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First Fossil Discoglossinae (Anura) from the Siwaliks of the Indian Subcontinent

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Abstract

A fossil amphibian, Discoglossinae indet. is described from the Middle Miocene Lower Siwalik deposits exposed near Ramnagar town in Jammu and Kashmir. Discoglossinae indet. is reported for the first time not only from the Lower Siwalik deposits of Jammu but from the entire Siwalik Group of the Indian subcontinent.

Keywords: Middle miocene, lower siwalik, anura, Jammu, India.

Introduction

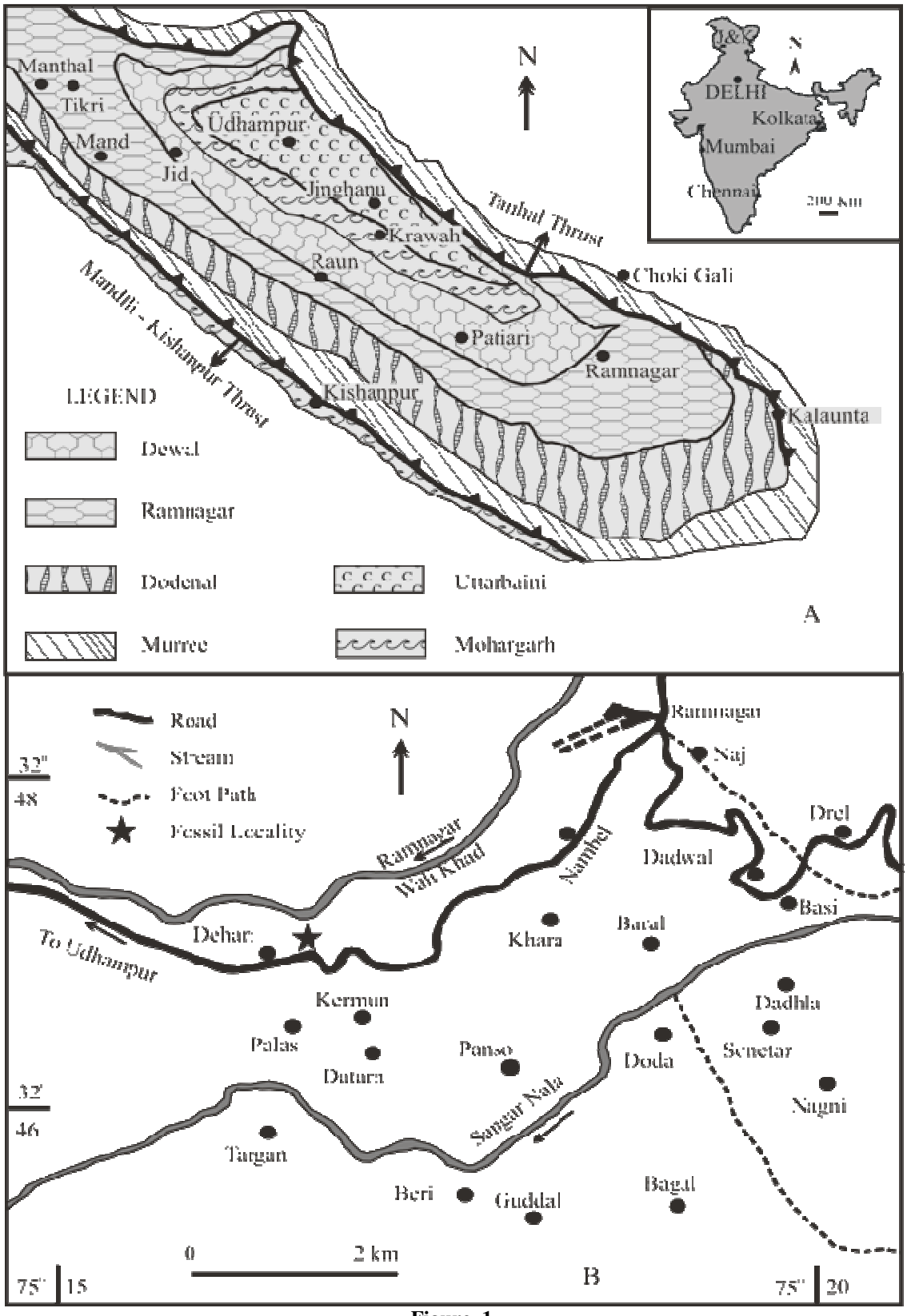
The Himalayan orogenic belt is the result of collision of the Indian and the Eurasian plates. It represents at least five phases of upliftment. The Himalayan foreland basin is the southernmost and last phase of the upliftment. It is an area of active sedimentation in which sediments eroded and transported from the Himalayan uplift had accumulated for the last 55 million annum (Ma). The sedimentary sequence of the foreland basin spans from Palaeogene to Quaternary and has a thickness of more than 10 km. The Neogene to Quaternary sedimentary deposits of the foreland basin have largely been designated as Siwaliks. This continental, orogenic (Molassic) Siwalik deposit had its inception in the Middle Miocene and culminated in Late Pleistocene. The Siwalik rocks extend throughout a linear belt along the Himalayan foothills between river Indus in the west and the Brahmputra gorge in the east.

