Journal of Human Evolution 102 (2017) 21–41

Contents lists available at ScienceDirect

Journal of Human Evolution

journal homepage: www.elsevier.com/locate/jhevol

# New sivaladapid primate from Lower Siwalik deposits surrounding Ramnagar (Jammu and Kashmir State), India

Christopher C. Gilbert [a, b, c, *], Biren A. Patel [d, e], N. Premjit Singh [f], Christopher J. Campisano [g, h], John G. Fleagle [i], Kathleen L. Rust [a], Rajeev Patnaik [f]

[a] Department of Anthropology, Hunter College of the City University of New York, 695 Park Avenue, New York, NY 10065, USA
[b] PhD Programs in Anthropology and Biology, Graduate Center of the City University of New York, 365 Fifth Avenue, NY 10016, USA
[c] New York Consortium in Evolutionary Primatology, New York, NY, USA
[d] Department of Cell and Neurobiology, Keck School of Medicine, University of Southern California, Los Angeles, CA 90033, USA
[e] Human and Evolutionary Biology Section, Department of Biological Sciences, University of Southern California, Los Angeles, CA 90089, USA
[f] Department of Geology, Panjab University, Chandigarh, 160 014, India
[g] School of Human Evolution and Social Change, Arizona State University, Tempe, AZ 85287, USA
[h] Institute of Human Origins, Arizona State University, Tempe, AZ 85287, USA
[i] Department of Anatomical Sciences, Stony Brook University, Stony Brook, NY 11794, USA

ARTICLE INFO

*Article history:*
Received 16 March 2016
Accepted 11 October 2016

*Keywords:*
*Ramadapis sahnii*
*Sivaladapis*
*Indraloris*
Chinji
Sunetar
Miocene

ABSTRACT

Over the past century, numerous vertebrate fossils collected near the town of Ramnagar, India, have proven to be important for understanding the evolution and biogeography of many mammalian groups. Primates from Ramnagar, though rare, include a number of hominoid specimens attributable to *Sivapithecus*, as well as a single published mandibular fragment preserving the $P_4$-$M_1$ of the Miocene adapoid *Sivaladapis palaeindicus*. Since 2010, we have renewed fossil prospecting in the Lower Siwalik deposits near Ramnagar in an attempt to better understand the evolution, biogeographic timing, and paleoclimatic context of mammalian radiations in Asia, with a particular focus on primates. Our explorations have resulted in the identification of new fossil localities, including the site of Sunetar. The age of Sunetar and the Ramnagar region, in general, is tentatively dated between 14 and 11 Ma. In 2014, a partial right mandible of a sivaladapid primate was recovered at Sunetar, preserving the corpus with $P_4$ roots and worn $M_1$-$M_3$ dentition. Although sivaladapids are known by numerous specimens of two genera (*Sivaladapis* and *Indraloris*) at Lower Siwalik sites on the Potwar Plateau (Pakistan) and at the Middle Siwalik locality of Haritalyangar (India), this new specimen is just the second sivaladapid recovered from the Ramnagar region. Our analyses suggest that the new specimen is distinct from all other sivaladapids, and we therefore describe it as a new genus and species close to the base of the Sivaladapinae.



## 1. Introduction

Fossiliferous deposits in the Siwalik Hills surrounding the town of Ramnagar (Jammu and Kashmir State), India, have been known to paleontologists for almost a century (Brown et al., 1924; Pilgrim, 1927; Vasishat et al., 1978). In fact, the earliest published records documenting systematic collection of material from the area derive from the Barnum Brown American Museum of Natural History Expedition, 1921–1923. Brown was tipped off to the potential of the Ramnagar area in 1922 by Charles Middlemiss, a prominent geologist and Superintendent of the Mineral Survey in the state of Jammu and Kashmir at the time (Brown, 1922; Fermor, 1945). Middlemiss also collected in the area himself, recovering a hominoid partial mandible later described by Pilgrim (1927) as *Sivapithecus middlemissi* in his honor. How and when Middlemiss came to know of the fossiliferous deposits surrounding Ramnagar is not published, but since he worked extensively in Jammu and Kashmir beginning in 1908 (Fermor, 1945), and was Superintendent beginning in 1917, it is likely that he was generally aware of the area before 1922, and it is also possible that other paleontologists (amateur or otherwise) collected there even earlier.

