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Zoological Survey of India**

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through Owl Pellet Analysis**

**S.S. TALMALE
M.S. PRADHAN**

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**Zoological Survey of India
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INTRODUCTION

Owls feed on small mammals such as shrews, bats, rats, mice, squirrels etc. They regurgitate undigested food material from mouth in the form of oval and greenish black coloured pellets [Pl.- 1 Ph.- 1]. Pellets contain broken parts of skulls, mandibles, vertebrae, pectoral and pelvic girdles, limb bones [Pl.- 1 Ph.- 2], chitinous remains of insects etc. (Neelananarayanan *et al.*, 1998, Mandal, 1988).

Contribution on owl pellet analysis and identification of small mammals on the basis of key bone pieces collected from the pellets have been made by various workers (Errington, 1930, 1932; Driver, 1949; Huebschman *et al.*, 2000; Lyman *et al.*, 2003; Trejo and Guthmann, 2003). Driver (1949) reported that teeth and teeth sockets are very important characters for identification of small mammals. They give some clues from their shape, size and arrangement.

In India, most of the work has been concentrated on feeding habit, prey frequency, occurrence and prey biomass of different owl species (Kanakasabai *et al.*, 1998; Neelananarayanan and Kanakasabai, 2004; Pande *et al.*, 2004; Jathar and Rahmani, 2004; Jathar *et al.*, 2005 and Ramanujam, 2006). Little attention was given to the detailed aspects of taxonomic identification of prey species. Khajuria and Ghosal (1970) could identify seven small mammal species from pellet of Barn owl (*Tyto alba* Scopoli) on the basis of skeletal pieces (without any mention of the names). Further, Khajuria (1972) reported two insectivores (*Crocidura* and *Talpa*) from pellets of barn owl (*Tyto alba* Scopoli) from Jabalpur, Madhya Pradesh. Neelananarayanan *et al.* (1998), Neelananarayanan and Kanakasabai (2003) and Ramanujan (2004) reported identification of seven common rodents and one insectivore species (*Suncus murinus*) on the basis of mandibles obtained from pellets of Barn and Indian Eagle owls respectively. With the help of mandibles, only limited or common species could be identified by these workers. Due to limitations these methods did not help much in identification of *Mus* and *Suncus* species which were most common in owl / owlet pellets.

Present study reports identification of 19 small mammal species under three different orders (Insectivora, Chiroptera and Rodentia), on the basis of composition

of key characters present in the skull and mandible pieces of small mammals found in owl / owlet pellet material collected from Maharashtra State. An attempt has been made here to give dichotomous key to identify these species from the skull and mandible material, alone, obtained from the pellets with photographs of these key bones. Literature reveals that no such type of key (with photographs showing key characters) is available for identification of small mammals species found in owl / owlet pellets from Maharashtra State as well as other parts of India. Species discussed here also occur in other parts of India. Therefore, present study will help in identifying the small mammal species from owl pellet material obtained from other parts of India too.

MATERIAL AND METHODS

During the present study pellet material of following owl species was received from Director, Bombay Natural History Society, Mumbai and Dr. Satish Pande, Ela Foundation, Pune, for identification of small mammal prey species.

Class	:	Aves
Order		Strigiformes
Family		Strigidae
Subfamily		Tytoninae
Genus		<i>Tyto</i> Billberg

1. *Tyto alba* (Scopoli, 1769) (Barn Owl)

Subfamily STRIGINAE

Genus *Bubo* Dumeril

2. *Bubo bengalensis* (Franklin, 1831) (Indian Great Horned Owl)

Genus *Athene* Boie

3. *Athene brama* (Temminck, 1821) (Southern Spotted Owlet)

Genus *Heteroglaux* Hume

4. *Heteroglaux blewitti* Hume, 1873 (Forest Spotted Owlet)

Pellets were collected from different localities in Maharashtra state by the teams of BNHS, Mumbai and Ela Foundation, Pune. These localities are: Dist. Amaravati: Amaravati and Melghat Tiger Reserve; Kolhapur Dist. Kolhapur; Nandurbar Dist. : Toranmal Reserve Forest; Pune Dist. : Pune, Narayanpur, Jejuri, Kodit Tal. Purandar; Saswad and around (Dive Ghat, Waghdongar, Jadhavgadhi jungle, Garade, Karha river, Sonori, Pangara ghat) , Talegaon, Raigad Dist. : Alibag; Ratnagiri Dist. : Chiplun; Satara Dist. : Satara, Patan, Wai, in Maharashtra State. Washed and cleaned pellets kept in separate packets were received from BNHS and Ela Foundation. Each pellet material was kept in separate packets. Small mammal material was identified by examining the bones under dissecting microscope (Carl Zeiss Jena, with 6.3, 10, 16, 25 and 40X Magnification). Measurements of skull and mandibles were taken by Vernier calipers with a dial graduation reading up to 0.1 mm. Microphotographs were taken with the help of Digital Still Camera (Sony DSC-W5, 5.1 Mega Pixels, 3 X Optical Zoom). Photographs with actual magnifications with size adjustments to highlight the characteristic features are provided wherever necessary. Selected skull and mandible pieces were computer scanned and photographed. Identification of small mammal species was carried out with the help of Lindsay (1929); Ellerman (1961); Agrawal (1967 and 2000); Marshall (1977) and Corbet and Hill (1992). The dichotomous key for identification of small mammal species reported from the owl pellet material from Maharashtra State has been prepared. It is followed by the species account in brief. Species identification is based on the combination of key skull and mandible characters observed in the broken pieces of skulls. Total 573 examples of small mammals were studied and identified. Number of examples studied for the present work was counted as per Lyman *et al.* (2003). Crania with both left and right maxillae, crania with the left or right maxilla, isolated left or right maxillae, and isolated left or right mandibles were considered while counting number of specimens. Only small mammal species out of the entire lot have been reported and discussed in the present work.

ABBREVIATIONS

Abbreviations used in the text are given below :

Cranial measurements (Based on Ellerman, 1961 for rodent species; Lindsay, 1929 for Insectivore species and Bates and Harrison, 1997 for bat species)

1. Occipitonasal length (onl) (For Rodentia species).
2. Condylbasal length (cbl) [Pl.- 2 Ph.- 3C].
3. Greatest zygomatic width (zw) (For Rodentia & Chiroptera species) [Pl.- 20 Ph.- 26A], [Pl.- 6 Ph.- 10A].
4. Interorbital width (iw) [Pl.- 10 Ph.- 16A].
5. Nasal length (nas) [Pl.- 10 Ph.- 16A].
6. Length of anterior palatal foramina (apf) (For Rodentia sps.) [Pl.- 10 Ph.- 16B].
7. Length of diastema (dia) (For Rodentia species) [Pl.- 10 Ph.- 16B].
8. Length of maxillary toothrow (mtr) (For Rodentia species) [Pl.- 8 Ph.- 14].
9. Length of palate (pal) [Pl.- 19 Ph.- 25A].
10. Mandibular length (ml) [Pl.- 4 Ph.- 5C], [Pl.- 6 Ph.- 10C], [Pl.- 10 Ph.- 16D].
11. Upper toothrow (utr) (For Insectivora species) [Pl.- 2 Ph.- 3C].

Following cranial measurements have been used only for Chiroptera species

12. Greatest length of skull (gtl) [Pl.- 7 Ph.- 12A].
13. Condyllo-canine length (ccl) [Pl.- 6 Ph.- 9A].
14. Breadth of braincase (bb) [Pl.- 6 Ph.- 10A].
15. Interorbital constriction (ic) [Pl.- 6 Ph.- 10A].
16. Maxillary toothrow ($c-m^1$ or $c-m^2$ or $c-m^3$) [Pl.- 7 Ph.- 12B].
17. Mandibular toothrow ($c-m_2$ or $c-m_3$) [Pl.- 7 Ph.- 12C].
18. Posterior palatal width ($m^1 - m^1$ or $m^2 - m^2$ or $m^3 - m^3$) [Pl.- 6 Ph.- 9B].
19. Anterior palatal width ($c^1 - c^1$) [Pl.- 6 Ph.- 9B].

BNHS Bombay Natural History Society, Mumbai

Dist. District

mm. Millimeter

No. Number

Ph. Photograph

Pl. Plate

Pm. : Premolar

ZSI.WRS. : Zoological Survey of India, Western Regional Station, Pune.

Key to the identification of small mammal species from the skeletal material obtained from the owl species pellets :

1. Zygoma absent [Pl.- 2 Ph.- 3A], Mandible with angular process in slender projection [Pl.- 2 Ph.- 3D] (Order Insectivora) 2
 Zygoma present [Pl.- 6 Ph.- 9B], Mandible with angular process not slender [Pl.- 6 Ph.- 10C] 5
2. Insectivore species, with 4th unicuspid teeth (pm⁴) absent in upper jaw [Pl.- 5 Ph.- 6B] *Crocidura horsfieldi*
 Insectivore, with 4th unicuspid teeth (pm⁴) present in upper jaw [Pl.- 2 Ph.- 3B] 3
3. Skull size large (28.1-36.3 mm in length), Upper toothrow length (incisor to last molar) 12.5-15.2 mm [Pl.- 2 Ph.- 3C] *Suncus murinus*
 Skull size small (below 28 mm in length), Upper toothrow length below 12.0 mm 4
4. Skull length 20-23mm, Upper toothrow 8.7-10.1 mm. [Pl.- 3 Ph.- 4]
 *Suncus stoliczcanus*
 Skull length 12.5-18.2mm, Upper toothrow 5.1-8.1 mm. [Pl.- 4 Ph.- 5]
 *Suncus etruscus*
5. Canine teeth present [Pl.- 6 Ph.- 10B]; Diastema absent [Pl.- 6 Ph.- 9A] (Order Chiroptera) 6
 Canine teeth absent; Diastema present [Pl.- 10 Ph.- 16B] (Order Rodentia) ...
 8
6. Frugivorous or Megachiropteran species with molars simple, flat crowned with longitudinal furrows [Pl.- 6 Ph.- 10B]; Post orbital process well developed [Pl.- 6 Ph.- 10A] 7

Insectivorous or Microchiropteran species with molars complex with regular pattern of cusps and ridges forming a definite W or N surface outline (Transverse furrows)[Pl.- 7 Ph.- 12B]; Post orbital process absent)[Pl.- 7 Ph.- 12A], skull with 1 or two incisors in upper jaw and 3 pairs of incisors in lower jaw (Pl.- 7 Ph.- 12BC)

..... Family Vespertilionidae (*Pipistrellus* sp.)

7. 5 pairs of upper cheekteeth (3 premolars and 2 molars) [Pl.- 6 Ph.- 10B] (Skull size smaller than *Pteropus* sp.) *Rousettus* sp.
4 pairs of upper cheekteeth (3 premolars and 1 molar)[Pl.- 7 Ph.- 11C] (Skull size smaller than *Pteropus* sp.) *Cynopterus* sp.
8. Upper incisors grooved on front surface [Pl.- 8 Ph.- 13], Cusps in cheekteeth arranged in two longitudinal rows [Pl.- 8 Ph.- 14] *Tatera indica*
Upper incisors not grooved (except in *Golunda*), Cusps in cheekteeth arranged in three longitudinal rows [Pl.- 11 Ph.- 17B] 9
9. Upper incisors proodont, Condylbasal length of skull equal or exceeds occipitonasal length, Mandible large sized, robust and with well developed masseteric process [Pl.- 19 Ph.- 25B] 10
Upper incisors opisthodont or orthodont [Pl.- 13 Ph.- 19A], Occipitonasal length of skull exceeds condylbasal length, Mandible small size, not robust with poorly developed masseteric process[Pl.- 13 Ph.- 19F] 11
10. Anterior palatal foramina equally broad at both ends [Pl.- 20 Ph.- 26A]; Mandibles with straight coronoid process, posterior cingulum present behind lower molar m_1 and m_2 [Pl.- 20 Ph.- 26C] *Bandicota indica*
Anterior palatal foramina narrower at posterior than anterior end [Pl.- 19 Ph.- 25A], Mandibles with curved coronoid process [Pl.- 19 Ph.- 25B], Posterior cingulum absent behind lower molars m_1 and m_2 [Pl.- 19 Ph.- 25D]
..... *Bandicota bengalensis*
11. First upper molar more than one half the length of toothrow [Pl.- 13 Ph.- 19D]; Its antero internal cusp (t1) distorted inwards to reach the level of second lamina; Third upper molar extremely reduced 12

- First upper molar less than half the length of toothrow; Its antero-internal cusp (t1) not distorted inwards; Third upper molar not extremely reduced..... 16
12. Maxillary toothrow less than 4 mm 13
 Maxillary toothrow 4mm and or more 15
13. Skull with poorly developed supraorbital ridges [Pl.- 13 Ph.- 19C] 14
 Skull with well developed supraorbital ridges *Mus phillipsi*
14. Rostrum short and deep [Pl.- 13 Ph.- 19A], its least depth two-thirds of rostral length; Anterior accessory cusp on first upper molar (m¹) absent [Pl.- 13 Ph.- 19D] *Mus musculus*
 Rostrum long shallow [Pl.- 14 Ph.- 20A], its least depth only one half of rostral length , Presence of anterior accessory cusp on first upper molar (m¹) [Pl.- 14 Ph.- 20C] *Mus booduga*
15. An anterior accessory cusp present on first lamina of first upper molar [Pl.- 17 Ph.- 23B] *Mus saxicola*
 No anterior cusp present on first lamina of first upper molar [Pl.- 16 Ph.- 22D] *Mus platythrix*
16. Incisors grooved on front surface [Pl.- 18 Ph.- 24A], molars heavily cuspidate (Grape shaped) [Pl.- 18 Ph.- 24B] *Golunda ellioti*
 Incisors not grooved, Molars not heavily cuspidate 17
17. Skull sized small, Molar toothrow below 4 mm; Interorbital width of skull less than 4 mm [Pl.- 10 Ph.- 16A] *Vandeleuria oleracea*
 Skull size large, Molar toothrow above 4 mm; interorbital width more than 4mm 18
18. Anterior palatal foramina long and extending between maxillary toothrow [Pl.- 12 Ph.- 18A] *Millardia meltada*
 Anterior palatal foramina short and not extending between maxillary toothrow [Pl.- 11 Ph.- 17B] *Rattus rattus*

SYSTEMATIC ACCOUNT

1. *Suncus murinus* (Linnaeus)

Diagnostic characters

Cranial : Zygoma absent [Pl.-2 Ph.-3A] , Diastema absent in both, upper and lower jaw; Bullae imperfect; Skull size in the range of 28.1-36.3 mm; Rostrum long.

Mandible : Mandible length in the range of 13.4-17.5 mm. Coronoid process prominent, vertical, broad with a blunt end; Condyle short and stumpy; Notch between condyle and angular process in V shaped appearance; Angular process in slender projection [Pl.-2 Ph.-3D].

Dental : Upper toothrow (incisor to last molar) length in the range of 12.5-15.2 mm [Pl.-2 Ph.-3C]; Upper incisor curved; 4th upper unicuspid teeth (pm⁴) present, minute as compared to other premolars [Pl.-2 Ph.-3B]; Total 18 teeth in upper jaw; Two unicuspid lower premolars present; Lower incisors long, project forward horizontally; Total 12 teeth in lower jaw.

No. of examples studied 198 examples.

Study areas Amaravati, Kolhapur, Nandurbar, Pune, Raigad and Satara districts.

Predators Southern spotted owlet, Forest spotted owlet, Barn owl & Great Horned owl.

Remarks Most common in owl pellets.

2. *Suncus stoliczkanus* (Anderson)

Diagnostic characters

Cranial : Skull medium sized, 20-23 mm in length; Zygoma absent [Pl.-3 Ph.-4A].

Mandible : Mandible length 8.5-12.3 mm [Pl.-3 Ph.-4D].

