

and anthers remain at two different planes; the filaments being very long and slender, anthers remain at a much lower plane than the stigma. Thus there is a physical barrier to pollination of a stigma by pollen from anthers of the same flower (self-pollination). There can be some seeding during sporadic flowering (in species where there is no self-incompatibility). In the second category 'lemma' and 'palea' do not open up but stigma and anthers are exerted at different times, when they mature. There is a gap between the female and male phases (3-4 days or more depending on the species). Thus, it is a physiological barrier. In species under this category there may not be seed-set during sporadic flowering and also in gregarious flowering of isolated clumps. We propose a division of the tribe *Bambuseae* into two groups: (i) *Bambusa* type and (ii) *Dendrocalamus* type. A survey of the literature and published photographs, diagrams and descriptions indicate that the genera *Bambusa*, *Phyllostachys*, and *Pseudosasa* belong to the first category and *Dendrocalamus*, *Melocanna* and *Ochlandra*²² belong to the second category. When reproductive biology is studied in more and more species and genera (as and when they flower), it would be apparent how they are distributed under these two broad categories.

Both *Bambusa arundinacea* and *Dendrocalamus strictus* belong to the group *Bambusae verae* (true bamboos) according

to Munro's¹⁵ system of classification, to the gregariously and periodically flowering category according to Brandis'¹⁶ system of classification and to the group having pachymorph (sympodial) rhizomes according to McClure's¹⁷ system of classification of bamboos. However, according to our system (on the basis of maturing of the reproductive structures) they show marked difference. These observations show the importance of studies on reproductive biology in bamboos for planning breeding in them as well as in understanding their inter-relationships better.

1. Janzen, D. H., *Annu. Rev. Ecol. Syst.* 1976, **7**, 347-391.
2. John, C. K., Nadgauda, R. S. and Mascarenhas, A. F., *Curr. Sci.*, 1993, **65**, 665-666.
3. John, C. K., Joshi, M. S., Nadgauda, R. S. and Mascarenhas, A. F., *Curr. Sci.*, 1994, **66**, 822-824.
4. Nadgauda, R. S., Parasharami, V. A. and Mascarenhas, A. F., *Nature*, 1990, **344**, 335-336.
5. Nakai, T., *J. Arnold Arboretum*, 1925, **6**, 145-153.
6. Soderstrom, T. R. and Calderon, C. E., *Natl. Geogr. Soc. Res. Rep.*, 1980, **12**, 647-654.
7. Soderstrom, T. R., *Ann. Mo. Bot. Gard.* 1981, **68**, 15-47.
8. Camus, E. C., *Les Bambusees*, Paul Lechevalier, Paris, 1913.
9. Bentham, G., in *Genera Plantarum (Bambuseae)*, (eds Bentham, G. and Hooker, J.

- D.), London, 1883.
10. Camus, A., *Arch. Natl. Hist. Naturelle Paris*, 1935, Ser. 6, 601-605.
11. Holttum, R. E., *J. Arnold Arboretum*, 1946, **27**, 340-346.
12. Holttum, R. E., *Phytomorphology*, 1956, **6**, 73-90.
13. Grosser, D. and Liese, W., *J. Arnold Arboretum*, 1973, **54**, 293-308.
14. Clayton, W. D. and Renvoize, S. A., *Kew Bull.*, 1986, Addl. Ser. **13**, 34-57.
15. Munro, C., *Trans. Linn. Soc. London*, 1869, **26**, 1-157.
16. Brandis, D., *Indian For.*, 1899, **25**, 1-25.
17. McClure, F. A., *The Bamboos - A Fresh Perspective*, Harvard University Press, Cambridge, Harvard, 1966.
18. Blatter, E., *Indian For.*, 1929, **55**, 541-562.
19. Nadgauda, R. S., John, C. K. and Mascarenhas, A. F., *Tree Physiol.*, 1993, **13**, 401-408.
20. John, C. K., Nadgauda, R. S. and Mascarenhas, A. F., *J. Cytol. Genet.*, (in press)
21. Nadgauda, R. S., John, C. K. and Mascarenhas, A. F., *J. Biosci.*, (communicated).
22. Venkatesh, C. S., *Biotropica*, 1984, **16**, 309-312.