Brown published the first primate from Ramnagar, a hominoid partial jaw named *Dryopithecus pilgrimi* (Brown et al., 1924), now recognized (along with all other hominoid specimens from the

* Corresponding author.
*E-mail address:* cgilbert@hunter.cuny.edu (C.C. Gilbert).

http://dx.doi.org/10.1016/j.jhevol.2016.10.001
0047-2484/

Ramnagar region) as *Sivapithecus indicus* (Kelley, 2002, 2005). Brown et al. (1924), as well as later authors (e.g., Pilgrim, 1927; Colbert, 1935; Gregory et al., 1938), suggested the area and its fauna correlated well with the better-known Lower Siwaliks Chinji Formation fauna in the Salt Range region of the Indian Potwar Plateau, now in Pakistan. Collection in the Ramnagar area has persisted on and off since Brown's expedition, with notable faunal studies by Vasishat et al. (1978), Gaur and Chopra (1983), Nanda and Sehgal (1993), and Basu (2004) confirming a correlation with the classic Chinji fauna in Pakistan and again indicating a Lower Siwalik age for the area. More recent studies have reported the presence of rodent taxa possibly suggesting a more specific Lower Chinji age for the Ramnagar deposits, ~12.7–14 Ma (Parmar and Prasad, 2006; Sehgal and Patnaik, 2012; Patnaik, 2013; Gilbert et al., 2014; Parmar et al., 2016). However, these estimates remain to be confirmed by more complete specimens and a better understanding of Ramnagar chronostratigraphy.

Since the early 20th century (e.g., Brown et al., 1924; Pilgrim, 1927; Gregory et al., 1938), numerous additional hominoid specimens from the Ramnagar region have been recovered, mostly consisting of isolated teeth (Kelley, 2002, 2005). Thomas and Verma (1979) reported on the only other primate found in the area, a partial lower jaw preserving $P_4$-$M_1$ of the sivaladapid adapoid *Sivaladapis palaeindicus*, discovered at a locality ~2.5 km southeast of Ramnagar (Fig. 1). Since then, no new fossils definitively expanding the known primate taxonomic diversity at Ramnagar beyond *S. indicus* and *S. palaeindicus* have been found.

In 2010, we renewed fossil prospecting and collecting in the Lower Siwalik deposits surrounding Ramnagar in an attempt to better understand the evolution, biogeography, timing, and paleoclimatic context of mammalian radiations in Asia, with a particular focus on primates and the chronology of the Ramnagar region. Between 2010 and 2015, we conducted six field seasons in the area, each approximately 10–15 days in length. To date, our explorations have resulted in the identification of new fossil localities in the Ramnagar area (Fig. 1; see also Gilbert et al., 2014) and the extension and clarification of the existing stratigraphic framework of the area (e.g., Basu, 2004). In October 2014, a partial mandible of a sivaladapid primate was recovered by one of the authors (NPS) at the site of Sunetar (Fig. 1). This specimen, VPL/RSP1 (Vertebrate Paleontology Laboratory, Panjab University Department of Geology/Ramnagar Sunetar Primate 1), preserves the right mandibular corpus under $P_4$-$M_3$ with $P_4$ roots and worn $M_1$-$M_3$ dentition. Although sivaladapids are known by numerous specimens of at least two genera (*Sivaladapis* and *Indraloris*) at Lower Siwalik sites on the Potwar Plateau and at the Middle Siwalik locality of Haritalyangar, this new specimen is just the second known sivaladapid primate from the Ramnagar region. Based on comparisons with other known sivaladapid taxa, we describe this specimen here as a new genus and species. Our analyses suggest that this new sivaladapid taxon may lie near the ancestry of the other two Siwalik genera, *Indraloris* and *Sivaladapis*, and thus provide evidence of a diverse sivaladapine clade in the Mid-Late Miocene of South Asia.