Dental : Upper toothrow in the range of 8.0-9.4 mm; Large and prominent 4th upper unicuspid (pm⁴) tooth [Pl.-3 Ph.-4B,C]; Total 18 teeth in upper jaw and 12 in lower jaw. Other cranial, dental and mandibular characters are same as *Suncus murinus*.

No. of examples studied 21 examples.

Study areas Nandurbar and Pune districts.

Predators : Southern spotted owlet & Forest spotted owlet.

Remarks : Pande *et al.* (2004) and Jathar *et al.* (2005) reported this species as a prey of spotted owlet and Forest Owlet from Pune and Nandurbar districts, Maharashtra State respectively.

3. *Suncus etruscus* (Savi)

Diagnostic characters

Cranial Skull small sized, in the range of 12.5-18.2 mm; Zygoma absent [Pl.-4 Ph.-5A].

Mandible : Mandible length 5.6-9.2 mm [Pl.-4 Ph.-5C].

Dental : Upper toothrow 5.1-8.1 mm; pm⁴ prominent [Pl.-4 Ph.-5B]; Total 18 teeth in upper jaw and 12 in lower jaw. Other cranial, dental and mandibular characters are same as *Suncus murinus*.

No. of examples studied 13 examples.

Study areas : Amaravati, Nandurbar and Pune districts.

Predators Southern spotted owlet, Forest spotted owlet & Great Horned owl.

Remarks : Pande *et al.* (2004) and Jathar *et al.* (2005) reported this species as a prey of spotted owlet and Forest Owlet from Pune and Nandurbar districts, Maharashtra State respectively.

4. *Crocidura horsfieldi* (Tomes)

Diagnostic characters

Cranial Skull length in the range of 16.5-18.0 mm [Pl.-5 Ph.-6A].

Mandible Mandible length about 8.2 mm [Pl.-5 Ph.-8].

Dental : Upper toothrow length in the range between 6.8-8.0 mm; 4th Unicuspid teeth (pm⁴) absent in upper jaw [Pl.-5 Ph.-6B]; 3rd unicuspid greater than 2nd unicuspid teeth.

No. of examples studied One skull with mandible.

Study areas Saswad, Pune district.

Predators : Indian Great Horned Owl (*Bubo bengalensis* Franklin).

Remarks : While studying the skull material one interesting skull specimen was collected from Saswad, Pune Dist. on 19.vi.2005 by Dr. Satish Pande. It was collected from the pellet of Great Horned Owl species (*Bubo bengalensis* Franklin). It was observed that the skull of this specimen was bearing only three unicuspid teeth in the upper jaw [Pl.- 5 Ph.-6B, Marked by arrow] with third unicuspid tooth greater than the second. Comparison of the lateral view of the present skull with those of *Suncus murinus* and *Suncus etruscus* skulls has been given in Pl.-5 Ph.-7ABC. The characters and measurements of the skull under study (Table- 1) match with those of *Cocidura horsfieldi* as mentioned in Corbet and Hill (1992). Khajuria (1972) reported *Cocidura horsfieldi* from Jabalpur, in Central India on the basis of study of a skull without lower jaw collected from the pellet of an owl species (*Tyto alba*). Rao and Aswathnarayana (1978) also reported this species from Mysore, South India. Its range of distribution in India appears to be fragmented/isolated Jammu and Kashmir (Chakraborty, 1983), Karnataka (Rao and Aswathnarayana (1978), Central India (Khajuria (1972) and Pune Dist., Maharashtra State (Present Study). Present study reports distribution of *Cocidura horsfieldi* for the first time from Maharashtra State in Western India.

Table 1 : Cranial and dental measurements (mm) of *Cocidura horsfieldi* (Tomes) skull found in a pellet of Great Horned Owl (*Bubo bengalensis* Franklin) from Maharashtra State compared with those reported by Corbet & Hill (1992).

	Corbet and Hill (1992)	Present Study
cbl	16.5 – 18.0	15.7+
pal	—	7.4
nas	—	1.8
iw	—	3.0
utr	6.8 – 8.0	7.2
ml	—	8.2
4 th Unicuspid teeth	Absent	Absent
Unicuspid teeth	Third unicuspid greater than second unicuspid	Third unicuspid greater than second unicuspid

5. *Rousettus* sp.

Diagnostic characters :

Cranial : Skull big size; Zygoma present [Pl.-6 Ph.-9]; Post orbital process well developed [Pl.-6 Ph.-10A, Marked by arrow]; Rostrum slender.

Mandible : Mandible relatively more slender and delicate; Angular process of the mandible broad and low [Pl.-6 Ph.-10 C, Marked by arrow]; Mandible length in the range of 27.0-32.3 mm.

Dental : Canines present [Pl.-6 Ph.-10B, Arrow 1] on upper and lower jaw; Molars simple, flat crowned with longitudinal furrows; Second upper molar (m^2) present [Pl.-6 Ph.-10B, Arrow 2]; Total 16 teeth in upper jaw (In pair, 2 incisors, 1 canine, 3 premolars and 2 molars); upper toothrow (cm^2) ranges between 12.7-15.5 mm. Lower toothrow (cm_3) in the range of 14.2-17.1 mm; 18 teeth in lower jaw (In pair, 2 incisors, 1 canine, 3 premolars and 3 molars). Third lower molar (m_3) in mandible present [Pl.-6 Ph.-9A, Arrow 5].

No. of examples studied : 20 examples.

Study areas Pune district.

Predators : Great Horned Owl.

Remarks : Though only one species of *Rousettus* (*Rousettus leschenaulti*) has been reported from Maharashtra State it is not possible to identify up to species level on the basis of only skull pieces.

6. *Cynopterus* sp.

Diagnostic characters :

Cranial Skull size smaller than *Rousettus* sp.; Post orbital process well developed [Pl.-7 Ph.-11A, Marked by arrow 1].

Mandible Mandible length ranges between 22.4-27.5 mm.

Dental Upper toothrow (cm^1) ranges between 10.7-12.5 mm; Second upper molar (m^2) absent [Pl.-6 Ph.-9B, Arrow 4], presence of first upper molar (m^1) only [Pl.-7 Ph.-11C Arrow marked]; Total 14 teeth (In pairs, 2 incisors, 1 canine, 3 premolars and 1 molar) present in upper jaw; Total 16 teeth (In pairs, 2 incisors, 1 canine, 3 premolars and 2 molars) in lower jaw; Presence of lower second molar (m_2)

[Pl.-7 Ph.-11 B, Marked by arrow]; Lower toothrow (cm₂) ranges between 10.4-13.6 mm. Other skull and mandible characters are same as *Rousettus* sp.

No. of examples studied 4 examples.

Study areas : Pune district.

Predators Barn Owl and Great Horned Owl.

Remarks Two species of *Cynopterus* have been reported from Maharashtra State. On the basis of skull pieces alone identification up to species level is not possible.

7. *Pipistrellus* sp.

Diagnostic characters :

Cranial : Skull very small in size; Postorbital process absent [Pl.-7 Ph.-12A; Marked by arrow].

Mandible Mandible length about 8.2 mm.

Dental : molars complex with regular pattern of cusps and ridges forming a definite W or N surface outline with transverse furrows [Pl.-7 Ph.-12B]; skull with one or two incisors in upper jaw [Pl.-7 Ph.-12B, Arrow 1], two upper premolars [Pl.-7 Ph.-12B Arrow 2] and third upper molar (m³) present [Pl.-7 Ph.-12B, Arrow 3]. 3 pairs of incisors in lower jaw [Pl.-7 Ph.-12C, Arrow].

No. of examples studied : Only one example.

Study areas Satara district.

Predators Barn Owl.

Remarks Only two skull pieces were studied for identification during the present study. On the basis of the available key characters they were identified up to genus level only.

8. *Tatera indica* (Hardwicke)

Diagnostic characters :

Cranial Zygomatic plate projecting forwards to half of rostrum [Pl.-8 Ph.-13]; Diastema present in upper and lower jaw; Palate long extending posteriorly behind third molars [Pl.-8 Ph.-14].

Mandible : Mandibles possess backwardly pointing coronoid process. An elevated condylar process projecting backward and inward beyond coronoid process [Pl.-9 Ph.-15D]; Angular process narrow, considerably drawn backward nearly in a line with condylar process and twisted out distally; Condyle and angular processes separated by a deep notch; Masseteric process prominently developed.

Dental Upper incisors ophistodont, grooved on front surface [Pl.-8 Ph.-13]; Molars biserially cuspidate [Pl.-8 Ph.-14] (cusp like islands were observed in worn out molars [Pl.-9 Ph.-15A]); First upper molar (m^1) 4-rooted, second (m^2) 3-rooted and third (m^3) single rooted [Pl.-9 Ph.-15B,C]; Molar toothrow ranges 5.4-6.7mm.

No. of examples studied : 35 examples.

Study areas : Amaravati, Nandurbar, Pune and Ratnagiri districts.

Predators Southern Spotted Owlet, Forest Spotted Owlet and Great Horned Owl.

Remarks : Jathar *et al.* (2005) recorded *Tatera indica* (Hardwicke) as a prey species of Forest Owlet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State. It appears to be fairly common in owl pellets.

9. *Vandeleuria oleracea* (Bennet)

Diagnostic characters

Cranial Skull narrow and small in size; Diastema present in upper and lower jaw. Frontals constricted [Pl.-10 Ph.-16A], least interorbital width less than 4 mm.

Mandible : Mandible length ranges between 8.5-12.3 mm.

Dental Upper incisors narrow, yellow and not grooved; Three pairs of molars in each jaw; Maxillary toothrow in the range of 3.0-3.6 mm (below 4mm); Upper molars triserially cuspidate; First upper molar (m^1) 4-rooted [Pl.-10 Ph.-16B]; t_7 (postero-internal cusp) present in upper molars [Pl.-10 Ph.-16C]; m^1 with 9 cusps, m^2 8-cusped and m^3 reduced; Lower molars biserially cuspidate.

No. of examples studied 6 examples.

Study areas Nandurbar, Pune districts.

Predators : Southern Spotted Owlet, Forest Spotted Owlet, Barn Owl and Great Horned Owl.

Remarks : Jathar *et al.* (2005) recorded *Vandeleuria oleracea* (Bennet) as a prey species of Forest Owlet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State.

10. *Rattus rattus* (Linnaeus)

Diagnostic characters :

Cranial : Skull medium sized; Anterior palatal foramina long, reaching posteriorly up to molars [Pl.-11 Ph.-17B, Arrow 1]; Nasal short; Palate long, extending posteriorly beyond third upper molars [Pl.-11 Ph.-17B, Arrow 2].

Mandible Mandible long and broad; Moderately developed coronoid process, slightly curved with tapering and posteriorly extended angular process; Masseteric process poorly developed [Pl.-11 Ph. -17E]; Length of mandible in the range of 17.1-23.5 mm.

Dental : Upper incisors orthodont and not grooved; Three pairs of molars in each jaw; maxillary tooththrow in the range of 6.0-7.0 mm (above 4mm). First upper molar (m^1) 5-rooted [Pl.-11 Ph.-17C]; m^1 having 8 cusps (t7 absent); m^2 6-cusped (t2, t3, t7 absent), occasionally t3 present; m^3 small; Lower first molar (m_1) trilaminated, m_2 and m_3 bilaminated.

No. of examples studied : 22 examples.

Study areas : Kolhapur, Nandurbar, Pune, Raigad, Ratnagiri & Satara districts.

Predators : Forest Spotted Owlet, Barn Owl and Great Horned Owl.

Remarks : *Rattus rattus* (Linnaeus) appears to be a frequently occurring prey species in owl pellets.

11. *Millardia meltada* (Gray)

Diagnostic characters :

Cranial : Skull medium sized; Nasals long, Supraorbital ridges well developed; Diastema present in each jaw; Anterior palatal foramina long and extending between maxillary tooththrow [Pl.-12 Ph.-18A].

Mandible Mandible length ranges 16.2-17.4 mm; Coronoid process slightly curved with tapering end [Pl.-12 Ph.-18E]; Narrow and long condyle and angular processes; Deep curved notch between them present.

Dental Molar tooththrow length ranges between 5.5-6.2 mm; Three pairs of molars in each jaw; m^1 with 8 cusps, m^2 with 7 cusps (t^3 very small and usually present [Pl.-12 Ph.-18 B]); m^3 small with 6 cusps; m^1 5-rooted [Pl.-12 Ph.-18 C, D].

No. of examples studied : 34 examples.

Study areas : Amaravati and Pune districts.

Predators : Great Horned Owl.

Remarks : In Maharashtra State two species of *Millardia* have been reported. Out of these *Millardia meltada* is widely distributed, while other *Millardia kondana* has been reported only from its type locality (Sinhgad, Pune Dist.); Skulls of both the species are distinguished from each other only by size viz. smaller in *Millardia meltada* while larger in *Millardia kondana*. The prey species appears to be occurring frequently in owl pellets.

12. *Mus musculus* (Linnaeus)

Diagnostic characters

Cranial : Skull small; Supraorbital ridges poorly developed [Pl.-13 Ph.-19C]; Rostrum short and deep [Pl.-13 Ph.-19A], its least depth two-thirds of rostral length; Diastema present in both the jaws; Anterior palatal foramina elongated, extending posteriorly between maxillary tooththrows [Pl.-13 Ph.-19B].

Mandible : Mandible length ranges 7.2-11.1 mm; Coronoid process slightly curved with tapering end; condyle and angular processes narrow and long; Deep notch between condyle and angular processes [Pl.-13 Ph.-19F].

Dental Upper incisors ophistodont; Molars 3 pairs in each jaw; First upper molar more than one half the length of the entire tooththrow (m^1 larger than m^2 and m^3 together) [Pl.-13 Ph.-19D]; Maxillary tooththrow in the range of 3.0-3.5 mm (less than 4mm); Anterior accessory cusp on the first upper molar absent [Pl.-13 Ph.-19D].

No. of examples studied 18 examples.

Study areas : Kolhapur and Nandurbar districts.

Predators Forest Spotted Owlet and Barn Owl.

Remarks Jathar *et al.* (2005) recorded *Mus musculus* Linnaeus as a prey species of Forest Owlet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State. The species appears to be fairly common in owl pellets.

13. *Mus booduga* (Gray)

Diagnostic characters :

Cranial Skull size small; Rostrum long and shallow, its least depth only one half of the rostral length [Pl.-14 Ph.-20A]; Palate long, extending posteriorly behind third upper molar [Pl.-14 Ph.-20B]; Anterior palatal foramina long extending posteriorly between maxillary toothrow [Pl.-14 Ph.-20B].

Mandible : Other skull and mandible characters as same as *Mus musculus*.

Dental Anterior accessory cusp on first upper molar (m^1) present [Pl.-14 Ph.-20C, Arrow 1]. Anteroexternal cusp on the first molar prominent [Pl.-14 Ph.-20C, Arrow 2]. Antero internal cusp heavily distorted on the inner side [Pl.-14 Ph.-20C, Arrow 3].

No. of examples studied : 17 examples.

Study areas Kolhapur and Nandurbar districts.

Predators : Forest Spotted Owlet and Barn Owl.

Remarks, if any Jathar *et al.* (2005) recorded *Mus booduga* (Gray) as a prey species of Forest Owlet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State. The species appears to be fairly common in owl pellets.

14. *Mus phillipsi* (Wroughton)

Diagnostic characters

Cranial : Skull size small with well developed supraorbital ridges.

Mandible , Same as *Mus musculus*.

Dental : Maxillary toothrow less than 4mm; Upper incisors ophistodont [Pl.-18 Ph.-21A]; Anterior palatal foramina extending posteriorly between maxillary toothrow [Pl.-15 Ph.-21B]; Molars 3 pairs in each jaw; First upper molar without an anterior accessory cusp [Pl.-15 Ph.-21C].