Received 31 August 1994; accepted 8 September 1994

C. K. JOHN
R. S. NADGAUDA
A. F. MASCARENHAS

*Division of Plant Tissue Culture
National Chemical Laboratory
Pune 411 008, India*

First report of a fossil marsh crocodile *Crocodylus palustris* from the Manneru Valley, Andhra Pradesh

Fossil representatives of *Crocodylus palustris* were so far known only from the Himalayan foreland^{1,2}. We report here part of a fossilized skull of this species from riverine silts overlying a volcanic ash bed exposed in Manneru valley near Pamuru (15°5' 40" N, 79°25' E), Prakasam district, Andhra Pradesh (Figure 1). The volcanic ash bed compares well with that of the youngest (74,000 BP) Toba tuff from Sumatra³. The fossil is described below and its significance is discussed.

Class : Reptilia
Order : Crocodylia
Sub order : Eusuchia (Huxley, 1875)
Family : Crocodylidae
Genus : *Crocodylus*, Linn
Crocodylus palustris,
Lesson (Figures 2, 3, 4)

The specimen consists of the right portion of a skull preserving maxilla with dentition, partial premaxilla, jugal and epipterygoid. The sutures are intact. The

seventh and eleventh teeth are not preserved. All the teeth are broken mechanically near the base showing the circular pulp cavity. The specimen has suffered from prolonged erosive/weathering action that has obliterated many of external sculptural details. The characteristic shape of the specimen appears to be the result of mechanical breaking along a twisted plane.

Length of specimen is 30.6 cm. Snout is short. Teeth are unequal in size. Cra-

nium has a lateral notch for the fourth mandibular tooth. Maxilla bears fourteen teeth and the length of the maxillary

