ment but the Kheda specimens differ in other characters.

The Lameta sediments are generally assigned Turonian-Maestrichtian age on the basis of dinosaur remains[11-13]. Since the family Boraginaceae, to which the seeds described here belong, ranges from Palaeocene to Recent, the age of Lameta sediments of Kheda is inferred to be as young as Palaeocene. In view of the fact that the dinosaur eggs are now known elsewhere from Palaeocene sediments[14] as well, the Palaeocene age of dinosaur egg-bearing Lameta sediments of Kheda inferred here, is not an incongruity. However, the possibility of bringing down the lower age limit of the family Boraginaceae to Upper Cretaceous cannot also be ruled out completely because angiosperms had become a dominant part of the flora well before the dawn of Tertiary in the late Cretaceous. In either case, whether the age of Lameta sediments is extended to Palaeocene or the range of the family Boraginaceae is brought down to Upper Cretaceous, the new find assumes considerable significance.

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1. Mohabey, D. M., *Curr. Sci.*, 1983, **52,** 1194.
2. Mohabey, D. M., *J. Geol. Soc. India*, 1984, **25,** 1.
3. Mathur, A. K., *Bull. Indian Geol. Assoc.*, 1974 **7,** 43.
4. Berry, E. W., *Am. Mus. Nov.*, 1926, **221,** 1.
5. Berry, E. W., *Proc. U.S. Nat. Mus.*, 1928, **73,** 1.
6. Brown, R. W., *J. Palaentol.*, 1935, **9,** 573.
7. Elias, M. K., *Am. J. Sci.*, 1936, **29,** 24.
8. Elias, M. K., *Spec. Paper. Geol. Soc. Amer.*, 1942, **41,** 1.
9. Elias, M. K., *Am. Midland Nat.*, 1946, **36,** 373.
10. Chandler, M. E. J., *Brit. Mus. Nat. Hist. Publ.*, 1961, 1.
11. Huene, F. von and Matley, C. A., *Pal. Ind., N.S.*, 1933, **21,** 1.
12. Chatterjee, S., *J. Palaentol.*, 1978, **52,** 570.
13. Colbert, E. H., *Indian J. Earth Sci.*, 1984, **11,** 25.
14. Erben, H. K., Ashraf, A. R., Krumsiek, K. and Thein, J., *J. European Union of Geosci-Terra cognita*, 1983, **3,** 211.

MIOCENE CROCODILIAN (TOMISTOMIDAE) FOSSIL FROM SOUTHWESTERN KUTCH, GUJARAT

G. VIJAYASARATHI and A. B. SABALE
Geological Survey of India, Gujarat Circle, Ashram Road, Ahmedabad 380 014, India

A WELL-PRESERVED upper jaw of a crocodile with tomistomidian affinities was collected from the lower part of Vinjhan Shale[1,2]—Lower Miocene sequence of Kutch. This communication briefly describes this fossil.

The fossil locality (figure 1) is about one km southwest of village Sukhpar (23° 22′ 25″ : 68° 44′ 55″) in Abdasa Taluka of Kutch district, Gujarat. The jaw bones were collected from a road section, on Naliya-Narayansarover road, about 20 km northwest of Naliya.

The fossil jaw was found entombed in 30 cm thick fossilliferous greyish clays associated with gypsiferous olive green shales. The other fossils found in these beds are mainly *Turritella*, *Cerithium* and a variety of lamellibranchs.

The specimen forms a part of the upper jaw, which is elongated and tapers gradually towards the anterior end. The length of the jaw is about 190 mm and the