No. of examples studied 4 examples.

Study areas Nandurbar district.

Predators : Forest Spotted Owlet.

Remarks Jathar *et al.* (2005) recorded *Mus phillipsi* Wroughton as a prey species of Forest Owlet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State.

15. *Mus platythrinx* (Bennet)

Diagnostic characters

Cranial : Medium sized skull with prominent supraorbital ridges [Pl.-16 Ph.-22A]; Anterior border of zygomatic plate rises vertically then turns back in an arc of a quarter circle at the zygomatic notch [Pl.-16 Ph.-22C]; Anterior palatal foramina relatively short, extending posteriorly up to anterior root of first upper molar [Pl.-16 Ph.-22B Arrow 1]; Interpterygoid space wider (width 0.85 ± 0.12 mm) than *Mus saxicola* [Pl.-16 Ph.-22B Arrow 2].

Mandible : Mandible length ranges between 12.1-14.5 mm.

Dental : Maxillary toothrow more than 4 mm, ranges between 4.3-5.0 mm; Upper incisors ophistodont or orthodont, with or without notch; No anterior accessory cusp present on anterior root of first upper molar [Pl.-16, Ph.-22D].

No. of examples studied Two examples.

Study areas Nandurbar district.

Predators Forest Spotted Owlet.

Remarks : Jathar *et al.* (2005) recorded *Mus platythrinx* Bennet as a prey species of Forest Owlet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State.

16. *Mus saxicola* (Elliot)

Diagnostic characters

Cranial Medium sized skull with prominent supraorbital ridges; Anterior border of zygomatic plate arched forward convexly [Pl.-17 Ph.-23C]; Palate long, extending posteriorly behind third molar [Pl.-17 Ph.-23A]. Interpterygoid space narrower than in *Mus platythrinx* (width 0.5 ± 0.1 mm) [Pl.-17 Ph.-23A, Arrow 3]. Anterior palatal foramina long extending posteriorly up to second lamina of first upper molars [Pl.-17 Ph.-23A];

Mandible Mandible length in the range of 8.2-14.7mm.

Dental Upper incisors ophistodont or orthodont without notch; An accessory cusp present in the anterior root of first upper molars [Pl.-17 Ph.-23B]; Maxillary toothrow more than 4 mm ranges between 4.4-5.0 mm.

No. of examples studied 18 examples.

Study areas Kolhapur, Nandurbar, Pune and Satara districts.

Predators Southern Spotted Owlet, Forest Spotted Owlet, Barn Owl and Great Horned Owl.

Remarks Jathar *et al.* (2005) recorded *Mus saxicola* Elliot as a prey species of Forest Owllet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State. The species appears to be fairly common in owl pellets.

17. *Golunda ellioti* Gray

Diagnostic characters :

Cranial Palate ending posteriorly in between pair of third upper molars [Pl.-18 Ph.-24B, Arrow 3].

Mandible Mandible length in the range of 15.5-17.7 mm.

Dental Upper incisors red in colour, broad and prominently grooved [Pl.-18 Ph.-24A]; Molars heavily cuspidate (Grape-shaped) [Pl.-18 Ph.-24B]; Third upper molar large, lacks the outer row of cusps; Maxillary toothrow length in the range of 6.2-6.6 mm; First upper molar (m^1) with 8 cusps (t7 absent); m^2 7 cusps (t2, t7 absent); m^3 with 4 functional cusp; Lower molars biserially cuspidate [Pl.-18 Ph.-24E]

No. of examples studied : 44 examples.

Study areas Kolhapur, Nandurbar, Pune and Satara districts.

Predators Southern Spotted Owlet, Forest Spotted Owlet, Barn Owl and Great Horned Owl.

Remarks Jathar and Rahamani (2004) recorded *Golunda ellioti* Gray as a prey species of Forest Owllet from Toranmal Reserve Forest, Nandurbar Dist., Maharashtra State. Appears to be occurring frequently in owl pellets.

18. *Bandicota bengalensis* (Gray)

Diagnostic characters

Cranial Skull large; Condylbasal length exceeds occipitonasal length (If full skull is available in pellet, it can be measured); Supraorbital ridges well developed; Anterior palatal foramina long extending posteriorly upto first lamina of first upper

molar and narrower at posterior than anterior end [Pl.-19 Ph.-25A]; Nasal short; Diastema long.

Mandible : Mandibles strong stout and long. Mandibular length measures ranges between 19.5-30.3 mm; Backwardly curved coronoid process and broad angular process; Masseteric process prominently developed [Pl.-19 Ph.-25B].

Dental : Upper incisors broad, proodont, orange to lemon yellow in colour on front surface; Maxillary toothrow length ranges between 7.1-9.0 mm; First upper molar (m^1) 5 rooted, m^2 4 rooted and m^3 3 rooted; Three laminae on m^1 and two each on m^2 and m^3 [Pl.-19 Ph.-25C]; t_7 cusp is retained in upper molars, while t_8 and t_9 merged to form lamina; Traces of antero-internal cusp (t_1) present on m^2 and m^3 ; Lower molars like upper ones; No posterior cingulum behind m_1 and m_2 present [Pl.-19 Ph.-25D].

No. of examples studied : 109 examples.

Study areas : Amaravati, Kolhapur, Pune, Raigad, Ratnagiri & Satara districts.

Predators : Barn Owl and Great Horned Owl.

Remarks : Surprisingly, *Bandicota bengalensis* (Gray) appears to be a common prey species after *Suncus murinus* (Linnaeus) in owl pellets.

19. *Bandicota indica* (Bechstein)

Diagnostic characters :

Cranial : Skull large; Condylbasal length exceeds occipitonasal length; Anterior palatal foramina as long as *Bandicota bengalensis* but equally broad at both the ends and it may or may not extend between the upper molars [Pl.-20 Ph.-26 A]; Nasals long.

Mandible Mandible length ranges between 29.0-33.5 mm.

Dental First upper molar (m^1) 5 rooted (Pl.-20 Ph.-26B); m^1 trilaminate, m^2 and m^3 bilaminate; maxillary toothrow ranges between 7.8-11.4 mm; Posterior cingulum present behind first and second lower molars (m_1) and (m_2) [Pl.-20 Ph.-26C].

No. of examples studied 6 examples.

Study areas Pune, Raigad, Ratnagiri and Satara district.

Predators : Barn Owl and Great Horned Owl.

Remarks Since the molars are not at all worn out (Pl.-20 Ph.-26) in *Bandicota indica* skull pieces collected from the owl pellets under study. The age status apparently appears to be sub-adult.

SUMMARY

Altogether 573 examples of small mammals were studied and identified from the owl pellet material of 4 owl species viz., *Tyto alba* (Scopoli) (Barn Owl), *Bubo bengalensis* (Franklin) (Indian Great Horned Owl), *Athene brama* (Temminck) (Southern Spotted Owlet) and *Heteroglaux blewitti* Hume (Forest Spotted Owlet) from Maharashtra state. Small mammal species composition in owl pellets shows occurrence of twelve species of rodents, four species of shrews and 3 species of bats. It is also observed that rodents are most abundant prey species (55%; 315 out of 573 examples) followed by insectivore species (41%; 233 out of 573). Only 4% of Chiropteran species (25 out of 573 examples) were detected from the pellet material. Present study reports distribution of *Crocidura horsfieldi* for the first time from Maharashtra State in Western India. There is also a possibility of additions of other small mammal species in owl pellets other than those discussed in the present work.

Advantages of pellet analysis

- i) A large number pellet sample can be acquired with relatively little expense of time or disturbances to the owl species (raptors).
- ii) Owl pellets can be used for the taxonomic study of small mammal species, their diversity and distribution as well as in the studies of owl behaviour patterns.
- iii) Pellet analysis serves as a nondestructive means of diet determination.
- iv) Owl pellets represent a non-invasive sampling technique, which provides a valuable source of DNA for studying population genetics of small mammals (Taberlet and Fumagalli, 1996).

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PLATE 1

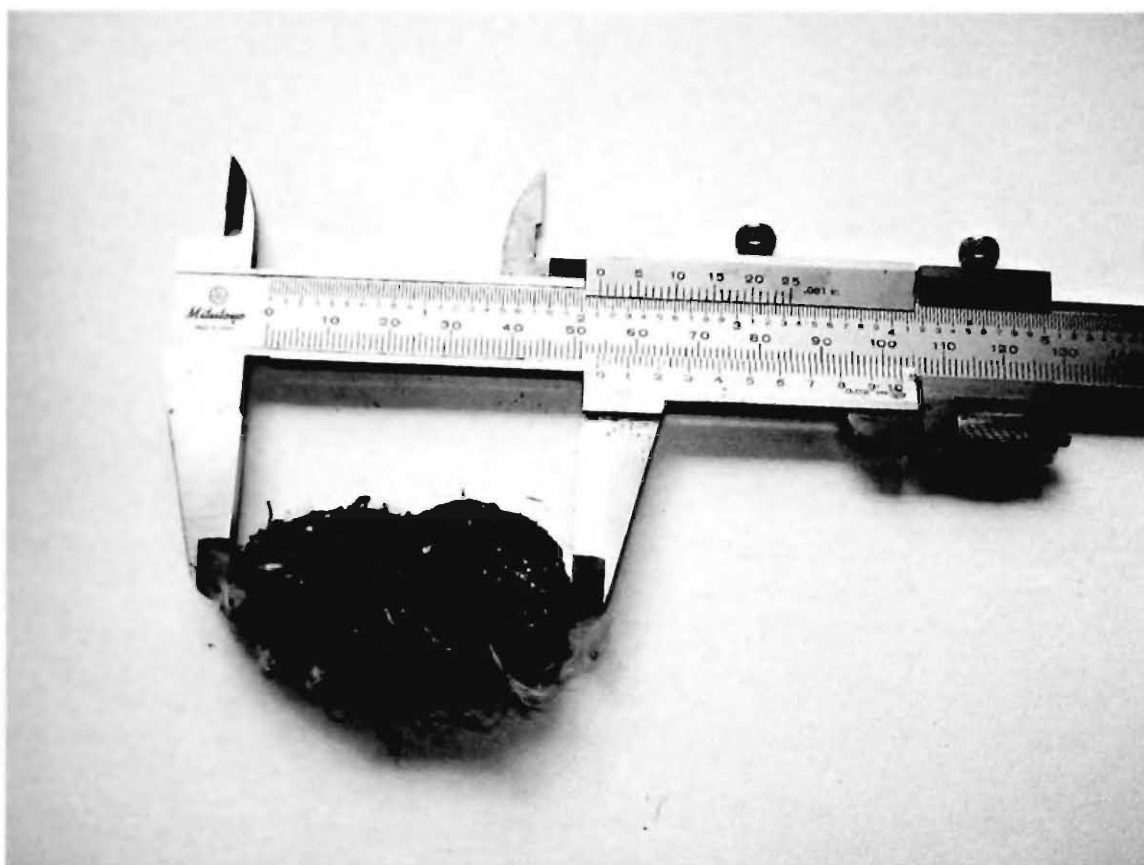


Photo 1 : A Barn owl pellet



Photo 2 : Bone material from single pellet of Barn owl showing upper and lower jaw (encircled) and other bone parts of *Suncus murinus* (Lin.)

PLATE 2

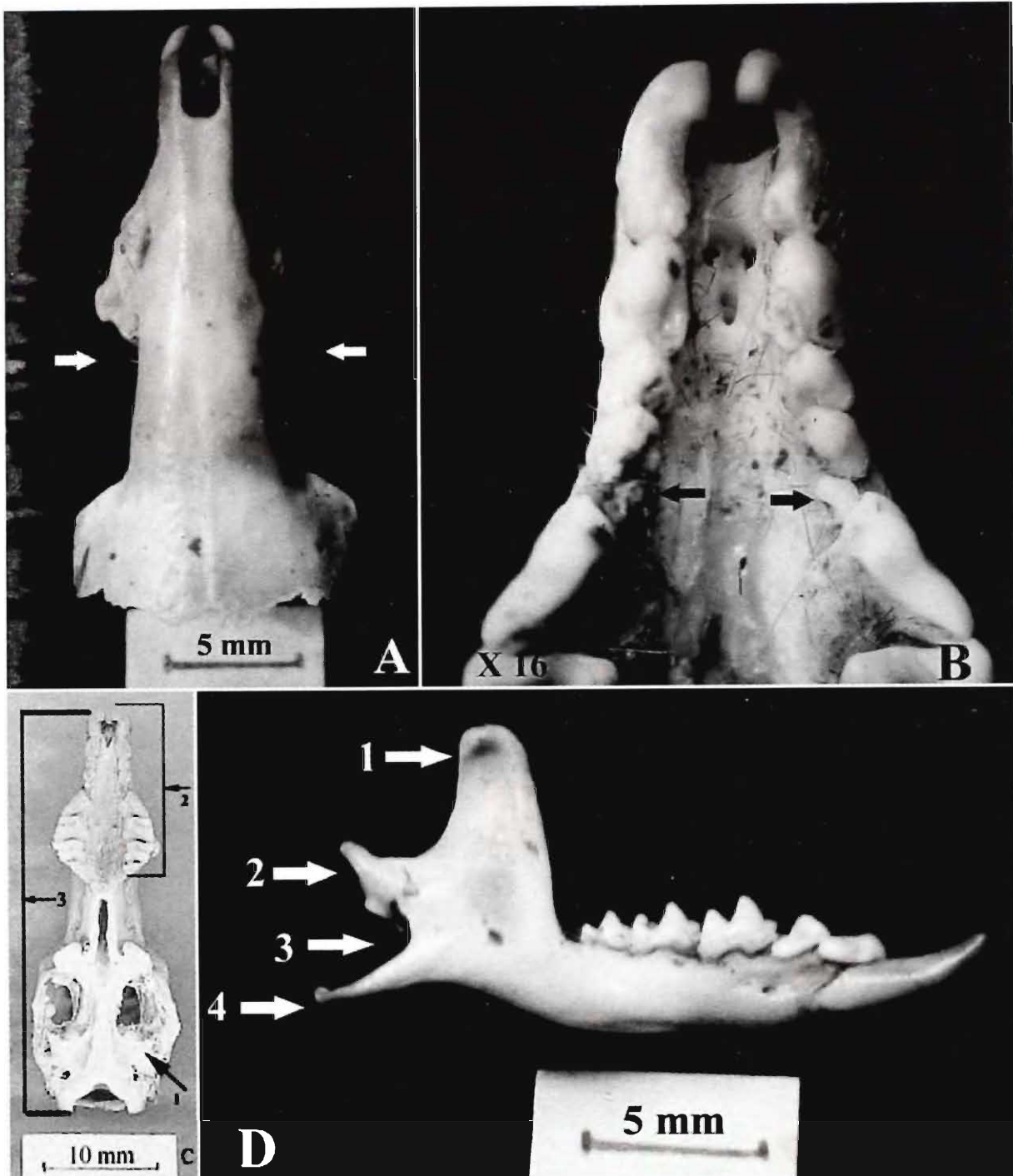


Photo 3 : *Suncus murinus* (Linnaeus) skull material from owl pellets.

- A. Dorsal view of skull piece of *Suncus murinus* (Linnaeus). Arrow marks show absence of zygoma.
- B. Ventral view of skull piece of *Suncus murinus* (Linnaeus). Arrow marks show presence of minute 4th upper unicuspid teeth (pm⁴).
- C. Ventral view skull of *Suncus murinus* (Linnaeus). 1. Arrow mark shows bullae imperfect. 2. Length of upper tooththrow (utr). 3. Condylobasal length (cbl).
- D. Mandible (Right side) of *Suncus murinus* (Linnaeus) Arrow marks show : 1. Coronoid process prominent, vertical, broad with a blunt end. 2. Condyle short and stumpy. 3. V-shaped notch between condyle and angular proceses and 4. Angular process in slender projection.