### 1.1. Geological context

The Siwalik Group of rocks, almost 7000 m in thickness, are exposed along the southern limb of the Suruin-Mastgarh anticline in the Mansar-Uttarbani section, Jammu District (Gupta and Verma, 1988). These deposits comprise the Mansar (Lower Siwalik), Dewal and Mohargarh (Middle Siwalik), and Uttarbaini and Dughor (Upper Siwalik) Formations (Fig. 1). The Mansar Formation is further divided into the lower Dodenal and the upper Ramnagar Members (Gupta, 1997, 2000). The Dodenal Member is characterized by the presence of thick massive sandstones, whereas the Ramnagar Member preserves thick mudstones and paleosols alternating with intraformational sandstones. The Ramnagar Member sequence that forms a part of the southern limb of the Udhampur Syncline can be best seen around the town of Ramnagar, situated approximately 38 km northeast of Jammu. Basu (2004) recognized 10 reference sandstones (A–J, youngest to oldest) in the upper 350 m of the Ramnagar Member to provide a temporal-spatial context for almost all of the fossil localities in the area. The Sunetar site complex lies in the vicinity of where Basu (2004) marked the location of reference sandstone H (just below midway in the sequence) and we had

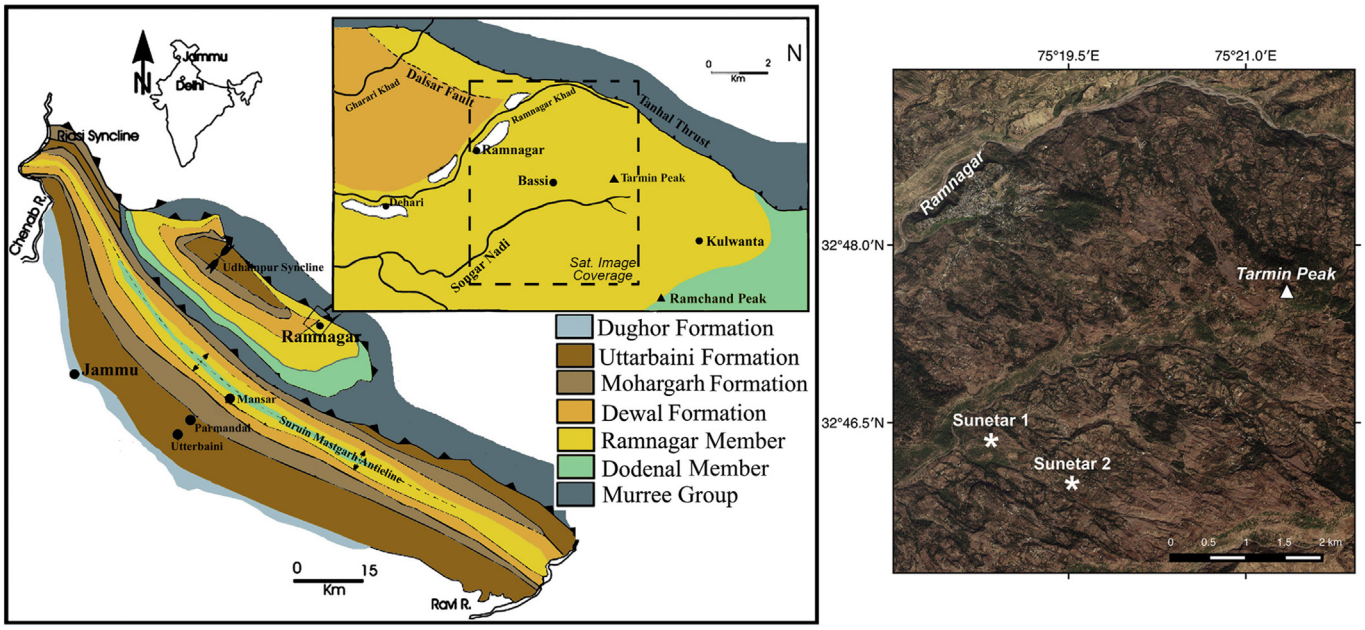


**Figure 1.** Left: General geological map of the Siwalik Group surrounding Ramnagar. Right: Close-up satellite imagery (GeoEye-1) of the Ramnagar region (corresponding to the dashed zone in insert of the geological map). Specimen VPL/RSP1 comes from the locality Sunetar 2. The previous sivaladapid specimen was reported to have been found ~2.5 km SE of Ramnagar, but no additional information was given (Thomas and Verma, 1979).