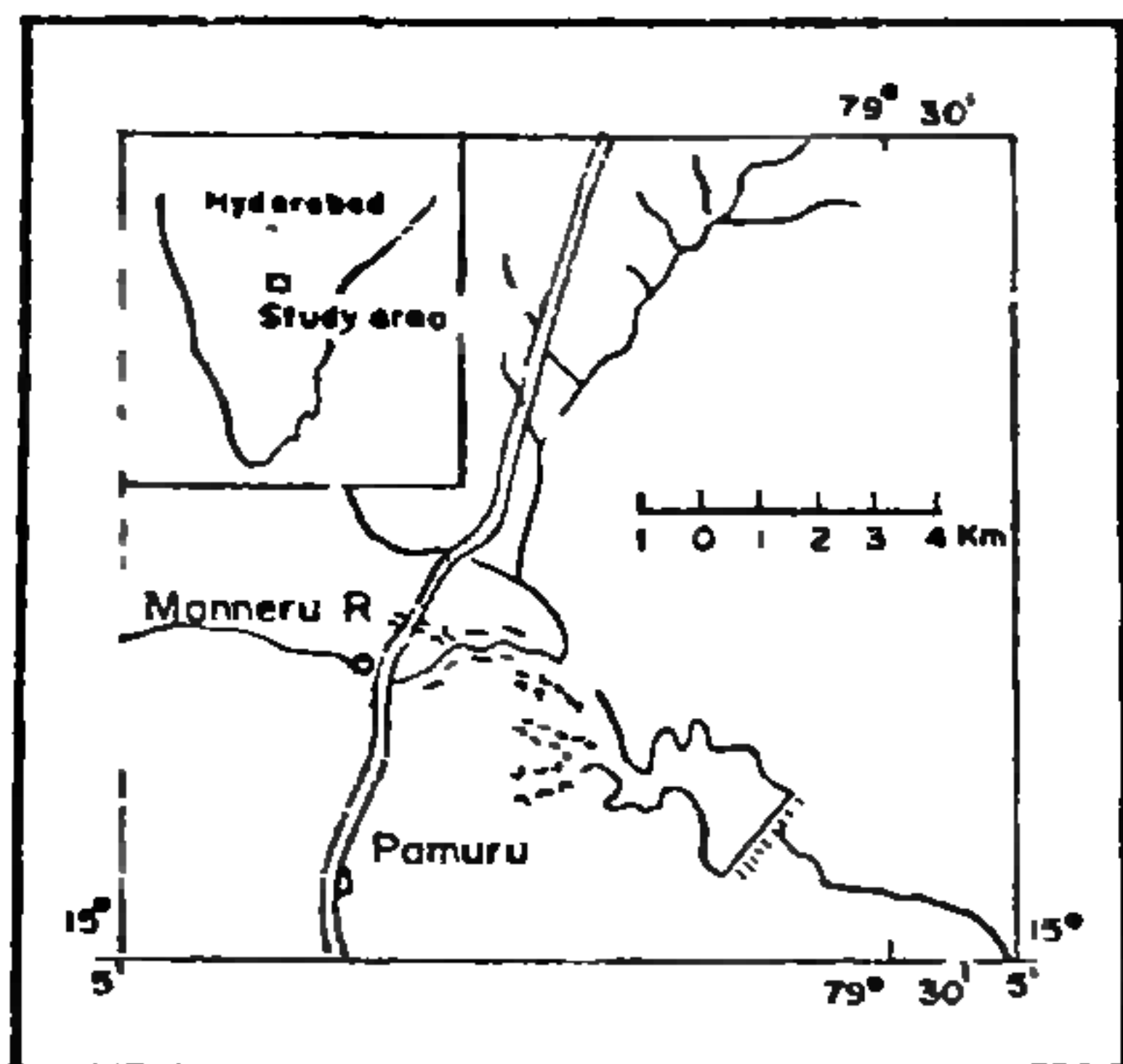


Figure 1. Location of Manneru River Basin showing fossil locality

tooth row is 25.5 cm. Pre-maxilla is incomplete. Assuming four teeth are generally borne in pre-maxilla, the total number of teeth in the upper jaw becomes 18. The ninth tooth is the largest. The diameter of alveolus varies from 2.7 cm to 1.1 cm. In the lateral profile, two prominent constrictions are visible; one is anterior to the fifth tooth and the other is located between the eleventh and twelfth teeth. Facial sculpture is strong. Pre-maxilla on palatal aspect is inferred to be short, but its posterior margin is seen to be straight. Maxilla extends posteriorly to join the jugal and epipterygoid postero-laterally. Length of maxilla is 25.7 cm dorsally and 27.6 cm ventrally. Maxillo-premaxillary suture extends on palate as far back as the fifth alveolus. The suture tends to trend transversely towards the middle of the palate.

It bays around the foramen adjacent to the lateral notch. In the area of lateral notch it runs at a distance anterior to the fifth tooth. On the facial side it is directed transversely. Expansion at ninth tooth is not greater. The twelfth tooth is placed after the second constriction in the lateral profile. The foramen adjacent to the lateral notch is in a straight line, directed transversely.

C. sivalensis and *C. palaeindicus* are members of the *C. palustris* group⁴. The specimen is distinguished from *C. sivalensis*, in not having the maxillo-premaxillary suture forming a blunt inverted V. It differs from *C. palaeindicus* in the characters of less expansion at ninth tooth, location of twelfth tooth and the placement of foramen adjacent to the lateral notch. Compared with the recent *C. palustris*, the fossil specimen shows a subtle variation in the character of maxillo-premaxillary suture in the area of lateral notch and on facial aspect. In the recent forms the suture runs close to the fifth tooth and on facial aspect directed backwards; in the fossil specimen it is at a distance from the fifth tooth and on dorsal side it is directed transversely. In all other aspects the specimen compares well with *C. palustris*.