PLATE 3

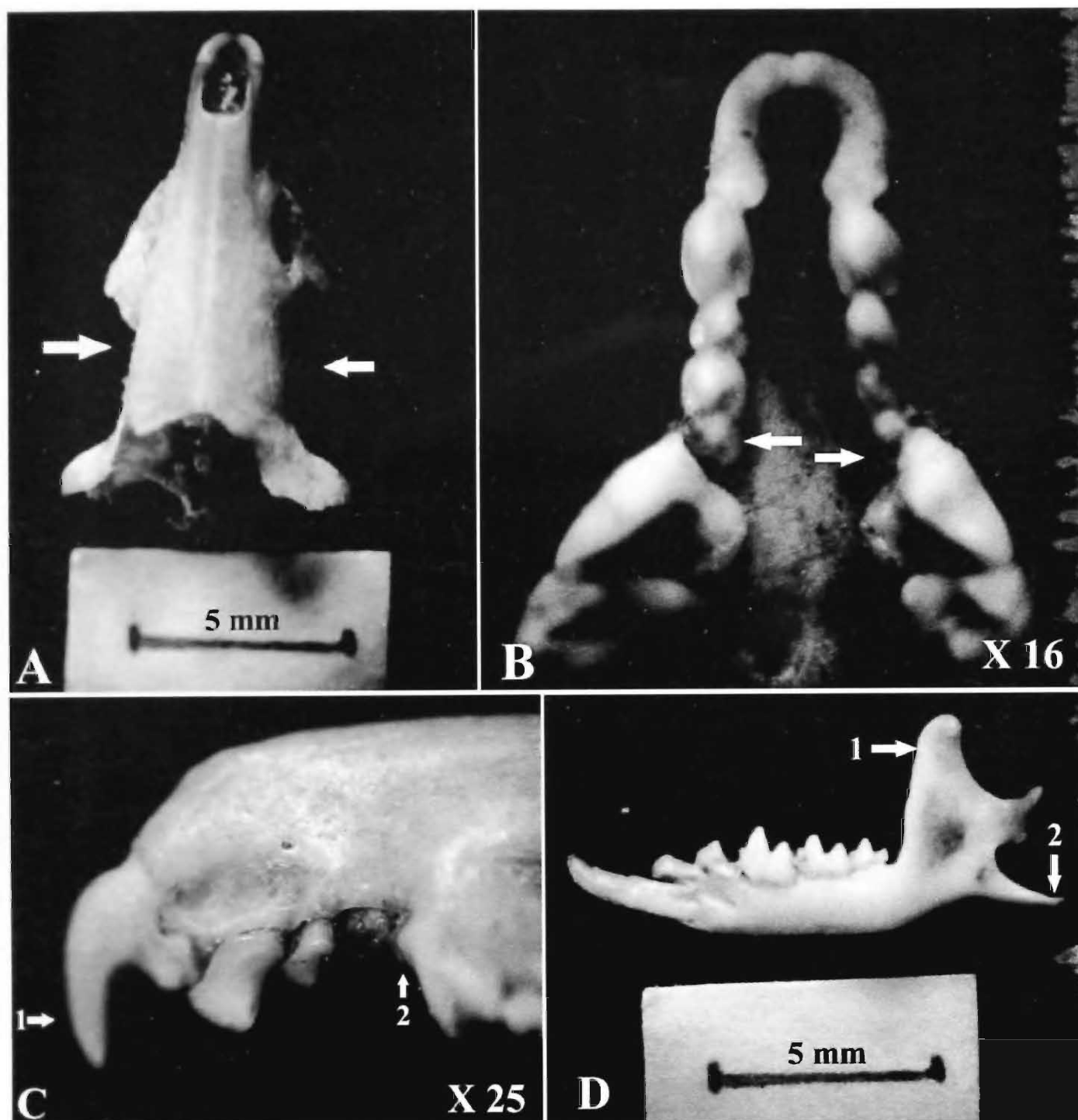


Photo 4 : *Suncus stoliczcanus* (Anderson) skull material from owl pellets.

- A. Dorsal view of skull piece of *Suncus stoliczcanus* (Anderson). Arrow marks show absence of zygoma.
- B. Ventral view of skull piece of *Suncus stoliczcanus* (Anderson). Arrow marks show prominent 4th upper unicuspid teeth (pm⁴).
- C. Lateral view of skull of *Suncus stoliczcanus* (Anderson) Arrow marks show 1. upper incisor curved 2. Upper 4th unicuspid teeth.
- D. Mandible (Left side) of *Suncus stoliczcanus* (Anderson) Arrow marks show : 1. Coronoid process prominent, vertical, broad with a blunt end 2. Angular process in slender projection.

PLATE 4

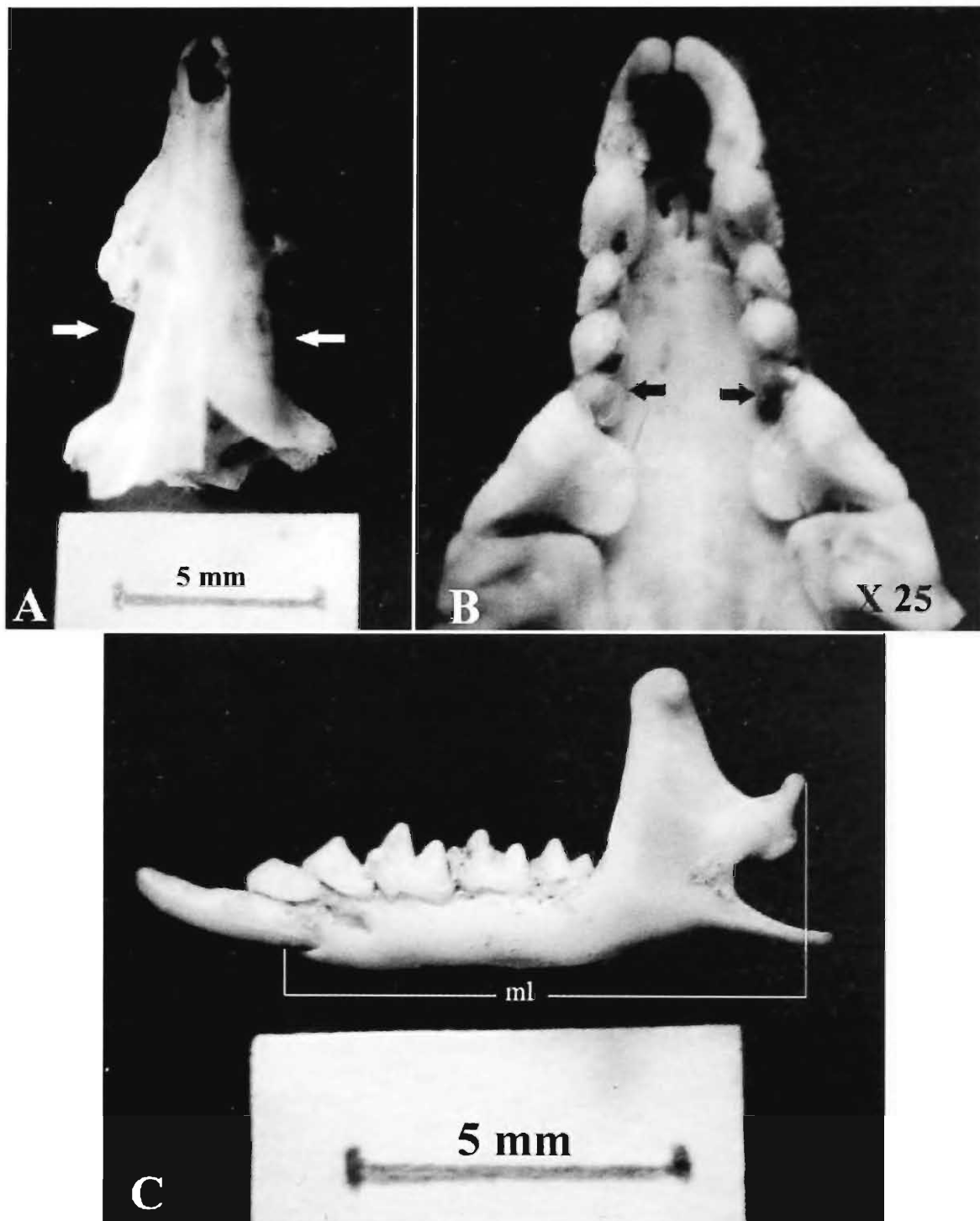


Photo 5 : *Suncus etruscus* (Savi) skull material from owl pellets.

- A. Dorsal view of skull of *Suncus etruscus* (Savi) Arrow marks show absence of zygoma.
- B. Ventral view of skull of *Suncus etruscus* (Savi) Arrow mark shows prominent upper 4th unicuspid teeth (Toothrow length 5.1-8.1 mm).
- C. Mandible of *Suncus etruscus* (Savi) showing mandibular length (ml).

PLATE 5

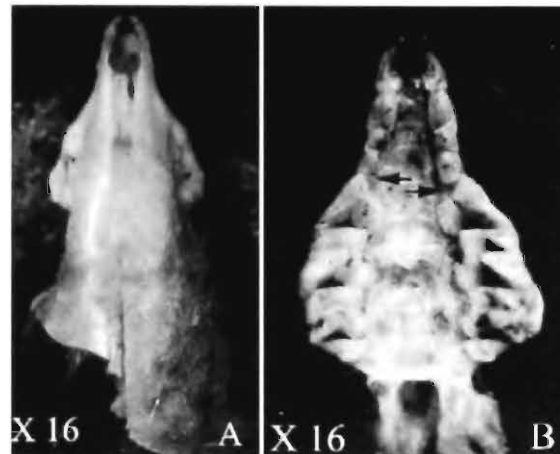


Photo 6 : Skull photos of *Crocidura* species **A.** Dorsal view. **B.** Ventral view : Arrow marks showing absence of 4th unicuspid teeth (pm^4).

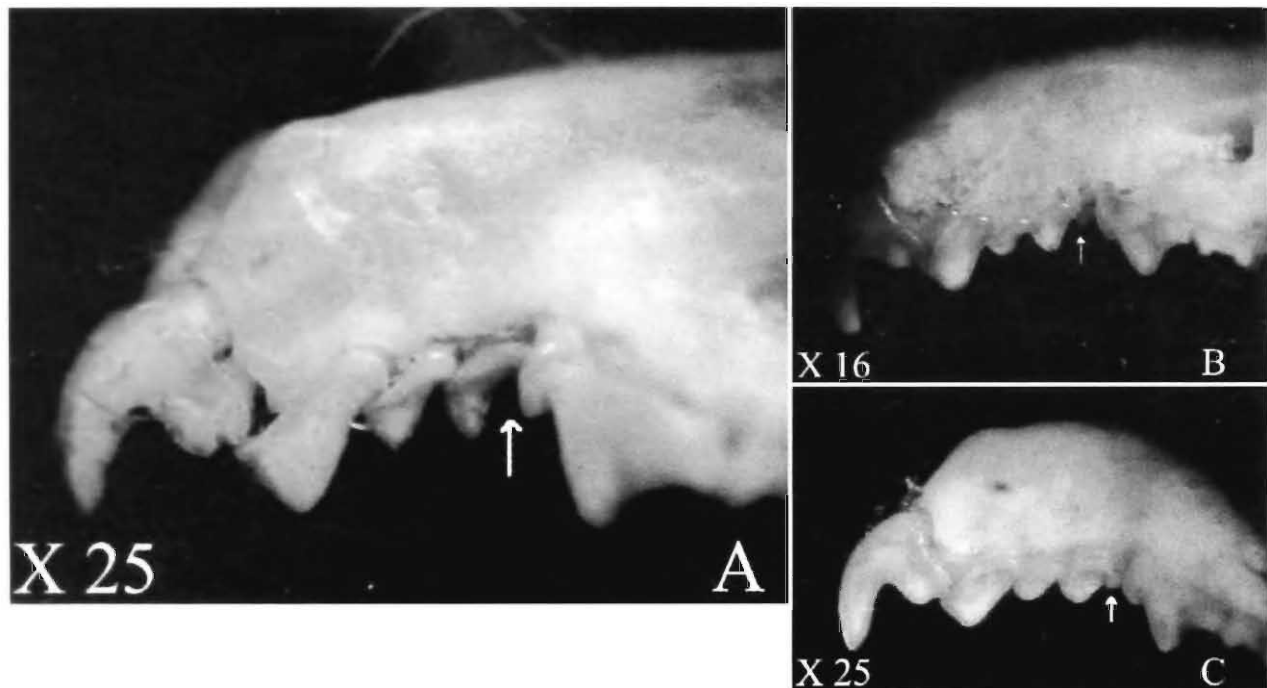


Photo 7 : Lateral views of skulls : **A.** *Crocidura* species (X25). Arrow mark shows absence of 4th upper unicuspid teeth (pm^4). **B.** *Suncus murinus* (Lin.) (X 16) (ZSI.WRS. M/664); **C.** *Suncus etruscus* (Savi) (X 25) (ZSI.WRS. M/476); Arrow marks showing 4th upper unicuspid (pm^4) in B and C.



Photo 8 : Mandible of *Crocidura* species (Tomes) (Lateral view).

PLATE 6

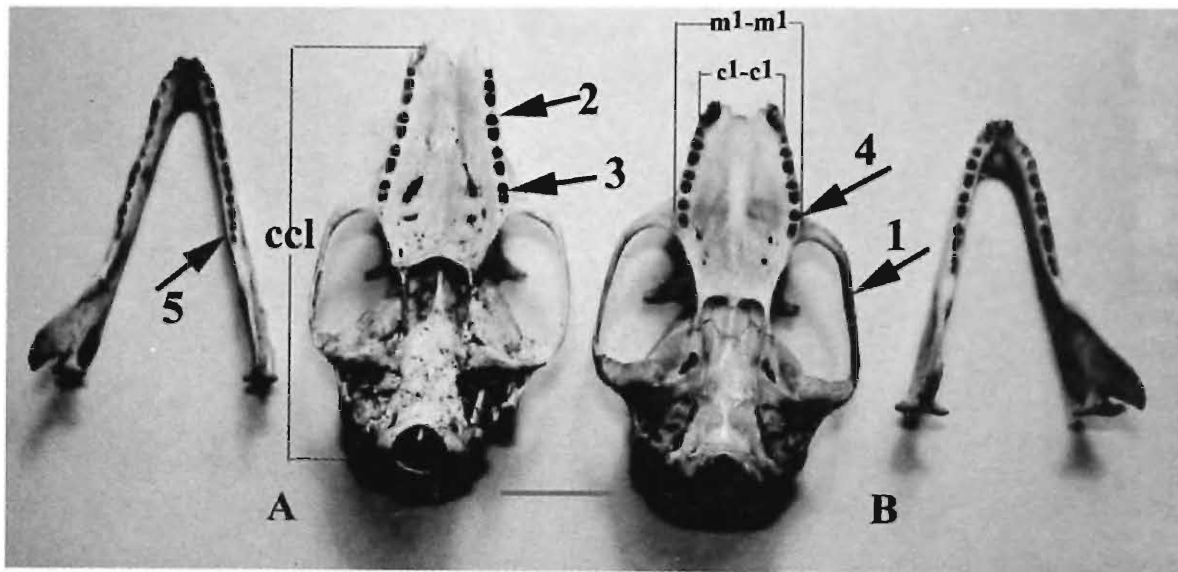


Photo 9 : Comparison of two Bat sp. (Ventral view of skull and mandibles obtained from owl pellets) :
A. *Rousettus* sp.
B. *Cynopterus* sp. (Scale bar A & B = 10 mm) 1. Arrow marks show presence of zygoma. 2. Arrow marks show toothrow without diastema. 3. Arrow mark show presence of second upper molar (socket of m^2) in *Rousettus* sp. 4. Arrow mark shows absence of second upper molar (Arrow show socket of m^1) in *Cynopterus* sp. 5. Arrow mark shows sockets of third lower molar (m_3) in mandible of *Rousettus* sp.