A complete succession of the Siwalik Group is exposed in the southern limb of Udhampur Syncline in Kishanpur–Raun–Jinghanu section west of Ramnagar, District Udhampur, Jammu and Kashmir State[1-2] as shown in figure–1A. The area exhibits excellent development of Mansar Formation of the Lower Siwalik Subgroup. The Mansar Formation comprises of two members, the lower Dodenal Member and the upper Ramnagar Member[2]. The Ramnagar Member named after the Ramnagar town that lies 38 km northeast of Jammu has been equated with the Lower Siwalik Chinji deposits of Pakistan[2-4]. Based on rodent biochronology an age of 13.8–13.2 Ma has been assigned to the rocks occurring in the vicinity of Ramnagar[5-7]. The Ramnagar Member is dominantly argillaceous with brown, orange, red clay; claystone; siltstone; fine to medium grained, grey, greyish-green, brown, sandstone[2].

Palaeontological prospecting was carried out in Ramnagar area. Samples of gritty brownish-grey sandstone exposed 8 km southwest of Ramnagar town and about 0.5 km northeast of village Dehari as shown in figure–1B were screen-washed in bulk for the recovery of microfossils. The sample yielded isolated dental, cranial and post cranial fossil remains of freshwater fishes, crocodiles, snakes, insectivores, rodent, shells of molluscs and gyrogonite of charophytes in addition to the iliac remains of a discoglossid frog which form the subject of the present paper. The fossil fishes and molluscs have already been reported from the Dehari site[8-9].

Material and Methods

About 200 kg of rock sample from Dehari site was collected for processing. The sample was then macerated employing oil-water immersion method in the laboratory at University of Jammu. In this method the rock sample was broken into fragments of a few centimeters and were first dried in sun to evaporate moisture and then dried in oven to remove the intragranular moisture. The samples so dried were then soaked in kerosene oil for about 3-4 hours in plastic tubs, where after the kerosene was decanted and water was added to the sample and was left for about 2 hours. Because of the difference of specific gravity of water and oil, the water forces its way in to the sample and expels the kerosene oil out. This forceful intrusion of water in to the sample and expelling out of oil results in an agitation, which brings in the disintegration of rock samples into mud slurry. Thereafter the sample was washed under running water using sieve. The residue left after screen washing was dried in sun and was sieved through sieves of different mesh size. The dried sample was then sorted under CENSICO stereoscopic zoom binocular microscope DZ-240, which resulted in recovery of microfossils, including the anuran specimen being described here. The specimens described in this paper are housed in the Vertebrate Palaeontology Laboratory of the Department of Geology, University of Jammu, Jammu, under the acronym VPL/JU/SA (Vertebrate Palaeontology Laboratory, Jammu University, Siwalik Amphibians). The photomicrographs of the fossil specimen were taken and line drawings were made using Nikon Stereoscopic Microscope SMZ 1500 attached with a drawing tube.



Figure–1
A. Geological map of Udhampur Syncline (after Gupta & Shali, 1989; Gupta, 2000). B. Location map of the fossil yielding site

Systematic Descriptions:

Class	*Amphibia*
Superorder	*Lissamphibia*
Order	*Anura*
Family	*Discoglossidae*
Subfamily	*Discoglossinae*

Gen. et sp. indet., (figure–2A-L)

Referred Material: VPL/JU/SA/1-4, four almost complete ilia.

Stratigraphic Position and Age: Ramnagar Member of the Mansar Formation of Lower Siwalik Subgroup, Middle Miocene (13.8-13.2 Ma) in age.