Quaternary formations in the area are of fluvial origin chiefly made up of

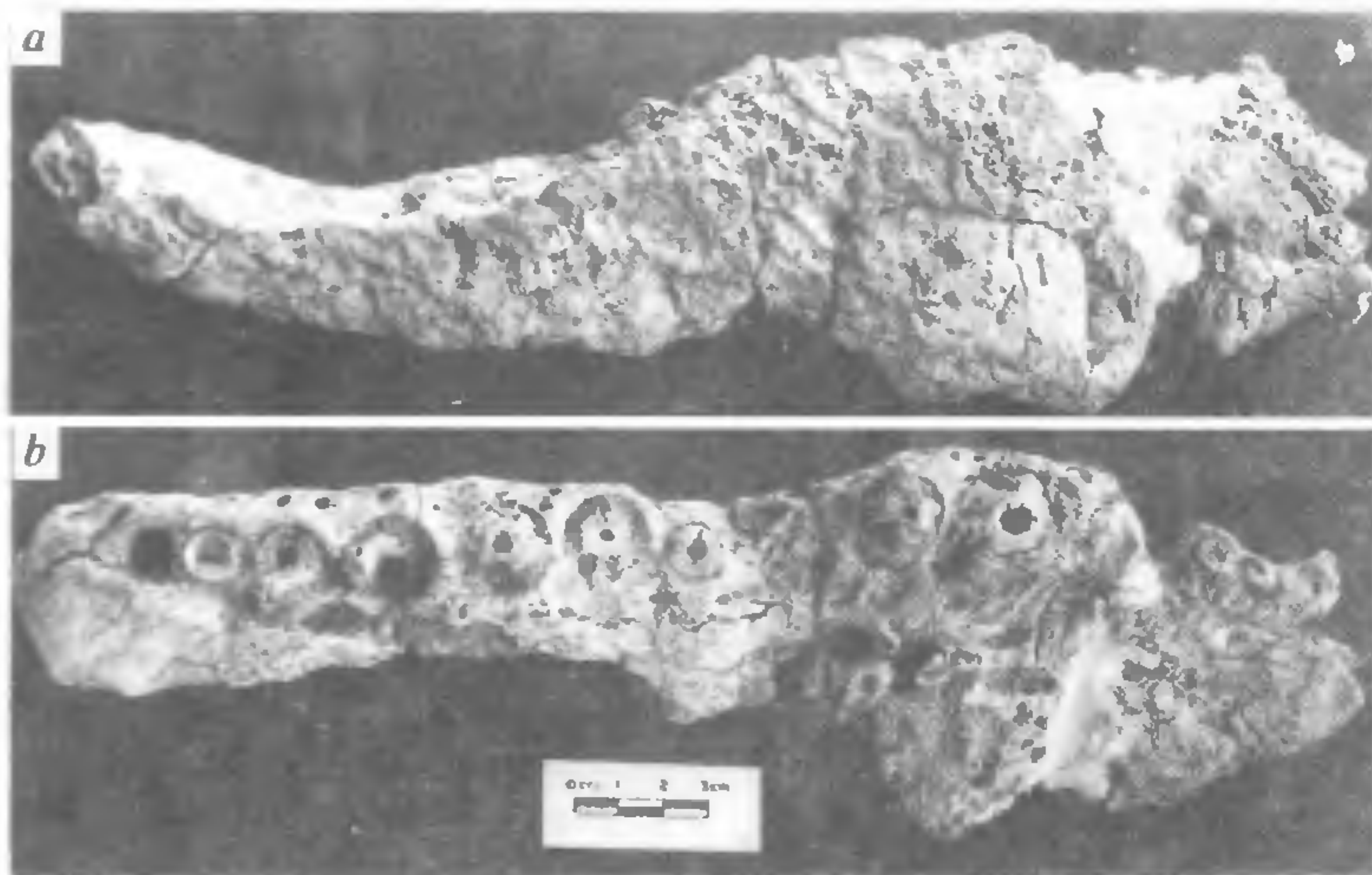


Figure 2. Part of a skull of *Crocodylus palustris*, Lesson. a, Facial view showing strong sculpture; b, Palatal view showing sutures and position of teeth.