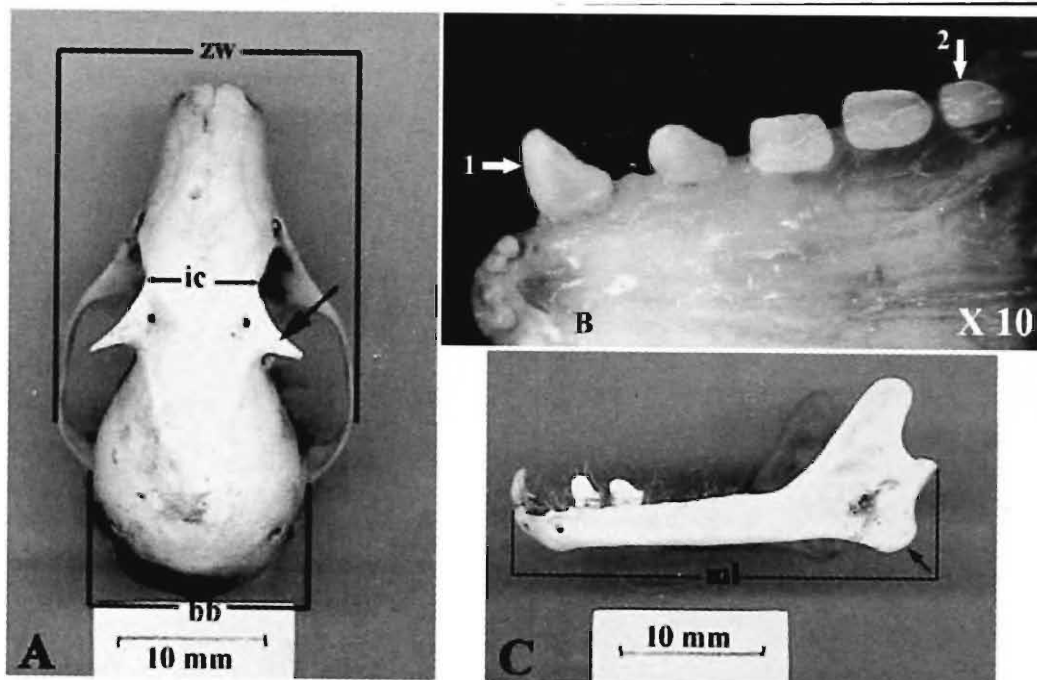


Photo 10 : *Rousettus* sp. skull material from owl pellets.
A. Dorsal view of skull shows greatest zygomatic width (zw), Interorbital constriction (ic), Breadth of brain case (bb) and Arrow shows well developed postorbital process.
B. Upper toothrow of *Rousettus* sp. Arrow marks show 1. Canine 2. Second upper molar (m^2) present (which is absent in *Cynopterus* sp.). Molars simple, flat crowned with longitudinal furrows.
C. Mandible (left side) : Showing length of mandible (ml). Arrow shows broad and low Angular process.

PLATE 7

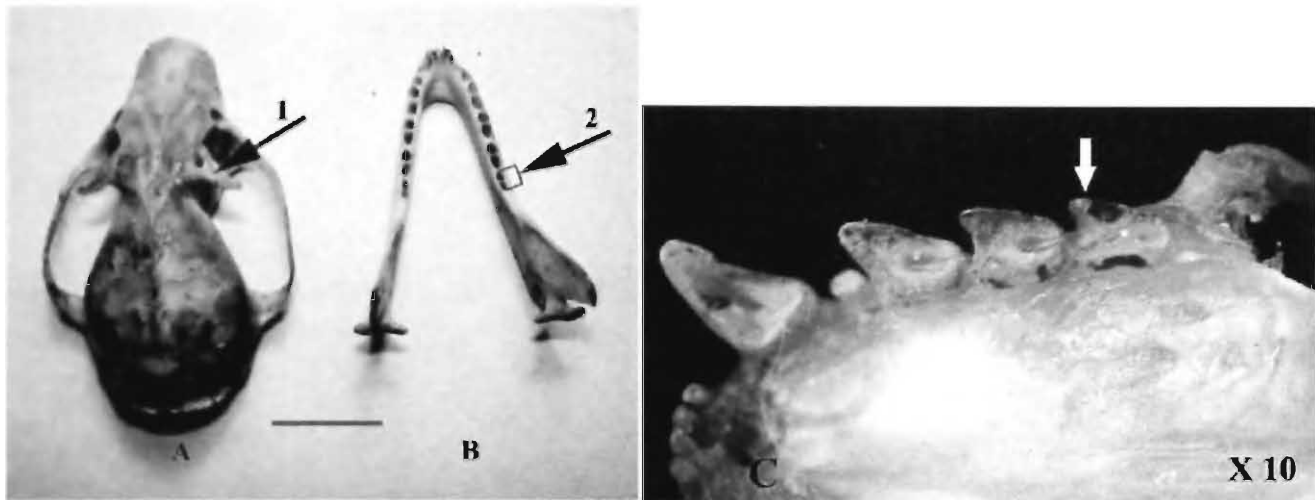


Photo 11 : *Cynopterus* sp. skull material from owl pellet (Scale bar A & B = 10mm).
 A. Skull of *Cynopterus* sp. showing well developed postorbital process (Arrow mark)
 B. Ventral view of mandible of *Cynopterus* sp. Arrow shows sockets of second lower molar (m_2).
 C. Upper toothrow of *Cynopterus* sp. Arrow mark shows first upper molar (m^1) and absence of upper second molar tooth (m^2).

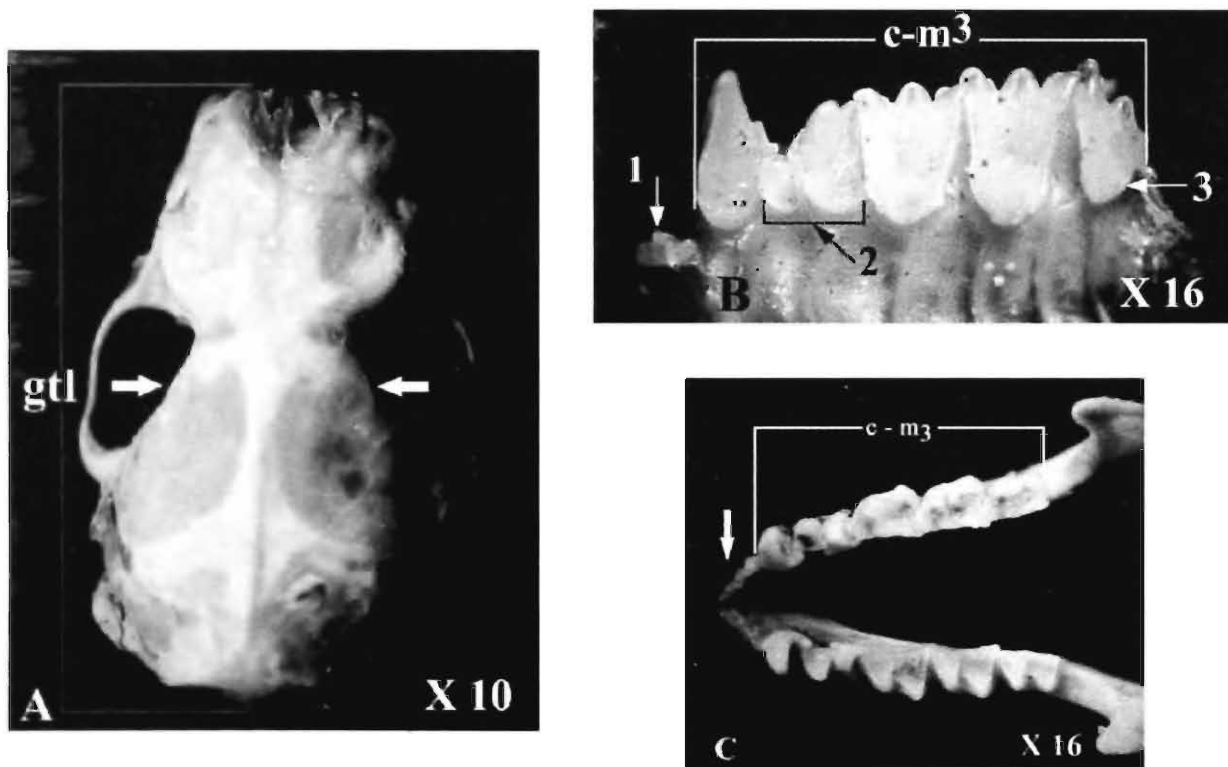


Photo 12 :
 A. Dorsal view of skull of Vespertilionid bat (*Pipistrellus* sp.) showing greatest length of skull (gtl); Arrow marks shows absence of postorbital process.
 B. Occlusal view of upper toothrow ($c-m^3$) of vespertilionid bat (*Pipistrellus* sp.) showing complex molars with regular pattern of cusps and ridges forming a definite W or N surface outline (Transverse furrows). Arrow marks show 1. two upper incisors 2. Two upper premolars (pm) 3. Third upper molar (m^3) present.
 C. Occlusal view of mandible of Vespertilionid bat (*Pipistrellus* sp.) showing mandibular tooththrow length ($c-m$). Arrow mark shows three pairs of lower incisors.

PLATE 8

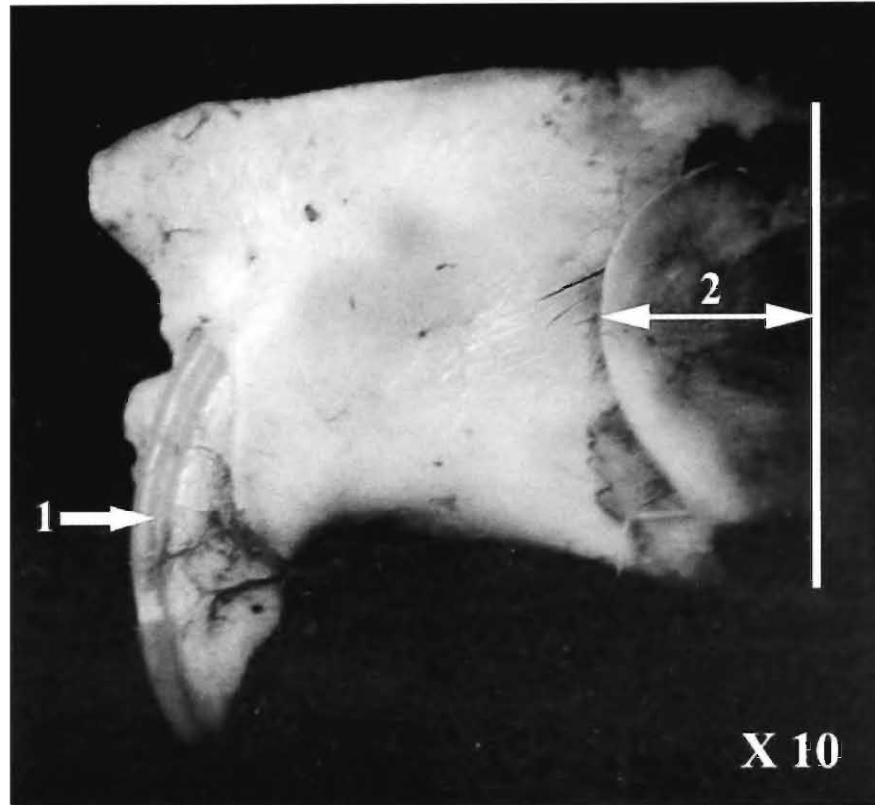


Photo 13 : Lateral view of skull of *Tatera indica* Hardwicke from owl pellet material. Arrow marks show: 1. Grooved incisors 2. Zygomatic plate projecting forward to half of rostrum.

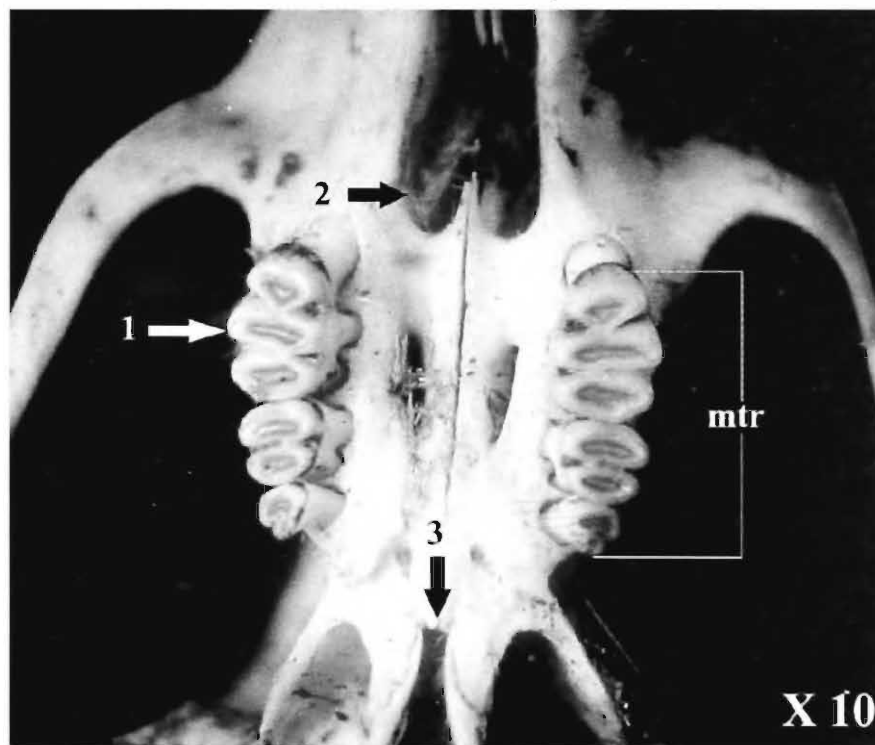
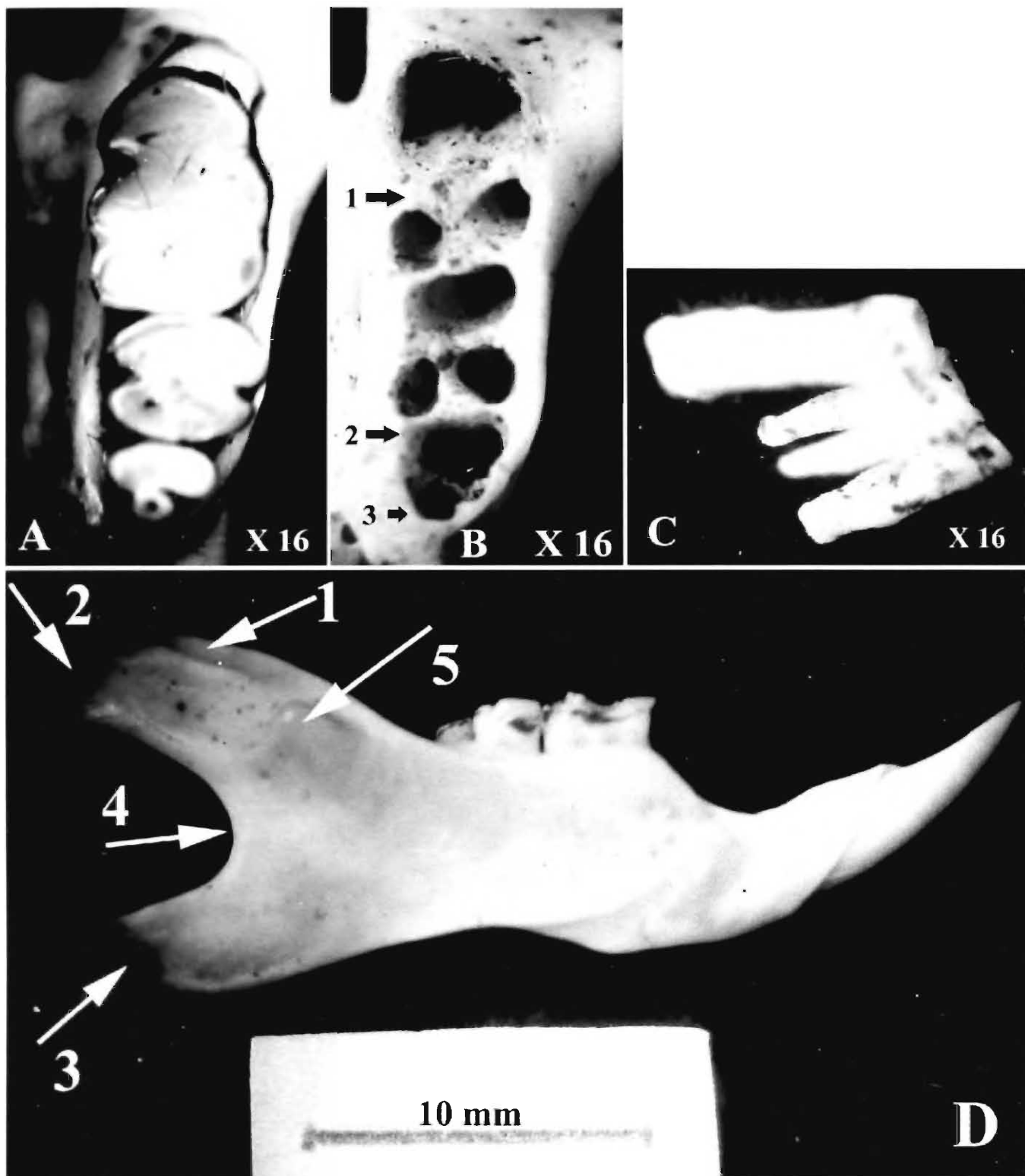