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

Description: The specimens represent almost complete proximal half of the frog ilia, with only the posterior parts of the pars ascendens and pars descendens and the distal part of the iliac shaft missing. Acetabular region is broad that tapers anteriorly. The acetabulum is fairly large and hemicircular. It has a flared ventral rim and markedly extends ventrally thereby concealing most of the ventral acetabular area. The acetabular region grades smoothly into the iliac blade, which is less than one half the bone's width. The iliac shaft is provided with a well–demarcated narrow dorsal crest (crista dorsalis) that thickens posteriorly to form the dorsal prominence–dorsal tubercle complex. The dorsal crest is moderately high and curves slightly inwards anteriorly. A longitudinal, shallow groove is present between the iliac blade and the dorsal crest in lateral view. The dorsal prominence-dorsal protuberance complex is well developed and externo–laterally oriented. The dorsal prominence is located anterior to the dorsal border of the acetabulum and is as high as long with a rounded triangular shape. The dorsal prominence is swollen and thus clearly separated from the dorsal crest and projects above it markedly. The dorsal prominence slopes gently into the supraacetabular region. The anterior slope of dorsal prominence is slightly steeper than the posterior slope. The dorsal margin of dorsal prominence protrudes into a dorsal tubercle (tuber superius) that extends beyond the dorsal margin of the bone and is deflected medially. The supraacetabular (pars ascendens) and subacetabular (par descendens) areas are distinct. Though incomplete, it seems that the supraacetabular and subacetabular processes were moderately developed. Two of the better-preserved specimens (VPL/JU/SA/1 and 3) bear a supraacetabular fossa on the posterodorsal margin of the pars ascendens. The par descendens is not broad and lacks a preacetabular fossa. The medial face is high at the center and slopes gently towards dorsal and ventral margins. The slope is more towards the posterior region of the ilia.

Results and Discussion

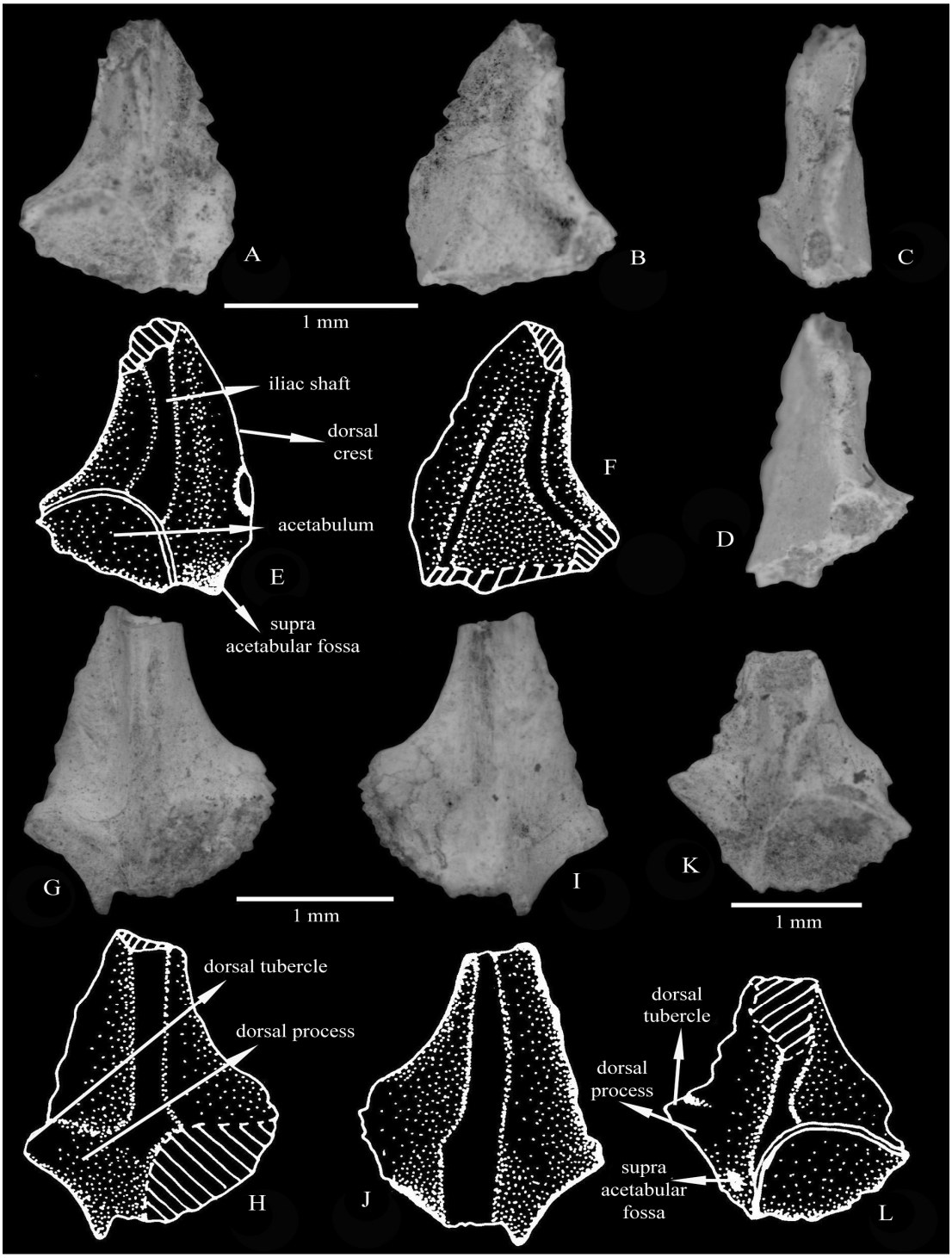
Ilia are the most common skeletal elements used in the diagnosis of anuran taxa. Widely used characters are presence and absence of dorsal crest; the shape of the iliac blade and its relationship to acetabular region; the presence, size and position of tuber superior and/or dorsal prominence; the relative sizes of the pars ascendens and pars descendens; the degree of expansion of the acetabular rim; the presence or absence of a supraacetabular fossa; and the presence or absence, size, and position of the interiliac tuberosity[10].

