



Research Article

Description of *Gazella* sp. from the Middle Miocene Siwaliks of Punjab, Pakistan

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Article History

Received: March 01, 2018

Revised: July 27, 2018

Accepted: August 04, 2018

Published: November 13, 2018

Authors' Contributions

AR discovered, identified and processed the samples. RMA improved the manuscript. AI did systematic paleontology and identification of samples. AMK supervised the research and wrote the manuscript.

Keywords

Antilopini, Bovids, Migrations, Pakistan.

Abstract | The fossil material of *Gazella* sp. from the Chinji Formation, Chakwal District, Pakistan, is described and discussed in this paper. The dental remains comprise isolated upper and lower molars. The antilopine genus *Gazella* has great diversity from Middle Miocene to Pliocene from Africa to Eurasia. The morphological characteristics indicate this genus as a conservative bovid with simple morphology.

To cite this article: Rafah, A., Ahmad, R.M., Iqbal, A. and Khan, A.M., 2018. Description of *Gazella* sp. from the middle Miocene Siwaliks of Punjab, Pakistan. *Punjab Univ. J. Zool.*, **33(2)**: 127-131. <http://dx.doi.org/10.17582/pujz/2018.33.2.127.131>

Introduction

Antilopinae is an extinct subfamily which is divided into tribe Neotargini and Antilopini. According to Gentry (1992), Neotargini is a small group that diverged from African antelopes, among which Antilopini developed. Antilopines are a major group of diversified Siwalik ungulates and are richly represented by the genus *Gazella*. The earliest record of *Gazella* sp. is from the Algerian Middle Miocene (Arambourg, 1959; Gentry, 1970, 2010). The great diversity of this genus is recorded from the Middle Miocene to early Pliocene, and from a wide variety of localities in China, Spain and South Africa (Pilgrim, 1937, 1939; Moya-Sola, 1983; Thomas, 1984; Chen, 1997; Bibi et al., 2009; Khan, 2008; Khan et al., 2012). The temporal range of *Gazella* sp. in the Siwaliks Middle Miocene

is recorded from 13.2-12.0 Ma (Gentry et al., 2014). According to Gentry (1999) and Kostopoulos (2009), the species level variety of this genus declined in the Asian region during the Pliocene due to cooler and unpredictable climatic conditions of this epoch but the genus maintained its survival in Africa and Middle East region during this interval.

Dhok Bun Ameer Khatoon is a fossil area that comprises five Siwalik formations i.e. Kamlial, Chinji, Nagri, Dhok Pathan and Soan. The Chinji Formation fossil site is located in Chakwal District (32° 47' 26.4" N 72° 55' 35.7" E) Punjab, Pakistan. The Chinji section lithology is identified by red-brown mudstone and common grey sandstone interbeds. According to Barry et al. (2002) and Cheema (2003), the fluvial deposits in these localities are mainly filled by sedimentary rocks in an unweathered condition.

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Materials and Methods

The studied specimens have been collected from Middle Miocene locality; Dhok Bun Ameer Khatoon. The collected sample were carefully transferred to the Paleontology Laboratory and cleaned well by washing the samples and removing sediments from them. The catalogue numbers are assigned to these fossils starting with abbreviation PUPC (Punjab University Paleontological Collection). The denominator consists of yearly catalogue number (year in which collection was made) and numerator donates the serial catalogue number (serial number of the specimen in that year). The specimens have been housed in the Paleontology Laboratory of Department of Zoology, University of the Punjab, Lahore. The samples were identified on the

basis of their morphometric analysis and comparison with the available literature. The measurements were made in mm using Vernier callipers.

Systematic palaeontology

Family Bovidae Gray, 1821
Subfamily Bovinae Gray, 1821
Tribe Antilopini Gray, 1821
Genus *Gazella blainville*, 1816

Gazella sp.

Stratigraphic range: Lower Siwaliks.

Locality: Chinji, Dhok Bun Amir Khatoon (District Chakwal).