Photo 14 : Ventral view of skull of *Tatera indica* Hardwicke from owl pellet material showing length of maxillary tooththrow (mtr). Arrow marks show 1. Biseriately cuspidate molars 2. Anterior palatal foramina long, reaching posteriorly upto the molars and 3. Palate long extending posteriorly beyond molars.

PLATE 9



- Photo 15** : Skull pieces of *Tatera indica* Hardwicke from owl pellets showing key characters :
- A. Worn out upper molars showing cusp like islands.
 - B. Upper molar root sockets showing 1. m^1 - 4 rooted, 2. m^2 - 3 rooted and 3. m^3 single rooted.
 - C. First upper molar showing 4 roots.
 - D. Mandible (Right) : Arrow marks show : 1. Backwardly pointing Coronoid process 2. Condyle 3. Angular process 4. Notch 5. Masseteric process prominently developed.

PLATE 10

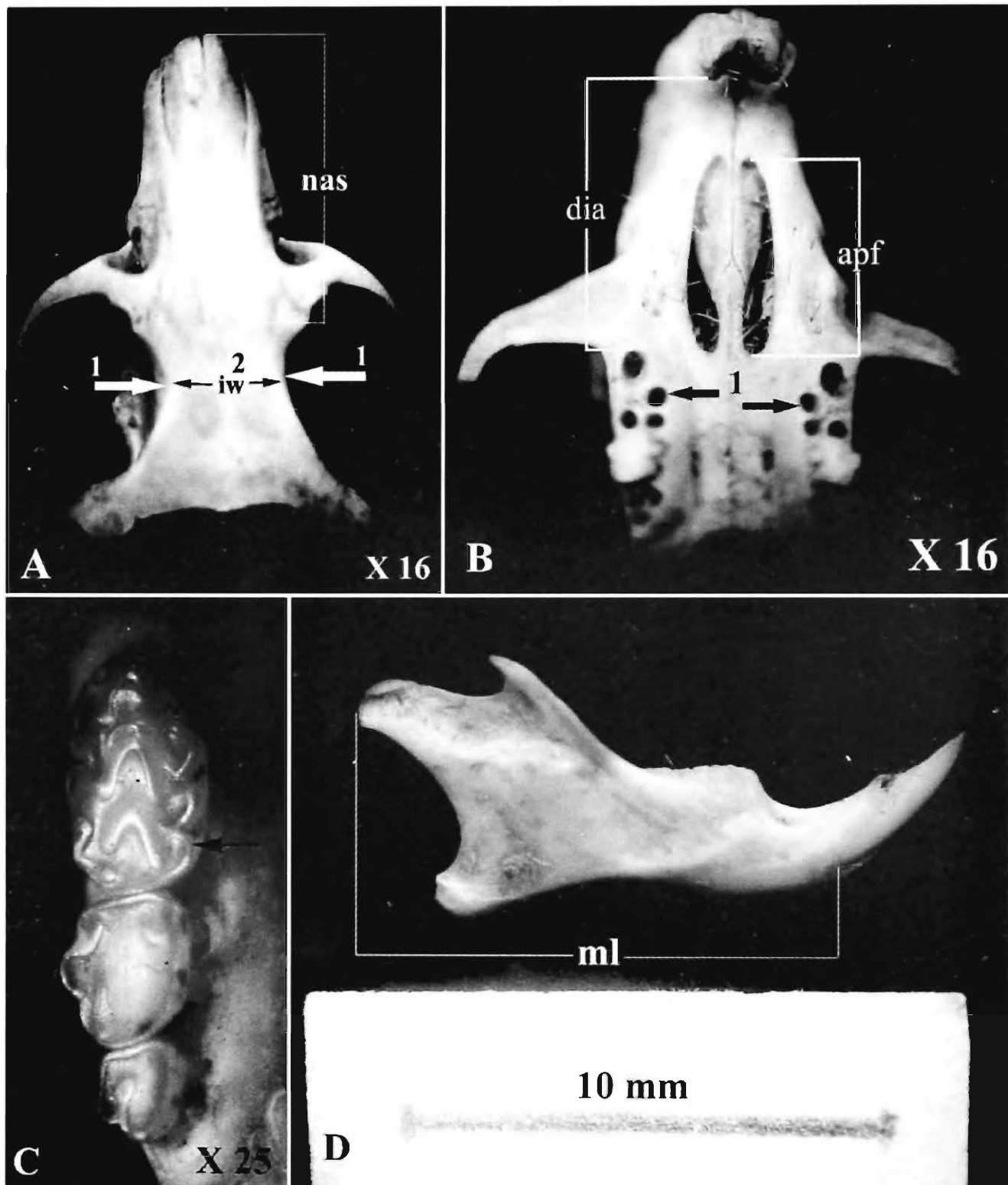


Photo 16 : Skull pieces of *Vandeleuria oleracea* (Bennet) from owl pellets.

- A. Dorsal view of skull piece : 1. Arrow marks show frontals constricted 2. Least interorbital width (iw) less than 4 mm.
- B. Ventral view of skull piece showing length of diastema (dia), Length of anterior palatal foramina (apf) and First upper molar socket, (m^1) 4-rooted (Arrow 1).
- C. Upper molars (Right side) : Arrow shows cusp t7 (postero-internal cusp) present in first upper molar.
- D. Mandible (Right side) of *Vandeleuria oleracea* (Bennet) showing mandibular length (ml).

PLATE 11

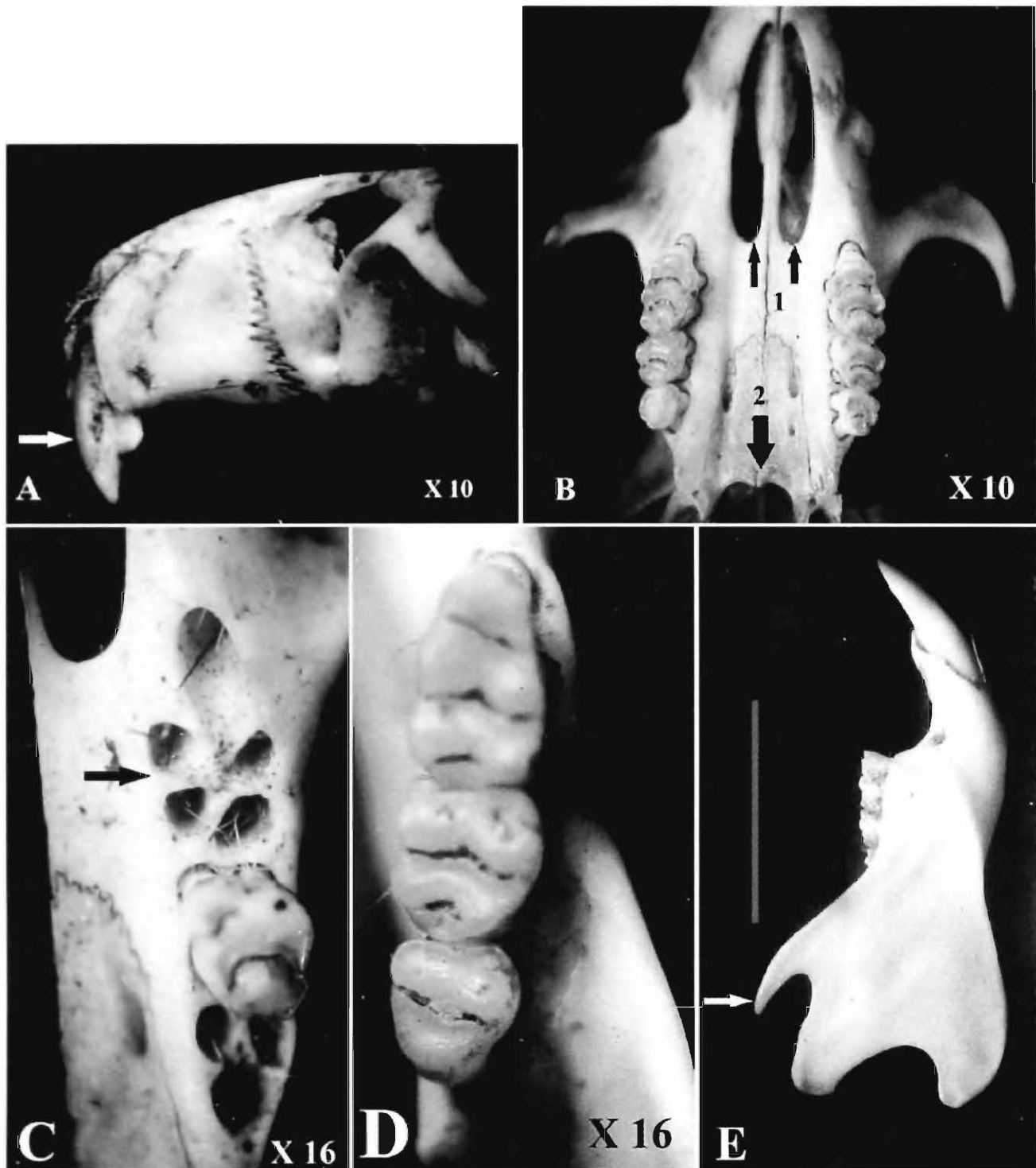


Photo 17 : Skull pieces of *Rattus rattus* (Linnaeus) from owl pellets.

- A. Lateral view of skull piece : Arrow showing upper incisor (Left side) narrow, plain and orthodont.
- B. Ventral view of skull piece showing triserially cuspidate upper molars Arrow marks 1. Anterior palatal foramina long, reaching posteriorly to molars. 2. Palate long, extending posteriorly behind third upper molars.
- C. Arrow mark shows first upper molar (m^1) 5-rooted.
- D. Lower molars : first lower molar (m_1) three laminate, m_2 and m_3 bilaminar.
- E. Mandible : Arrow mark shows moderately developed coronoid process, slightly curved with tapering end (scale bar = 10mm).

PLATE 12

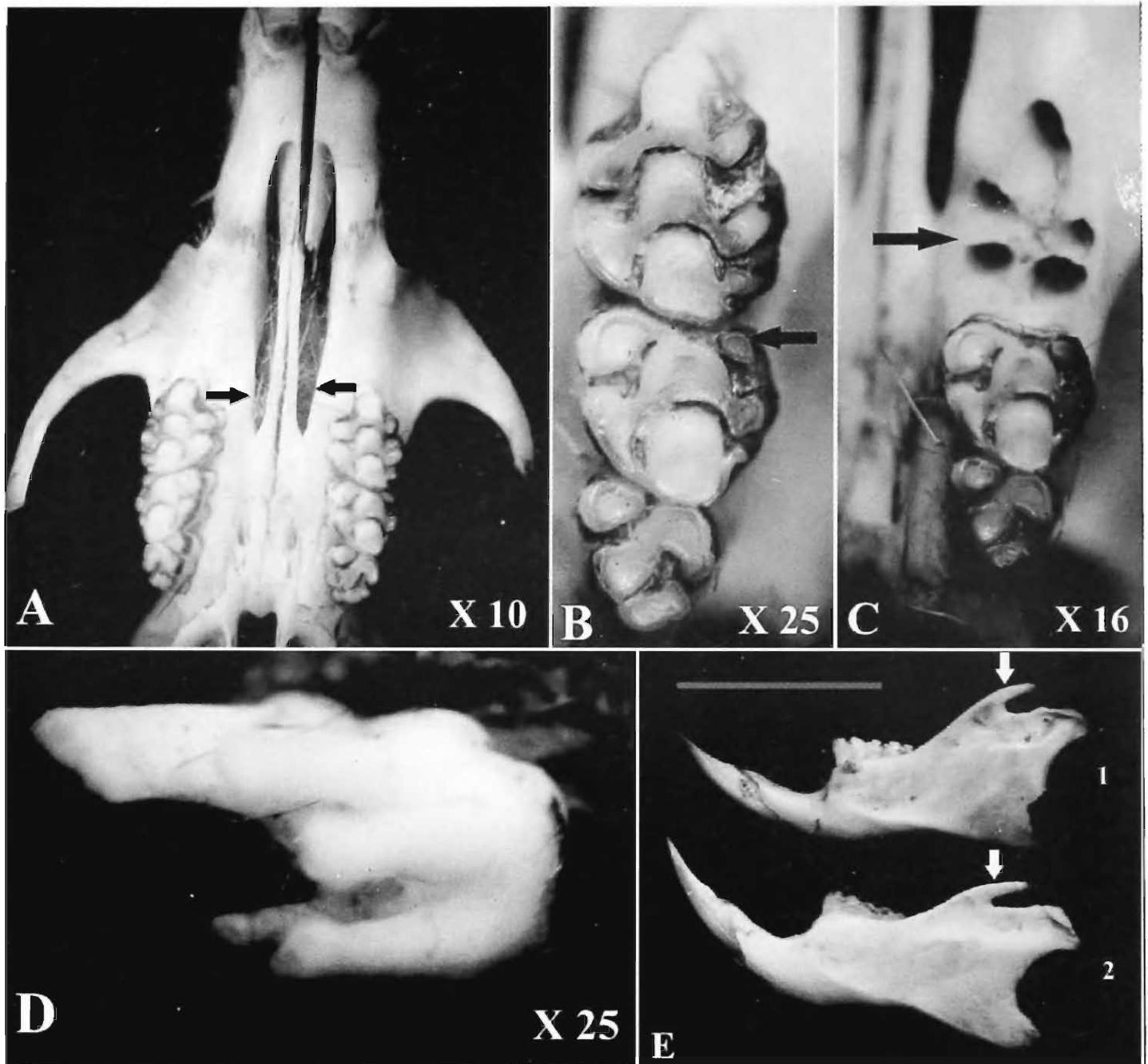


Photo 18 : Skull pieces of *Millardia meltada* (Gray) from owl pellet material.