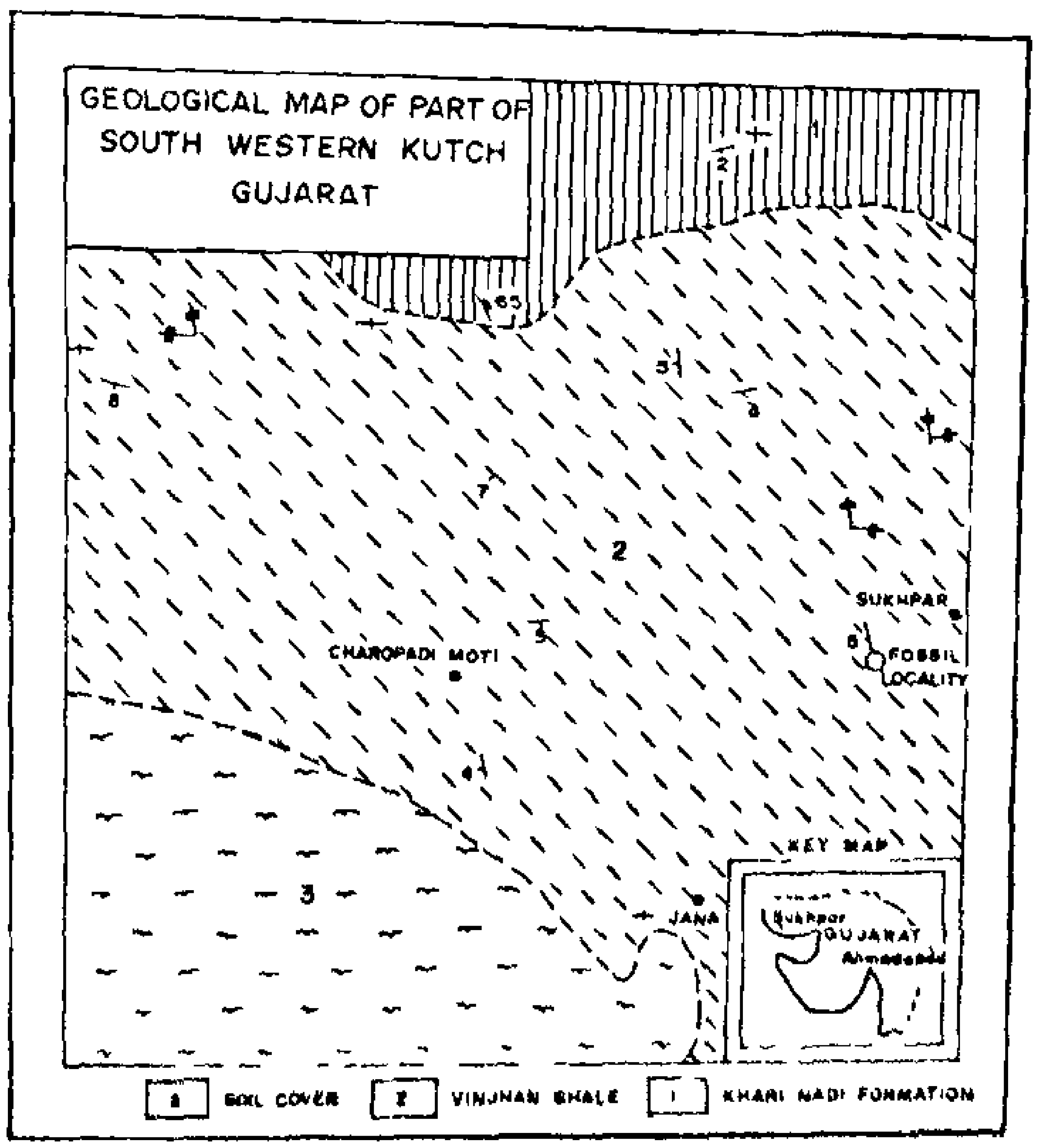

Figure 1. Geological map of part of southwestern Kutch, Gujarat.

maximum breadth at the posterior end is about 25 mm. The palatal portion of the jaw is planar whereas the dorsal portion is moderately convex in shape. The jaw consists of a part of maxilla and nasals (figures 2,3). The nasal is long, narrow and runs parallel to the outer margin of the jaw. It runs all through the maxilla and possibly also extended into the premaxilla.

In all, there are about 13 pairs of teeth sockets (alveoli) and some teeth are intact. The size of the alveoli is almost uniform, about 7 mm in diameter. The teeth are conical, curved inwardly, and characterised by minute flutings all over the surface. The height of the teeth is around 10 mm.