Roček and Rage[11] summarizing the Tertiary Anuran fauna of Europe, Asia, Africa, North America and Australia documented the presence of Discoglossidae ? (from early Miocene of Thailand and upper Miocene of Afghanistan), Palaeobatrachidae (from early Miocene of Turkey), Pelobatidae (from lower and middle Oligocene of Kazakhstan and Mongolia, and early-middle Miocene and lower Pleistocene of Turkey), Scaphiopodidae (from middle Oligocene of Mongolia, and middle Miocene of China), Bufonidae (from middle Oligocene, early Miocene and middle Miocene of Kazakhstan, early Miocene and lower pleistocene of Turkey, middle Miocene of China and upper Pliocene of Mongolia), Ranidae (from middle Oligocene of Kazakhstan, early Miocene of Thailand, early-middle Miocene and lower Pleistocene of Turkey, middle Paleocene of China, Pliocene of Azerbaydzhan, upper Miocene of Afghanistan and upper Pliocene of India) and Myobatrachidae ? (from Paleocene ? of India) from the Tertiaries of Asia.

The ilia studied under the present work have been compared with the forms found in Asia. Pelobatidae lacks dorsal crest and dorsal tuberosity unlike VPL/JU/SA/1-4, which has well-developed dorsal crest and dorsal tuberosity. VPL/JU/SA/1-4 differs from the ilia of Bufonidae as they too lack a dorsal crest and in addition frequently possesses a vertical groove on the dorsal protuberence that is lacking in any of the ilia recovered from the Lower Siwalik deposits of Jammu. The Palaeobatrachidae ilia posses a dorsal crest as do VPL/JU/SA/1-4 but they differ from the later on account of absence of supraacetabular fossa, division of tuber superius into two regions and supra and subacetabular regions, which are positioned nearly symmetrically in relation to centrally placed acetabular fossa. Roček[12-13] referred Scaphiopinae to Scaphiopodidae a taxon which was previously included within the Pelobatidae. The new family was based on anatomical and paleogeographic data viz. large size, well-developed columella, paired frontoparietal, uncoalesced sacral and urostyle, urostyle with a single condyle and ossified pubis. The ilia resemble those of pelobatids in lacking a dorsal crest and dorsal tuberosity and thus differ from the present ilia. The subfamily Myobatrachinae was placed within Leptodactylidae by Lynch[14], a view corroborated by Špinar and Hadrová[15-16].

Myobatrachinae characterized by reduced transverse processes of the presacral vertebrae and the presence of free intervertebral discs has been proposed as family Myobatrachidae[11]. However this referral is not well established and as such Myobatrachinae is often considered as Leptodactylid. Though the observable

features of the ilia recovered from Jammu Siwaliks are consistent with the Discoglossidae, Ranidae and Leptodactylid, they have been assigned to Discoglossidae because of the following reasons. In Leptodactylide, the tuber superius steeply descends into supraacetabular expansion and the acetabulum is large concealing most of the preacetabular region, which is not so in VPL/JU/SA/1-4 ilia.