- A. Ventral view of skull piece : Arrow marks show anterior palatal foramina long extending between maxillary tooththrow.
- B. Left upper molars : Arrow mark shows usual presence of second molar with 3 Cusp.
- C. Left upper molars : Arrow mark shows First upper molar socket (m^1) 5 rooted.
- D. First upper molar of *Millardia meltada* (Gray) with 5 roots.
- E. Comparison between 1. Mandible (Left side) from pellet material and 2. Mandible of registered specimen (ZSI.WRS. M/461). Arrow mark shows Coronoid process slightly curved with tapering end. (scale bar = 10mm).

PLATE 13

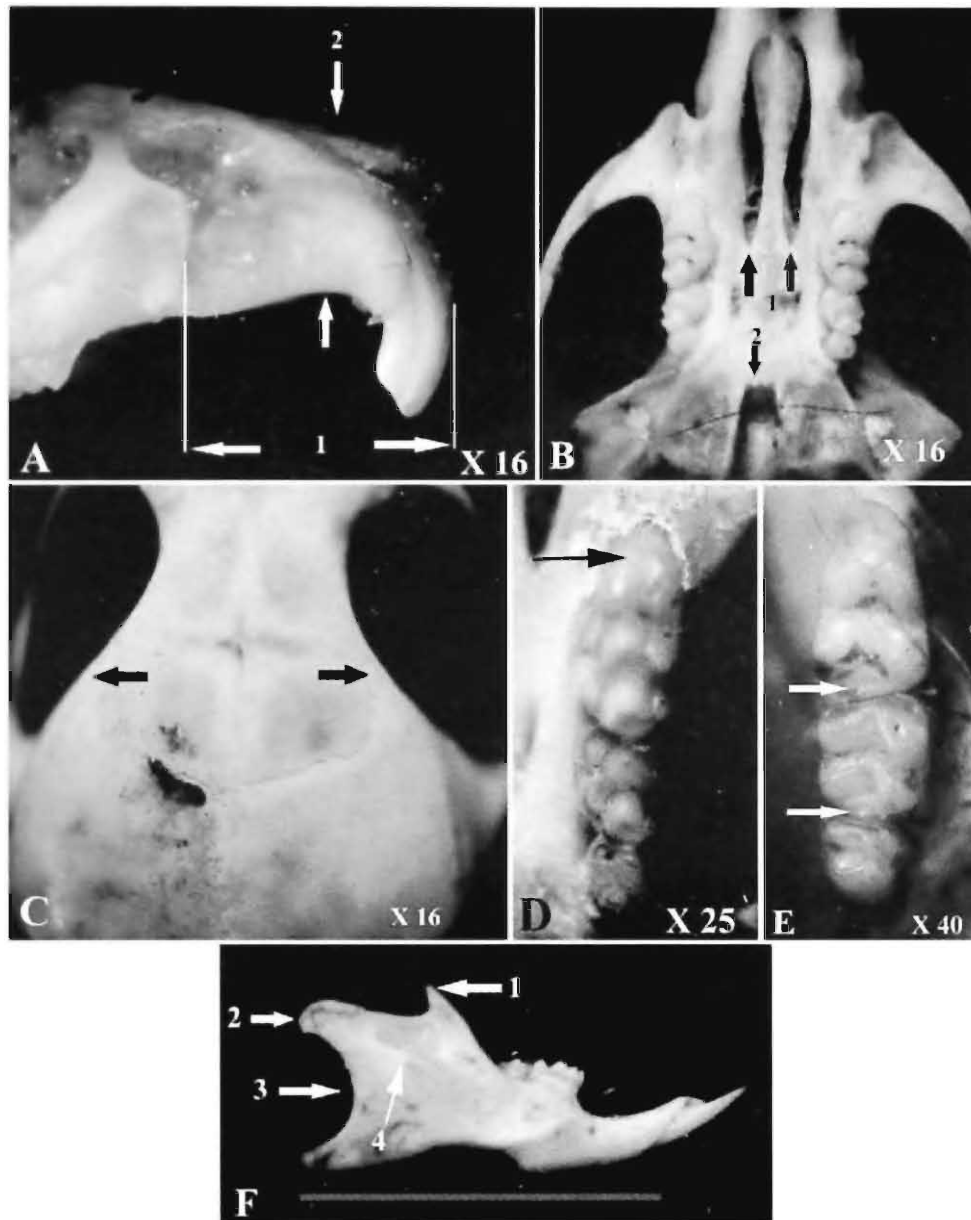


Photo 19 : Skull pieces of *Mus musculus* Linnaeus from owl pellet material.

- A. Lateral view of skull piece of *Mus musculus* Linnaeus (ZSI.WRS. M/727). Arrow marks show 1. Rostral length .2 . Least depth of rostrum. Rostrum short and deep, its least depth two-thirds of rostral length. Incisors ophistodont.
- B. Ventral view of skull : Arrow marks show 1. Anterior palatal foramina elongated, extending posteriorly between maxillary toothrow. 2. Palate long, extending posteriorly behind third upper molars.
- C. Dorsal view of skull of *Mus musculus* Linnaeus Arrow marks show poorly developed supraorbital ridges.
- D. Upper molars (Left side) of *Mus musculus* Lin. (ZSI.WRS. M/160). Arrow mark shows absence of an accessory cusp on first upper molar.
- E. Lower molars of *Mus* sp. Arrow marks show posterior cingulum present behind last lamina of m_1 and m_2 .
- F. Mandible piece (Right) of typical *Mus* sp. Arrow marks show :
 1. Coronoid process slightly curved with tapering end. 2. Condyles narrow and long 3. Deep notch between condyle and angular process. 4. Poorly developed masseteric process (Scale bar = 10mm).

PLATE 14

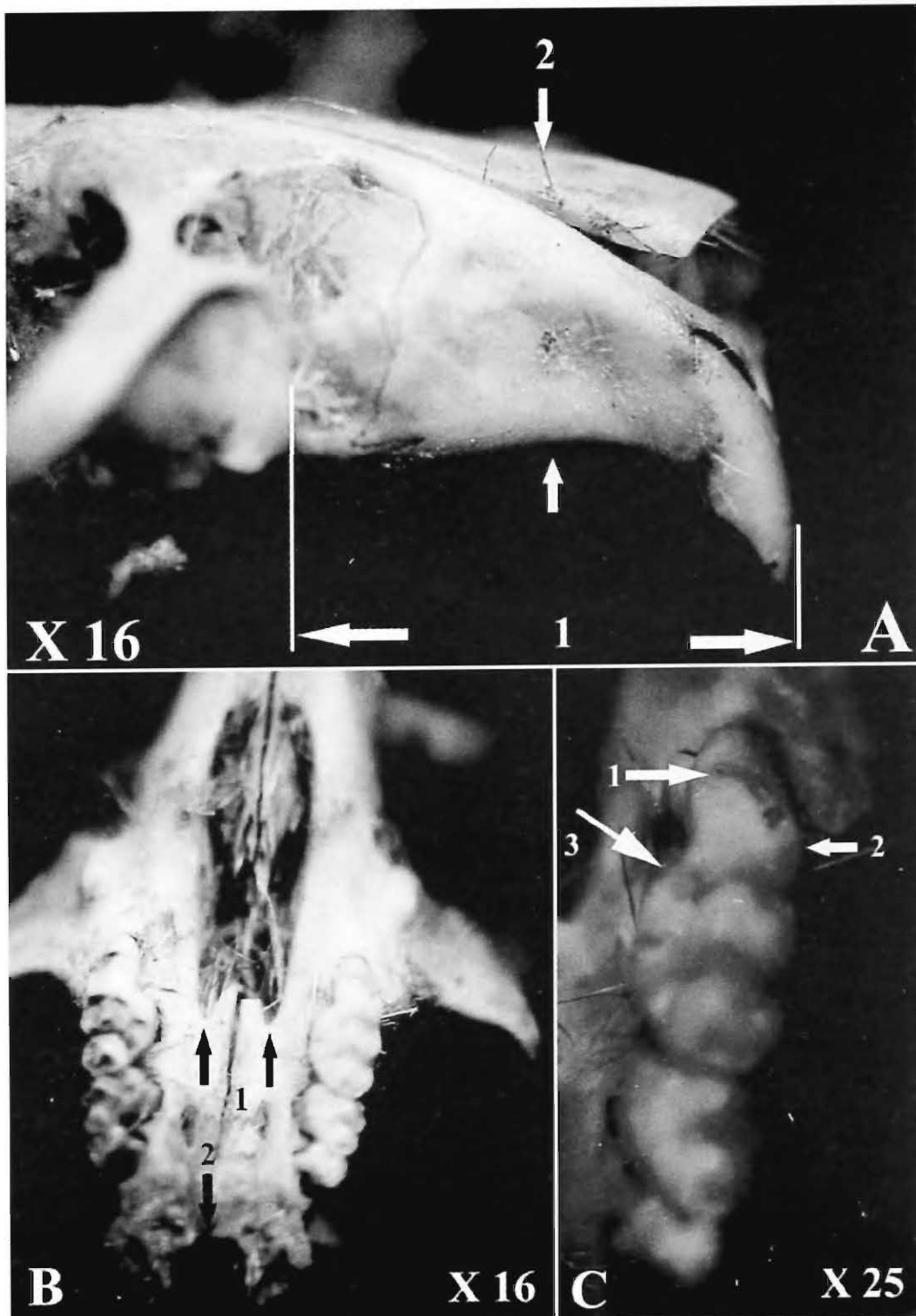


Photo 20 : Skull pieces of *Mus booduga* (Gray) from owl pellet material.

- A.** Lateral view of skull piece : Arrow marks show **1**. Rostral length. **2**. Least depth of rostrum. Rostrum long shallow, its least depth one half of rostral length.
- B.** Ventral view of skull piece : Arrow marks show : **1**. Anterior palatal foramina long extending posteriorly between maxillary toothrows. **2**. Palate long, extending posteriorly behind third upper molars.
- C.** Upper molars (Left side) : Arrow marks show **1**. Anterior accessory cusp on first upper molar. **2**. Anteroexternal cusp prominent. **3**. Antero internal cusp, heavily distorted on the inner side.

PLATE 15

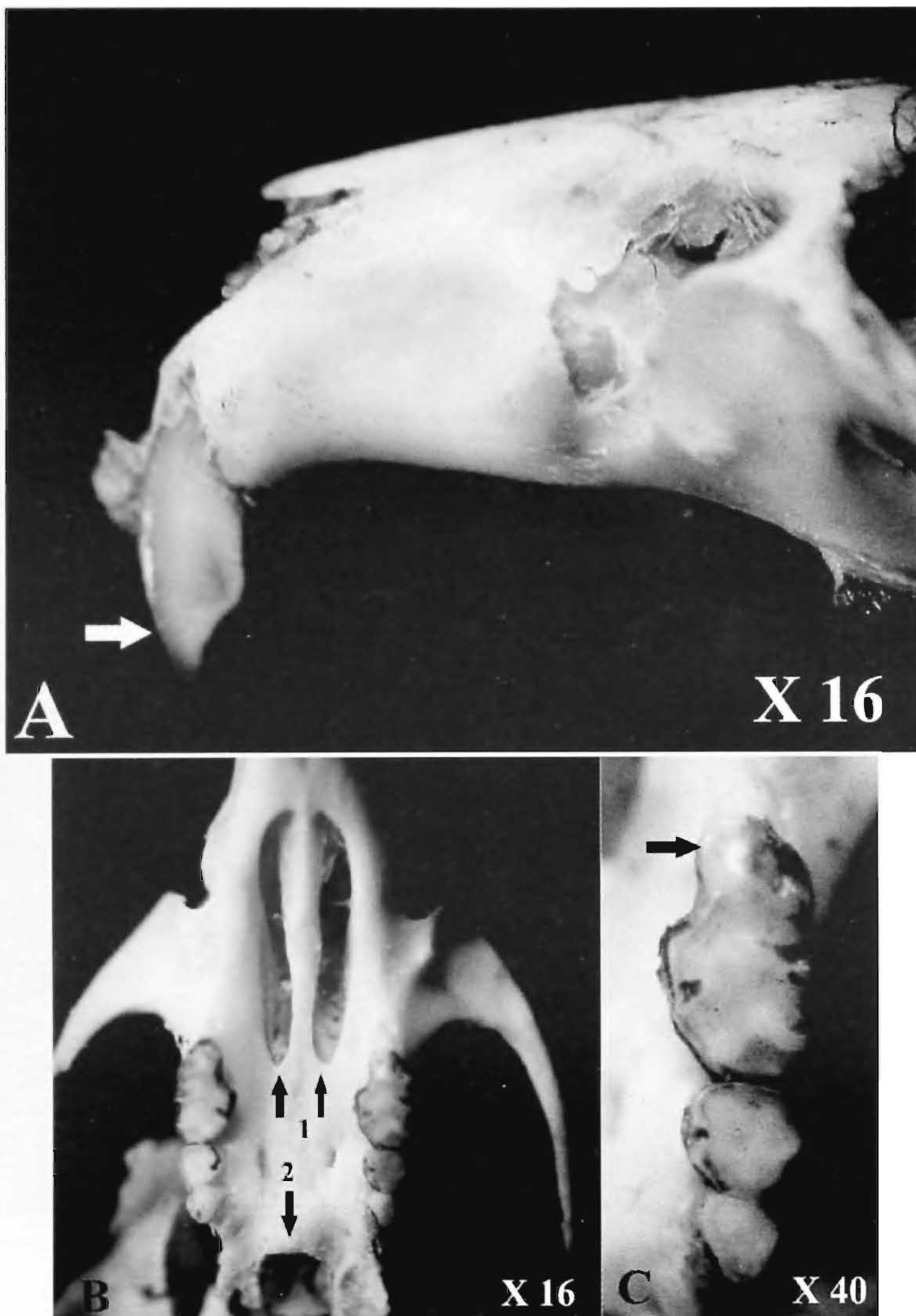


Photo 21 : Skull of *Mus phillipsi* Wroughton.

- A. Lateral view of skull : Arrow mark shows upper incisors opisthodont.
- B. Ventral view of skull : Arrow marks show 1. Anterior palatal foramina extending posteriorly between maxillary toothrow. 2. Palate long extending posteriorly behind third upper molar.
- C. Upper molars of *Mus phillipsi* Wroughton. Arrow mark shows first upper molar without an anterior accessory cusp.