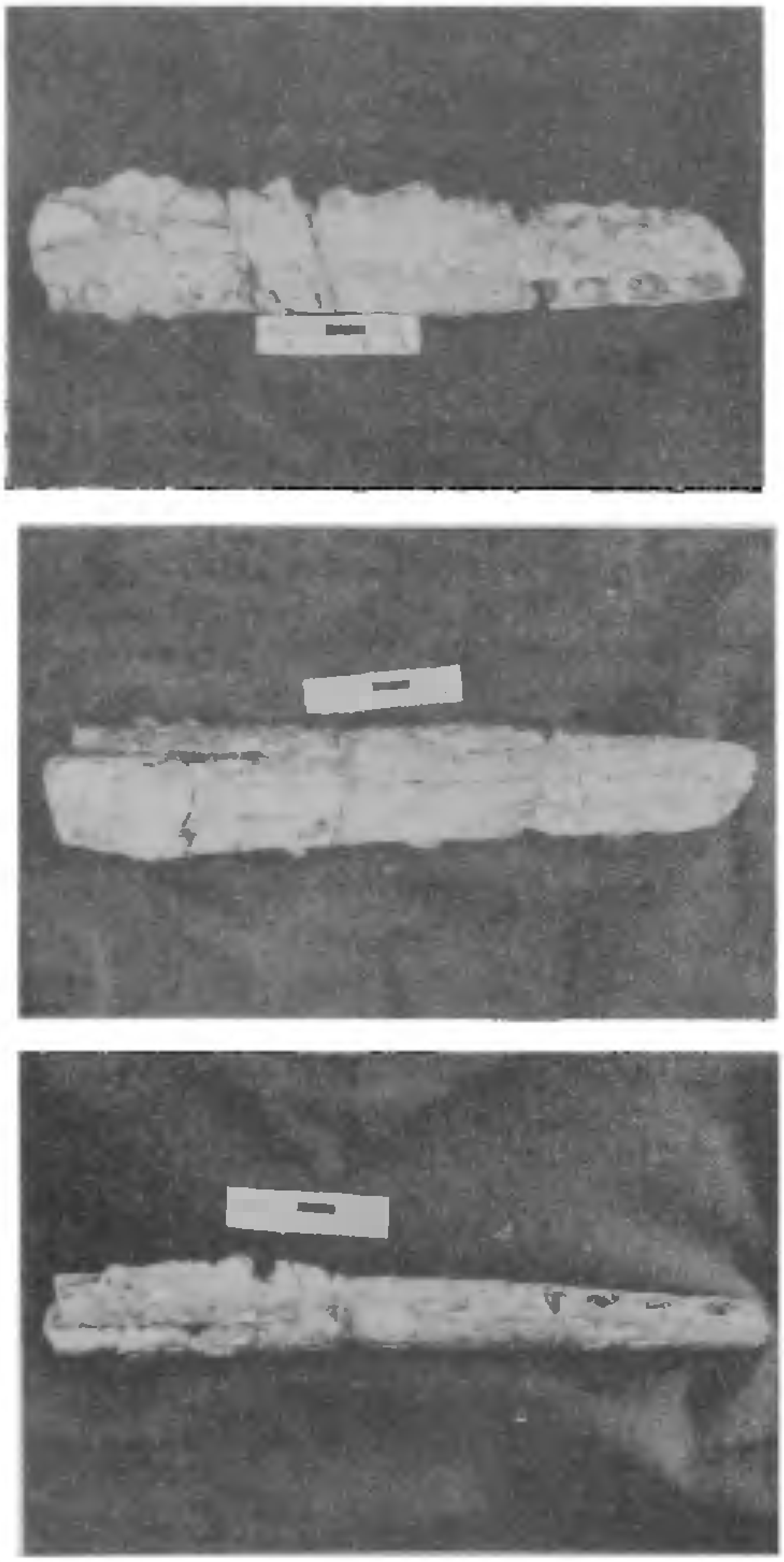

Figure 2a. Palatal b. Parietal c. Lateral view of the fossil jaw.