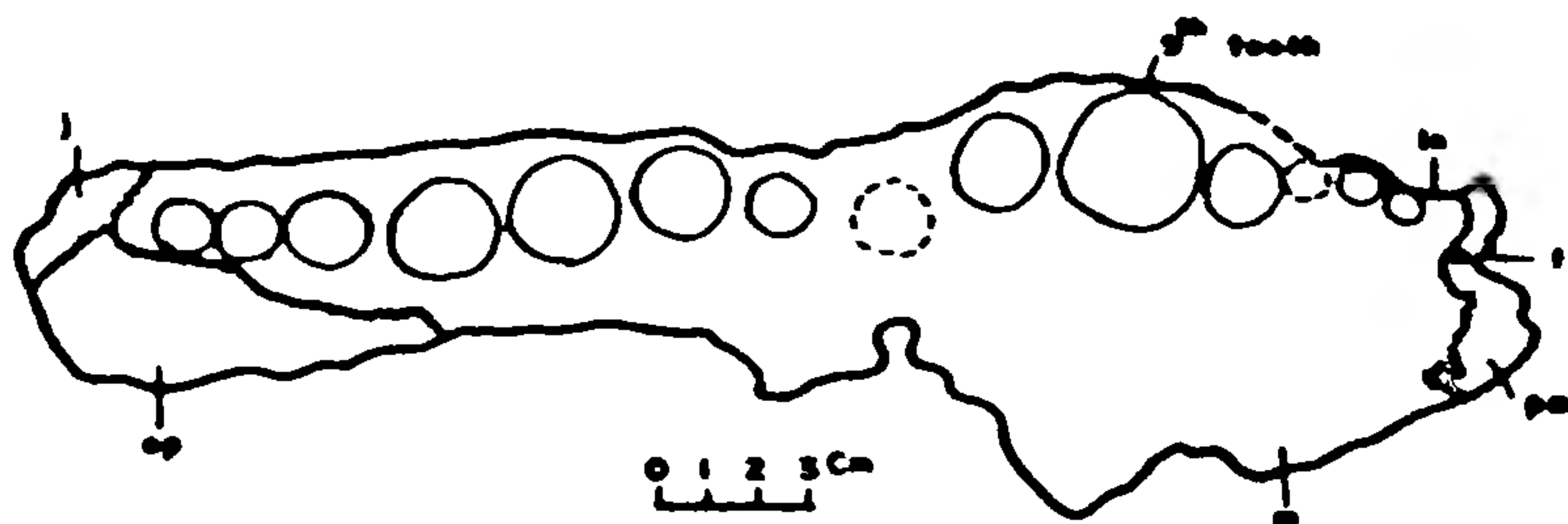


Figure 3. Sketch of palatal view showing pre-maxilla (pm), maxilla (m), epipterygoid (ep), jugal (j), lateral notch for the 4th mandibular tooth (ln), foramen (f).

