar same for figures I-J. **K-N.** Operculum of Mesogastropoda. **K** and **M** outer view. **L** and **N** inner view. Scale bar same for figures K-L; M-N

Conclusion

Until now the presence of molluscs in the Lower Siwalik deposits of Jammu province was almost unknown. Besides being enlisted in some faunal lists they have never been described or illustrated. Moreover, as no record was kept about the exact horizon or even the locality by early prospectors that yielded fossil remains, the spatial or temporal details of such material is always questionable. In the present work molluscan remains recovered from gritty brownish-grey sandstone bed Near Dehari village that forms part of the Ramnagar Member of the Mansar Formation (equivalent of Lower Siwalik Chinji Formation of Pakistan), dated at 14–13 Ma based on rodent biochronology⁴⁻⁵ have been described and illustrated for the first time. The molluscs are represented by shell remains of *Lamellidens* indet., *Parreysia* cf. *Parreysia* (*Parreysia*) *tatrotensis* (bivalves) and Thiaridae gen. et sp. indet. and unidentified shells and opercula of Mesogastropoda (gastropods). Though the taxa recovered are meager nonetheless their presence is significant as they have never been reported from the study area earlier and also throws insight in to Lower Siwalik palaeoenvironment of Jammu region. The recovered taxa is found living in low-energy environment ranging from pond, marsh, lacustrine, to margins of slow flowing river and prefer warmer and humid subtropical to tropical living conditions. Their presence in the study area further strengthens the freshwater nature of the Siwalik deposits and also attests to prevalence of warm and moist conditions during Lower Siwalik times as depicted by fossil remains of other flora and fauna.

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