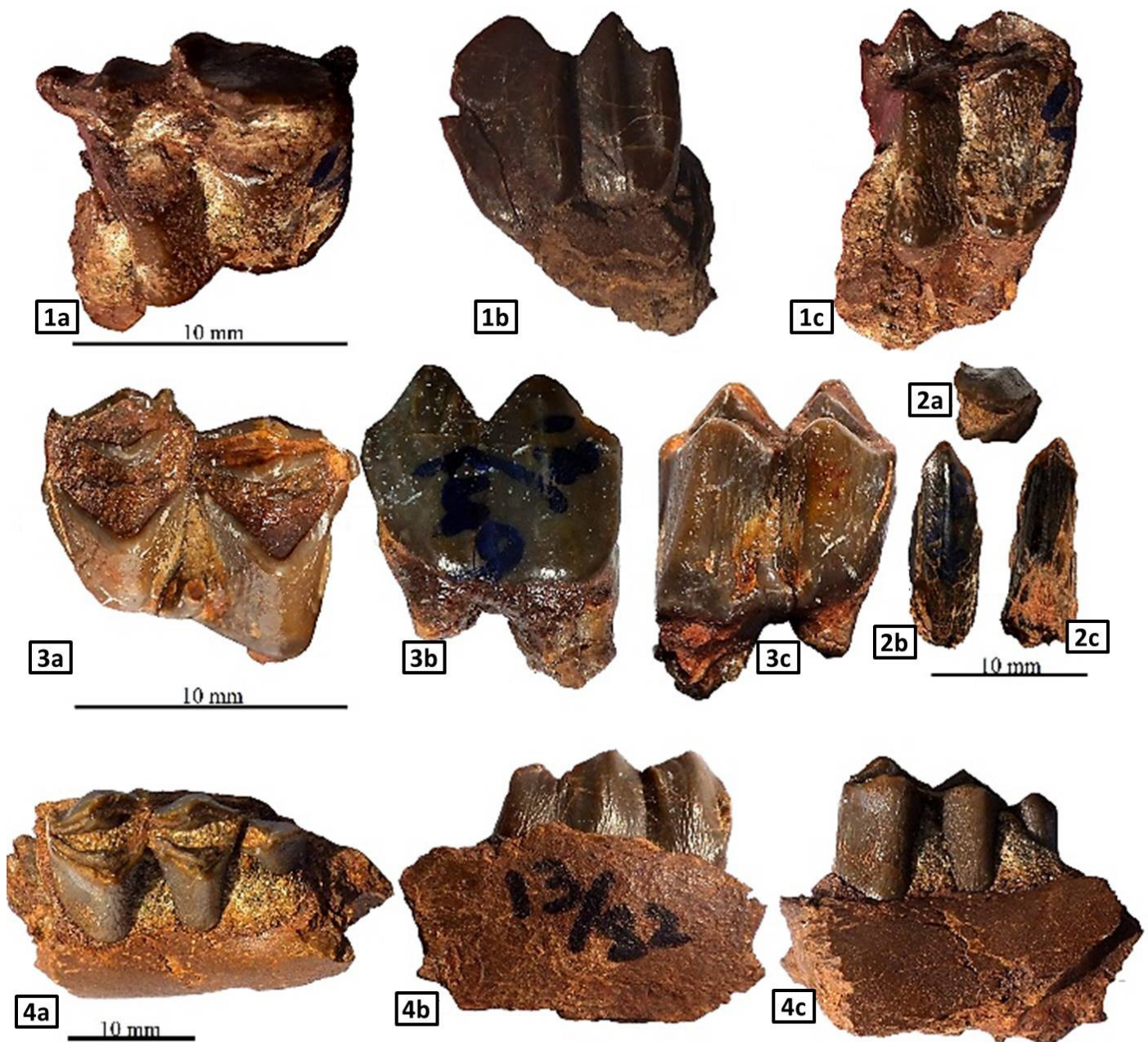


Figure 1: *Gazella sp.* from the Middle Miocene Siwalik Chinji Formation. 1, PUPC 13/83(1M2); 2, PUPC 13/116 (conid fragment); 3, PUPC 13/149 (rm2); 4, PUPC 13/82 (rm3) (a, occlusal surface; b, buccal side; c, lingual side).

Material studied: Isolated second left upper molar (IM2= PUPC 13/83) with a small fragment of upper jaw, a broken conid fragment (PUPC 13/116), isolated second right lower molar (rm2=PUPC 13/149), a fragment of dentary containing right third lower molar (rm3= PUPC 13/82). All these dental remains were discovered from Dhok Bun Amir Khatoon District Chakwal, Punjab, Pakistan.

Description

The second upper molar (PUPC 13/83) has a quadrate outline with shiny and prominent cusps that indicate its good preservation. The crown is wider in outline from the base and gradually narrows towards the top. The top of the buccal side is slightly bent towards the lingual side perhaps due to early wear and its position in the maxilla. The protocone is more crescentic in outline than hypocone; which is U shaped in outline. The parastyle and ectostyle ribs are strong and prominent. The entostyle is weakly developed. Preprotocrista is at lower level than posthypocrista, indicating slightly inclined position of tooth. The parastyle and metastyle are stronger like ribs (Figure 1).

Results

PUPC 13/116 is a broken anterior conid most probably of right lower molar with high crown, protoconid and metaconid. The metastylid seems to be less prominent and the metaconid rib protrudes slightly (Figure 1).