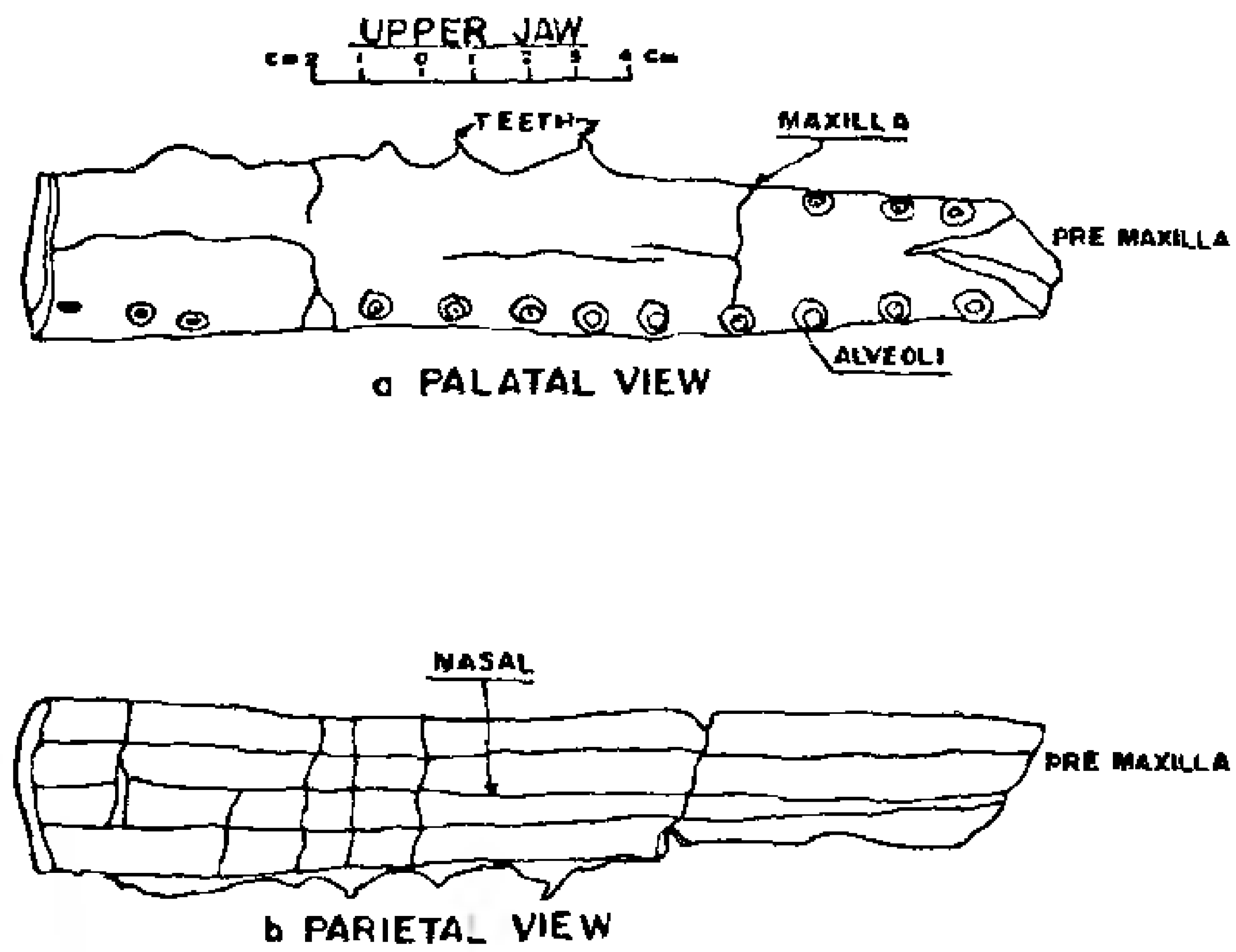

Figure 3a. Palatal **b.** Parietal view of the fossil jaw (Sketch).

Based on the articulation of nasals with premaxilla, elongate, narrow and anteriorly tapering snout and the number and uniformity of the teeth the specimen has been classified in the Family Tomistomidae (Reptilia, Crocodilia) as designated by Zittel[3].