Figure–2

A-L. Ilia of Discoglossinae indet. A-F. VPL/JU/SA/1; G-J. VPL/JU/SA/2; K-L. VPL/JU/SA/3. A,G,K lateral views; B,I medial views; C dorsal view; D ventral view. E,F,G,H,J,L are line drawings of A,B,G,I,K. Scale bar same for figures A-F; G-J; K-L

To our knowledge, only two reports of Amphibia exist in literature from the Siwalik deposits of the Indian subcontinent. Raghavan[17] reported the maxillae of an indeterminate species of *Rana* similar to modern taxa from Upper Pliocene deposits of the basal Pinjor Formation (Upper Siwalik) exposed near Chandigarh. Rage *et al*.[18] recovered vertebrae and ilia from the Upper Siwalik deposits (Upper Pliocene in age) exposed near village Dhami and Balli, Jammu. They assigned these ilia to ?Ranidae. In Ranidae dorsal crest is prominent and broad, the dorsal prominence slopes abruptly into the dorsal acetabular expansion and the tuber superius is not prominent. VPL/JU/SA/1-4 ilia have a narrow dorsal crest as compared to the ilia referred to ? Ranidae[18] from the Upper Siwalik deposits of Jammu and as such VPL/JU/SA/1-4 ilia cannot be assigned to Ranidae. VPL/JU/SA/1-4 ilia compare well with the ilia of Discoglossidae on account of presence of dorsal crest, prominent dorsal tubercle and small subacetabular expansion. In recent classification the discoglossids are placed in a single family taken to comprise the extant genera *Discoglossus*, *Balaeophryne*, *Barbourula, Alytes* and *Bombina* together with a series of fossil forms including *Eodiscoglosssus*, *Paradiscoglossus*, *Scotiophryne*[19-22] or as distinct subfamilies as Alytinae (the living *Alytes*), Bombinatorinae (the living *Bombina* and *Barbourula*), Discoglossinae (the living *Discoglossus* and a series of referred fossil taxa including *Eodiscoglossus*, *Latonia*, *Paradiscoglossus* and *Wealdenbatrachus*) and less certainly Gobiatinae (Late Cretaceous frogs from Asia)[10,23] within the family Discoglossidae. The *Enneabatrachus* and *Scotiophryne* are of uncertain position[3]. According to Lynch[19], Duellman and Trueb[20] and Gao and Wang[24] the Discoglossidae are monophyletic whereas, Ford and Cannatella[25] consider Discoglossidae as paraphyletic represented by Bombinatoridae and Discoglossidae.

Following Sanchíz's classification[10], the ilia recovered from the Lower Siwalik deposits of Jammu are assigned to the subfamily Discoglossinae on account of overall morphological similarities between the two viz., relatively small subacetabular region, nearly circular acetabular fossa and relatively high dorsal crest. The Jammu ilia differ from Bombinatorinae, Alytinae and Gobiatinae in having a prominent iliac crest. Unfortunately all the four ilia are incomplete and it is not possible to determine whether the supraacetabular process was long, as well as whether interiliac tubercle was present or not. Moreover the ilia show a matrix of characters, which do not correspond to any one known form of Discoglossinae. As such their referral at generic level is not possible with the current state of knowledge but they are consistent with the subfamily Discoglossinae.

The surviving members of the family discoglossidae are largely endemic to Europe[26] however, three species of discoglossidae are known from northwest Africa[26] and a species from Israel[27]. The presence of discoglossidae in the Lower Siwalik deposits of the study area suggests there was a wider geographic distribution of the discoglossidae in the past.

Conclusion

The fossil record of the amphibians from the Siwalik Group is the poorest among the vertebrates. Until now only two reports on Siwalik frogs exists in literature. One is of an indeterminate species of *Rana* from the Upper Pliocene Pinjor Formation near Chandigarh[17] whereas the other is of ?Ranidae described from the Upper Pliocene, Upper Siwalik Subgroup of Jammu[18]. The present find comes from a gritty brownish-grey sandstone bed Near Dehari village that forms part of the Middle Miocene Ramnagar Member of the Mansar Formation dated at 13.8–13.2 Ma based on rodent biochronology[5-7] and thus represents the oldest and the first report of discoglossid frogs from the Siwalik strata of the Indian subcontinent. The present find of discoglossidae too shows its spatial range extend up to India during the Middle Miocene times.

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