The M2 (PUPC 13/149) and M3 (13/82) are sub-hypsodont with normal crescent shaped fossettes. Short ectostylid is present in M2 while no ectostylid indicated in M3. The preprotocristid and post protocristids are roughly equal in length in both molars. The posteriorly inclined upward, but not so prominent cingulid is present in M2. The metastylid is less protruding in M2. Hypoconulid of M3 has slight folds towards buccal and lingual side (Figure 1).

Discussion

The genus *Gazella* is the most species rich and widespread genus of the Siwaliks. It is so diverse that according to Bibi and Guleç (2008), many new species and synonyms are recognized on the basis of slight morphological variations. Some features such as strong ribs and stylids and absence of median basal pillar include this species in the genus *Gazella*. However, the comparison in the present studies with the other described specimens of the Siwalik *Gazella* sp. indicates that the M2 in present specimens has the typical *Gazella* sp. morphology, i.e. absent/rudimentary entostyle, sizes of fossettes, prominent anterior and posterior ribs and overall tooth size similarities with already described *Gazella* sp. specimens. However, the M2 described in this study is slightly wider than the other studied Si-

walik specimens. According to Khan *et al.* (2016), the antero-posterior diameter of the upper molars of *Gazella* is greater than transverse diameter. The same is evident in the present specimen of M2. The comparative measurements of the *Gazella* sp. dentition is given in Table I.

Table I: Comparison of measurements of studied specimens of *Gazella* sp. with already published Siwalik data.

Specimens	Nature	Length	Width
PUPC 13/83	rM2	13.16	10.90
PUPC 13/149	rm2	13.65	8.85
PUPC 13/82	rm3	20.95	11.5
PUPC 13/116	m	XX	XX
PUPC 83/67	P4	9	9
(Akhtar, 1992)	M1	13.2	12
	M2	14	11.5
	M3	15.5	11
PUPC 84/133	m2	15.4	9.7
(Khan <i>et al.</i> , 2013)	m3	20.0	9.0

According to Khan (2007, 2008) and Akhtar (1992), *Gazella* is recorded from Lower and Middle Siwaliks. As per Pilgrim (1937, 1939) and Khan (2008), the two major species are known from Siwaliks; *Gazella* sp. from Lower Siwaliks (Middle Miocene) and *Gazella lydekkri* from Middle Siwaliks (Upper Miocene). Both species can be distinguished based on; (1) tooth size, which is larger in width in *Gazella lydekkri* and larger in length in *Gazella* sp., (2) tubercle-like entostyles which are rudimentary in *Gazella* sp. and slightly larger in *Gazella lydekkri* and (3) median ribs; prominent in *Gazella* sp. but paraconus rib stronger than metaconus in *Gazella lydekkri*. Overall, small sized molars and fine rugose pattern on enamel indicate this as a species of *Gazella* of medium size (Pilgrim, 1939; Khan *et al.*, 2009).

This species was well adapted to the warm conditions of Middle Miocene. According to Bibi and Guleç (2008) and Kostopoulos (2005), this gazelle community was well adapted for open or bushy lands which were at no great distance. They used to live in herds probably as their defence strategy against their predators (Brashares *et al.*, 2000).

The stratigraphic distribution of *Gazella* sp. indicates that early migrations and spread of the genus *Gazella*, according to Agusti and Anton (2002) took place in Middle Miocene from Africa to Eurasia. Thomas (1984) reported that the origin of the genus *Gazella* in the beds of Chinji Zone was likely during Early Miocene from the region of Majiwa, Kenya. This evidence has made it clear that the origin of *Gazella* and phylogenetically related antilopines began in Africa, followed by dispersal throughout Eurasia, given favourable environmental conditions (Agusti

and Anton, 2002). This view is further confirmed by Made (1999), giving the evidence of migrations of Rodentia and large mammals from Africa to Eurasia during Early Miocene due to exposed land bridges during low ecstatic levels. Discovery of this new material of *Gazella* sp. from the Middle Miocene deposits of the Siwalik region strengthens the already proposed idea for existence of this migratory route.

Conclusion

On the basis of their comparative morphometric analysis, the studied specimen has represented the presence of *Gazella* sp. in the middle Miocene Siwaliks of Pakistan. The studies indicate this species as an immigrant from Africa to Eurasia in the Early Miocene. This genus is indicative of vast open and bushy habitat and included in family Bovidae, other ungulate families present during the Middle Miocene period in the Siwaliks of Pakistan are Tragulidae, Suidae, Giraffidae, Anthracotheriidae and Rhinocerotidae.

Conflicts of interest

The authors declare no conflicts of interest.

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