The Miocene rocks of Kutch are mainly marine, near-shore deposits with few non-marine intercalations. The present form is found in association with the rocks containing *Miogypsina globulinatani* and *M. exdentrica* indicating Late Aquitanian to Burdigalian age to the sequence. The only other fossil tomistomin known from Kutch is *Tomistoma tandani*[4] from the Middle Eocene rocks. The present fossil is the first record of Tomistomidae from the Neogene rocks of Kutch. This form differs from the *T. tandani* in its smaller size. The estimated size of the skull of the present fossil is about 40 cm and thus it conforms to the size of the present day tomistomins, which are restricted to the streams of Malaya, Sumatra and Bornea.

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1. Biswas, S. K., *Geol. Min. Met. Soc. India*, 1971, **43**, 177.

2. Vijayasarathi, G. and Sabale, A. B., Unpub. GSI Report, 1984.
3. Zittel, Karl A von, *Text book of palaeontology*, 1932, **2**, 364.
4. Sahni, Ashok and Mishra, V. P., *Monograph, 3 Pal. Soc. India*, 1975, 12.

KINETICS OF ACETATE DISSIMILATION DURING METHANOGENESIS FROM CATTLE WASTE

R. SINGH, M. K. JAIN and P. TAURO
Department of Microbiology, Haryana Agricultural University, Hissar 125 004, India.

ACETATE is a key intermediate in the anaerobic production of methane from organic wastes[1]. However, so far only two species of methanogenic bacteria, namely *Methanosarcina barkeri*[2] and *Methanothrix soehngenii*[3] have been reported to favour this reaction at mesophilic temperature. The kinetics of this reaction have been examined using either enrichment cultures[5,6] or sewage sludge[7-9]. Although a key reaction in the production of methane from cattle waste, very little information is available regarding the rate of acetate utilization in cattle waste digesters[10,11]. In this paper, we report the kinetics of acetate dissimilation using effluent slurry from an Indian cattle waste digester.

To exhaust the residual acetate, 10 ml of the slurry was transferred to 20 ml CO_2 flushed tubes and incubated under CO_2 for 2 weeks at 37°C with regular discharge of gas produced. Acetate was injected into the tubes at different concentrations and the tubes were incubated further for 3 hr. The gas phase was analysed for methane and the slurry for the residual acetate using gas chromatographic techniques[12]. The rate of methane production was calculated from the increase in methane content of the gas in the tube at the end of incubation.

Table 1 shows the rate of acetate dissimilation and methane production at different concentrations of the acetate. It appears that the rate of acetate dissimilation of about 3 mmol/hr represents 75–85% of the rate of methane production. This indicates that acetate is the major route in the methane production in anaerobic cattle waste digester. Mountfort and Asher[10] reported the rate of acetate dissimilation under steady state conditions to be the 0.6 mmol/l/hr. The difference between the values reported[10] and the present data

Table 1 *Kinetics of acetate dissimilation and methane formation.*

Acetate concentration (mmoles/l)	Rate of acetate dissimilation (mmolwa/l/hr)	Rate of methane formation (mmoles/l/hr)
1.42		1.57
7.01		3.20
9 25		3 64
11.83		3.33
17 04		3.60
22.24	3.08	3.67
27.45		3 86
32.65		4.00
43.06		3.41
53.47	3.00	3.26