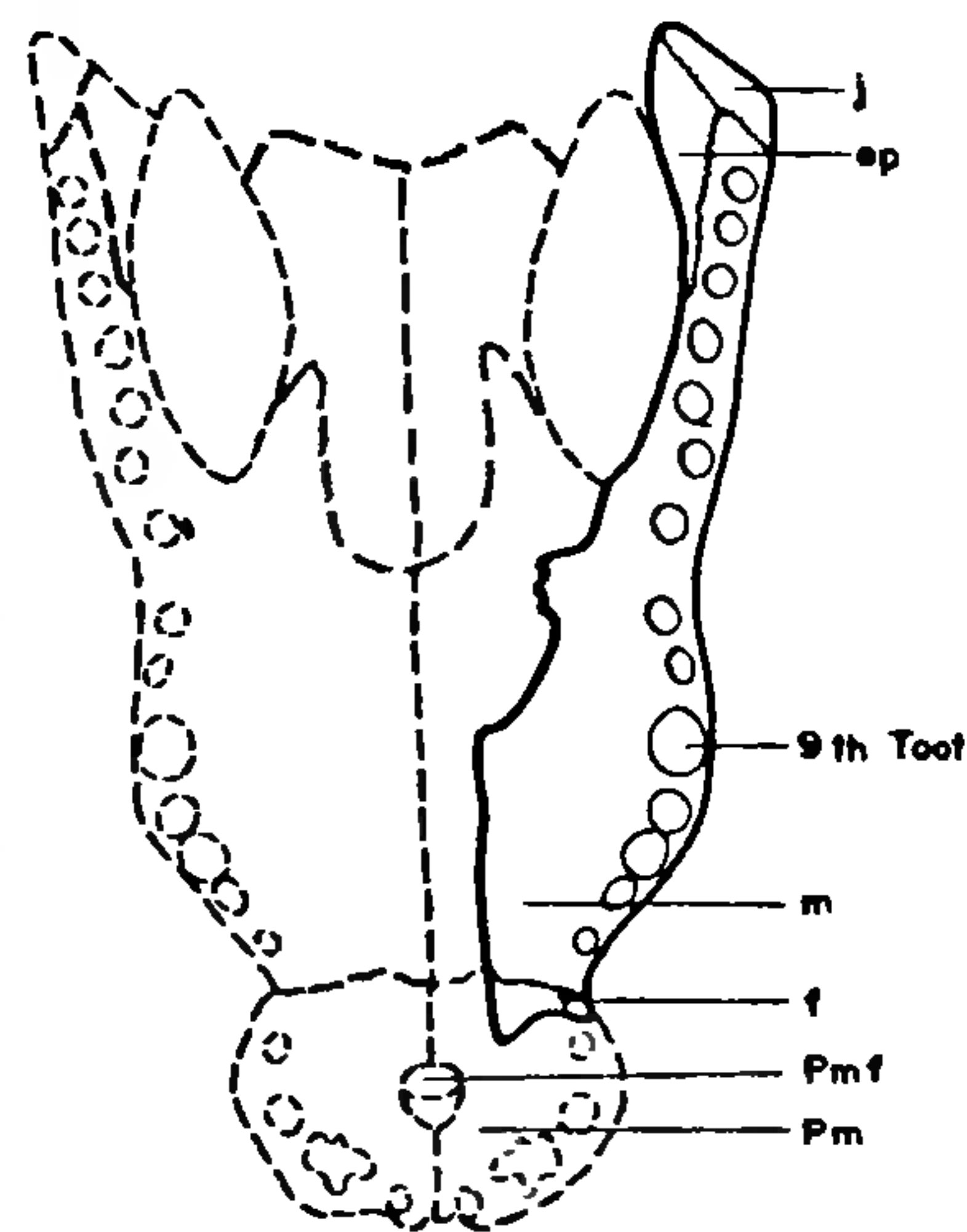


Figure 4. Sketch of ventral view of the skull of *C. palustris*, Lesson showing the original (in bold) and restored parts (dotted) approximately 1/4 natural size. Premaxillary fissure (pmf), pre-maxilla (pm), maxilla (m), epipterygoid (ep), jugal (j) and foramen (f).

oxidized and calcretized brownish to yellowish brown clayey silts. The terrace formed of these sediments is much dissected. The nature of oxidation and calcretization of the sediments together with the dissected nature of the terrace suggests an antiquity of these deposits. A volcanic ash bed underlies the sediments containing the fossil. (It is proposed to report separately the occurrence of the ash bed in detail.) Samples of Quarternary ash beds of comparable stratigraphic positions from the Indian sub-continent compare closely with that of the youngest (74,000 BP) Toba Tuff³. Summing up, a late Pleistocene age (less than 74,000 BP)

may be suggested for the sediments and the fossils contained in them.

The material has been deposited in the Regional Palaeontological Laboratory, Southern Region, GSI Complex, Hyderabad (GSI Type No. 20454).

1. Pascoe, E. H., *A Manual of The Geology of India and Burma*, 1964, vol. III, p 1810.
2. Ram, L. G., *Geol. Surv India, Spl. Publ.*, 1988, II, 207-211
3. Acharyya, S. K. and Basu, P. K., *Quart Res.*, 1993, 39, 1.
4. Lydekker, R., *Pal. Indi. Ser.*, X, 1866a, III pt. 7, 209-239.

ACKNOWLEDGEMENTS. We thank D. C.

Das Sarma, Director, Palaeontology Division, Geological Survey of India, Hyderabad for going through the manuscript and for his valuable suggestions. We also thank colleagues in the Division for their help.

Received 2 April 1994, revised accepted 15 September 1994

K. SHANKAR
C. V. N. K. RAO

*Geological Survey of India
Bandalguda GSI Complex
Hyderabad 500 060, India*

Occurrence of segmental distortion in larvae and pupae after refrigeration of non-diapause eggs of silkworm *Bombyx mori* L.

The non-hibernating eggs of tropical polyvoltine silkworm races generally complete their embryonic development under ideal incubation conditions by 9th day after oviposition¹. These eggs can be conveniently preserved in cold storage for a maximum of 20 days, to delay hatching. The effect of prolonged refrigeration of these eggs on hatching and rearing performance has been studied earlier²⁻⁴.

The present study was carried out at the Regional Sericultural Research Station, Majra, Dehradun, to understand the effects of prolonged refrigeration of eggs on rearing performance and on the morphology of larvae and pupae in a popular polyvoltine silkworm race, Nistari. The eggs (two egg layings of about 600 to 650 eggs in each replication in each treatment) of 24 to 30 h age were refri-

gerated for 30, 40, 50, 60 and 70 days at 2.5°C±1°C in cold storage. Hatching percentage was recorded and hatched larvae were brushed in three replications (actual hatched larvae of two egg layings in each replication as mentioned in Table 1) and reared till adult stage for recording further observations. Freshly laid eggs of 24 to 30 h age (two egg layings) were kept as control and were released in

Table 1. Rearing performance (mean of 3 replications) of the refrigerated eggs of the Nistari polyvoltine silkworm race

Refrigeration duration (days)	Actual no. of eggs treated in 3 replications	Actual no. of larvae brushed/reared in 3 replications after hatching	Average hatching percentage	Average cocoon yield/10000 larvae brushed wt. (kg)	Average effective rate of rearing	Percentage of deformed larvae (of total larvae brushed)	Percentage of deformed pupae (of total deformed larvae)
30	1967	1804	91.55 ±0.535	8.319 ±0.038	89.26* ±1.37	Nil	-
40	1794	1365	76.04* ±7.73	6.337 ±1.559	67.11* ±15.66	Nil	-
50	1849	1230	66.68* ±1.413	9.055 ±0.930	78.34* ±8.09	Nil	-
60	1881	934	49.69* ±7.49	6.059 ±1.044	66.27* ±9.92	5.3 ±2.52	100
70	1919	209	43.14* ±11.01	1.897 ±0.221	25.03* ±4.14	8.7 ±2.52	100
Control	1932	1777	92.04 ±1.98	8.673 ±0.074	94.51 2.25	Nil	-

*Significant (0.05) as against control in *t* test.
NS = Non-significant