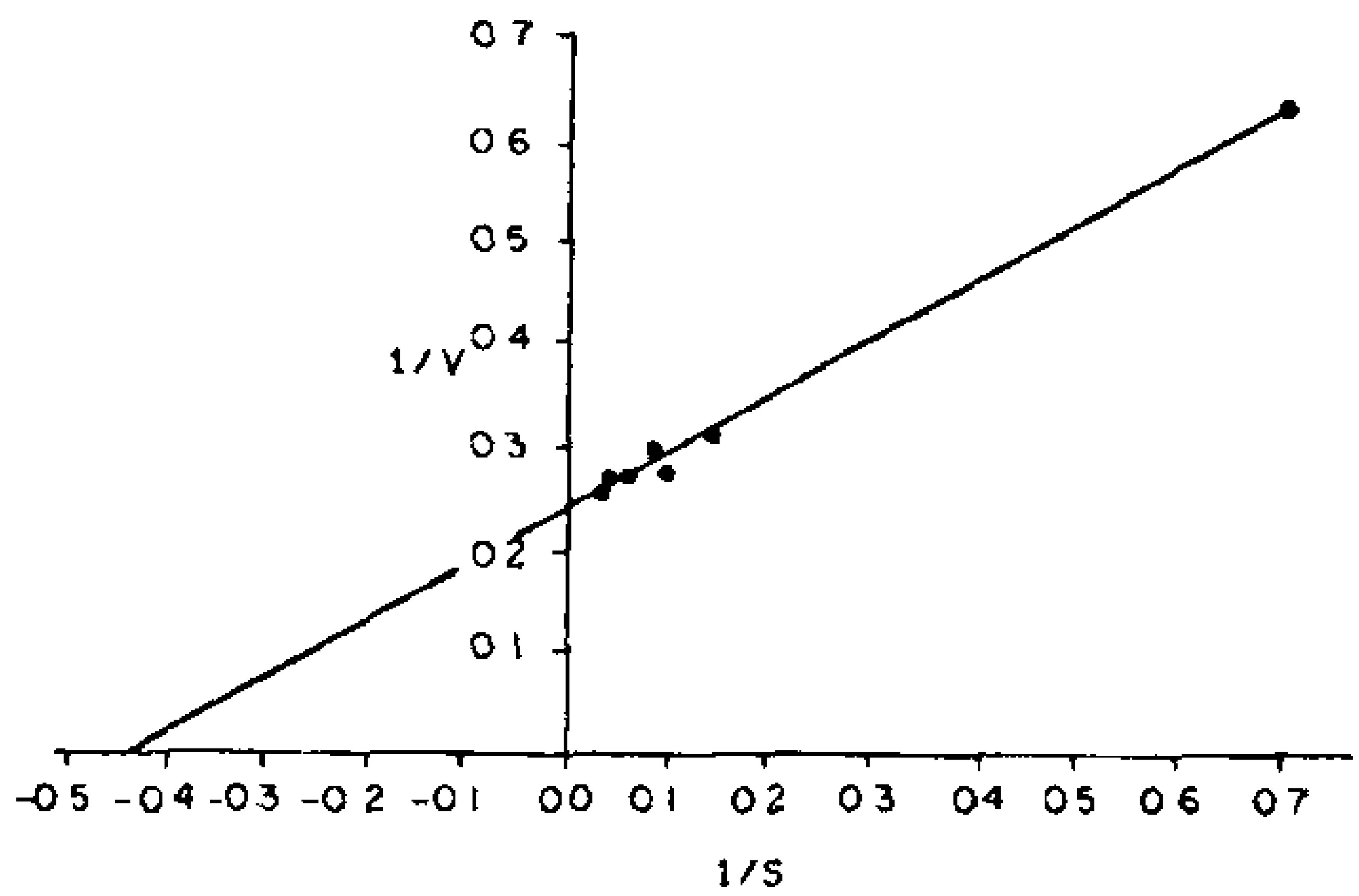

Figure 1. Double reciprocal plot between substrate concentration and rate of gas production.

appears mainly due to differences in the composition of two substrates (2.5 *vs* 8% volatile solids) and the retention periods (10 *vs* 50 days). The use of spent slurry to determine the rate of methane production from acetate is a better approach to estimate the potential of this reaction in Indian cattle waste digesters. The kinetic parameters, saturation constant (K_s) and the maximum rate of methane production (V_{max}) were determined from the graphical relationship between reciprocals of substrate concentrations and rates of methane production (figure 1). The estimated values of K_s and V_{max} in Indian cattle Waste digesters are 2.22 mM and 4.17 mmol,l,h, respectively. Divergent values for these parameters (K_s, 0.17 to 10 mmol/l) from other systems have appeared in literature[13] and the value of K_s (2.2 mM) presented here falls within this range.

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