PLATE 16

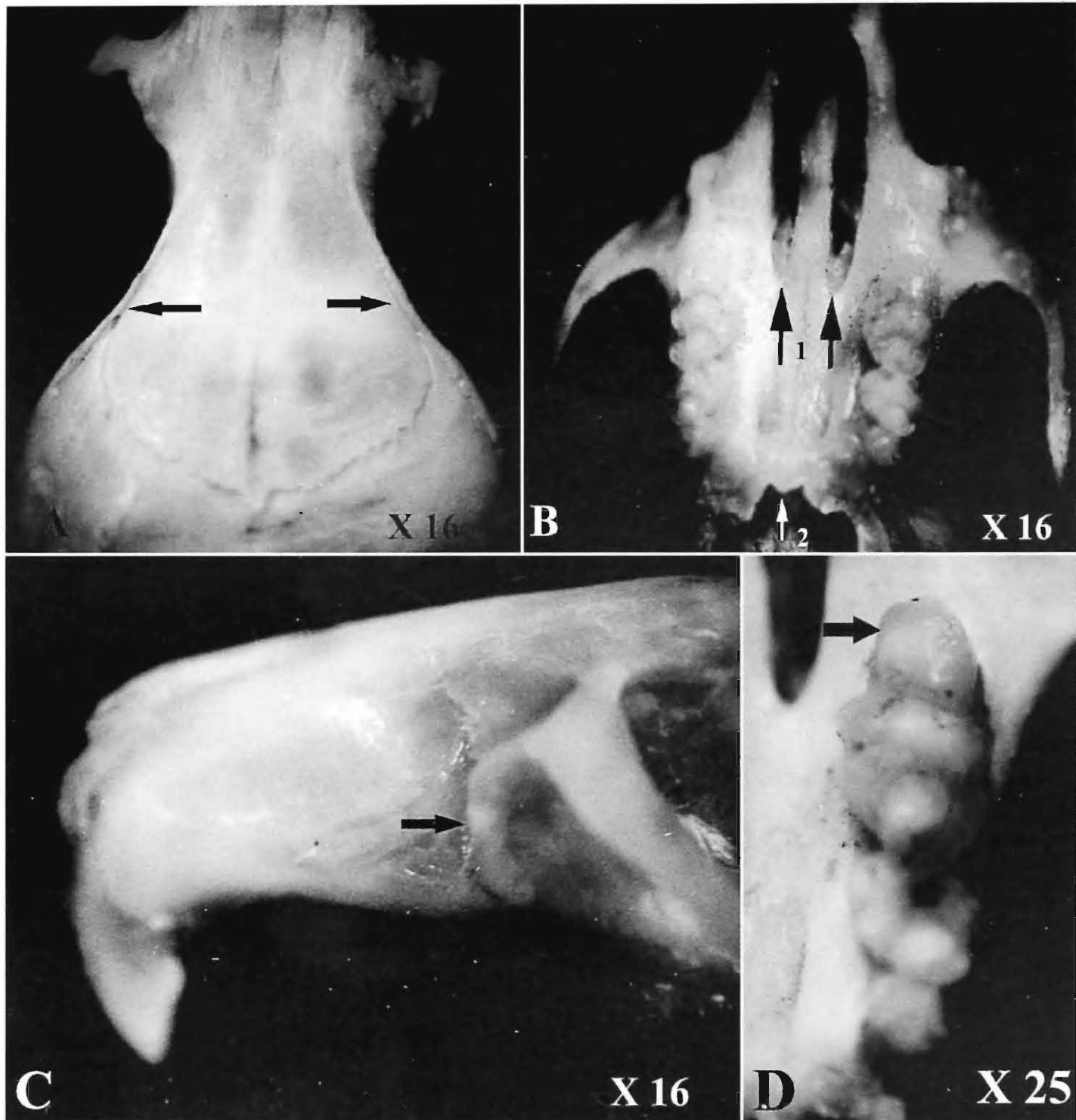


Photo 22 : Skull of *Mus platythrix* Bennet.

- A. Dorsal view of skull : Arrow marks show prominent supraorbital ridges.
- B. Ventral view of skull : Arrow marks show 1. Anterior palatal foramina short, extending posteriorly only up to anterior root of first upper molar. 2. Interpterygoid space wide.
- C. Lateral view of skull : Arrow mark shows anterior border of zygomatic plate rises vertically then turns back in arc of a quarter circle at zygomatic notch.
- D. Upper molars (Left side) : Arrow mark shows absence of an accessory cusp on the anterior root of first upper molar.

PLATE 17

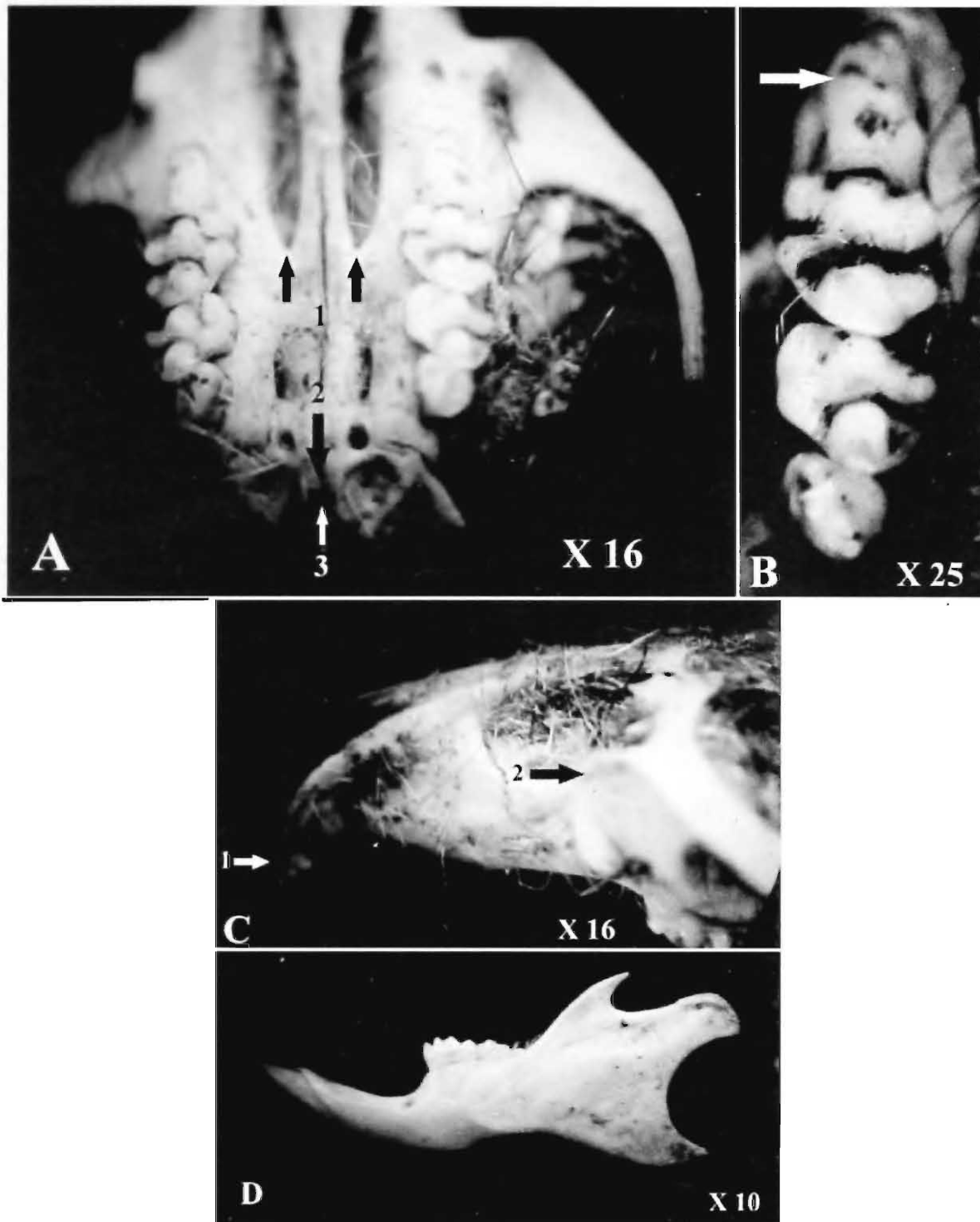


Photo 23 : Skull pieces of *Mus saxicola* Elliot from owl pellet material.

- A. Ventral view of skull piece : Showing triserially cuspidate upper molars. Arrow marks show: 1. Anterior palatal foramina long extending posteriorly up to second lamina of first upper molars. 2. Palate long, extending posteriorly behind third upper molars. 3. Interpterygoid space narrow.
- B. Upper molars (Left side) : arrow mark shows an accessory cusp present on the anterior root of first upper molar.
- C. Lateral view of skull piece : Arrow marks 1. Upper incisor (Left side) orthodont without notch. 2. Anterior border of zygomatic arched forward convexly.
- D. Mandible (Left side) of *Mus saxicola* Elliot.

PLATE 18

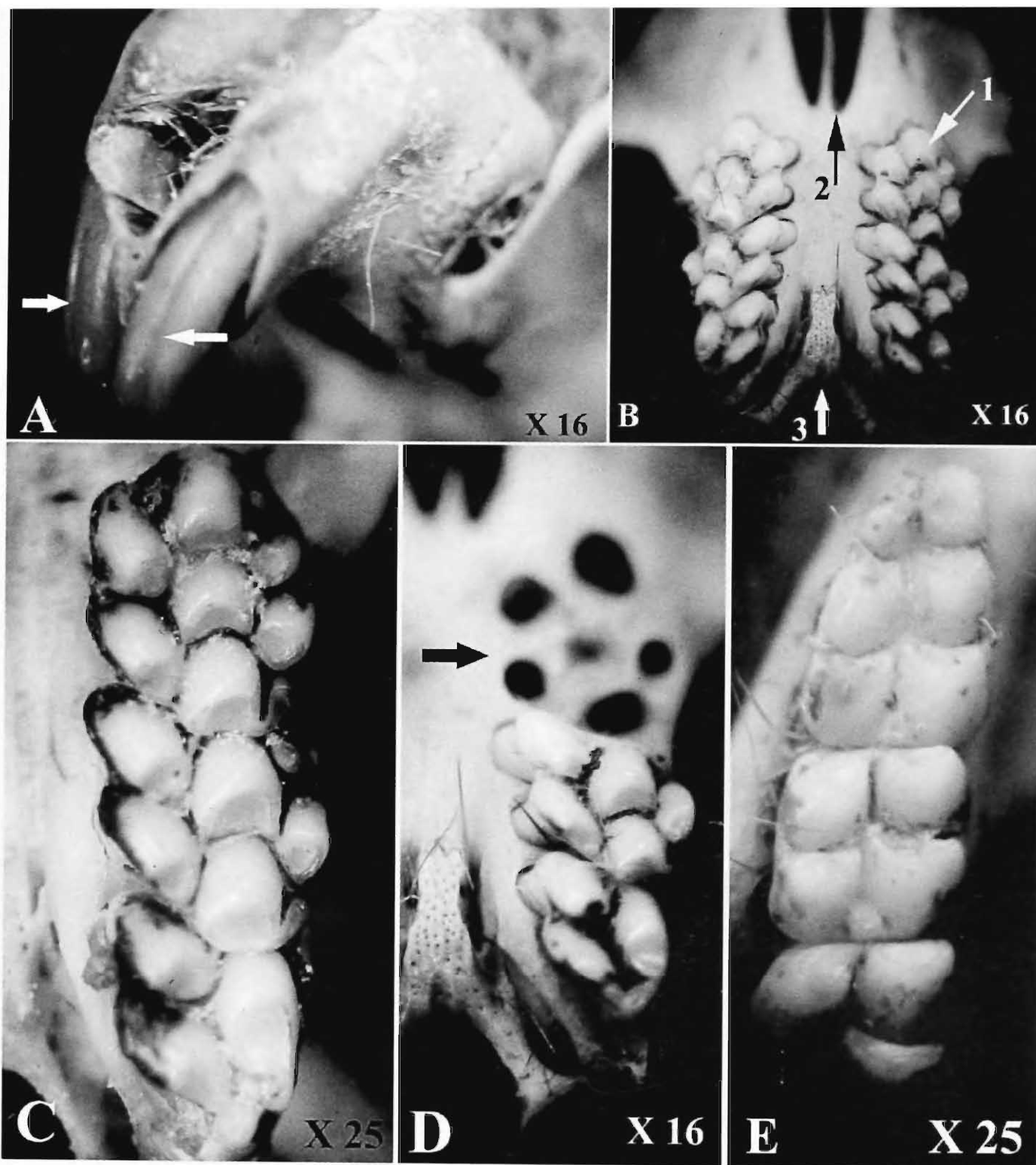


Photo 24 : Skull pieces of *Golunda ellioti* Gray from owl pellet material.

- A. Skull showing grooved incisors (Marked by arrows).
- B. Ventral view of skull piece : Heavily cuspidate (Grape-shaped) molars (Marked by arrow 1); Anterior palatal foramina just touching the first molars (Marked by arrow 2) and palate ending posteriorly in between third pair of upper molars (Marked by arrow 3).
- C. Left upper triserially and heavily cuspidate molars.
- D. Arrow shows sockets of first upper molar roots (Left side).
- E. Lower molars (Biserially cuspidate).

PLATE 19

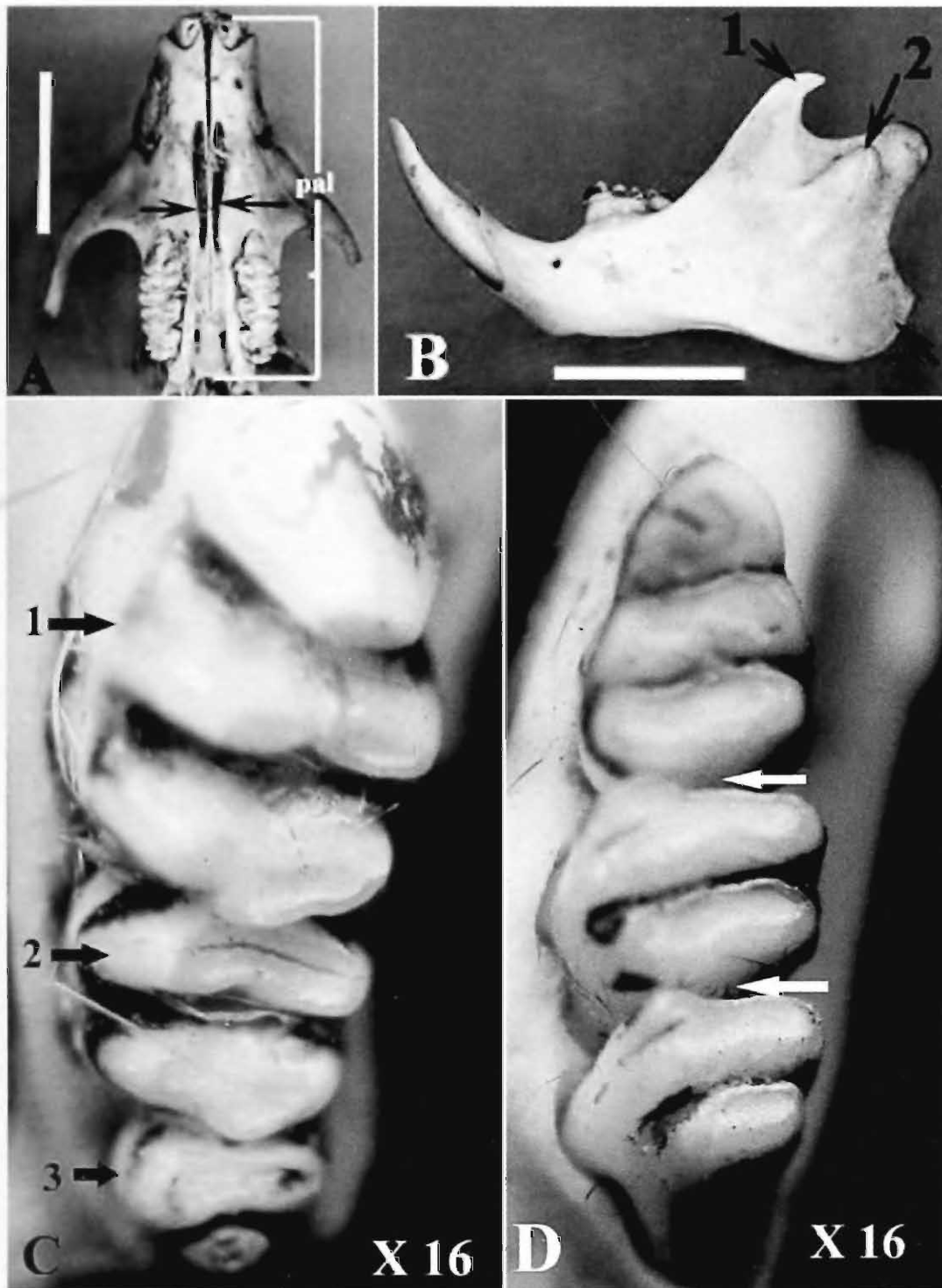
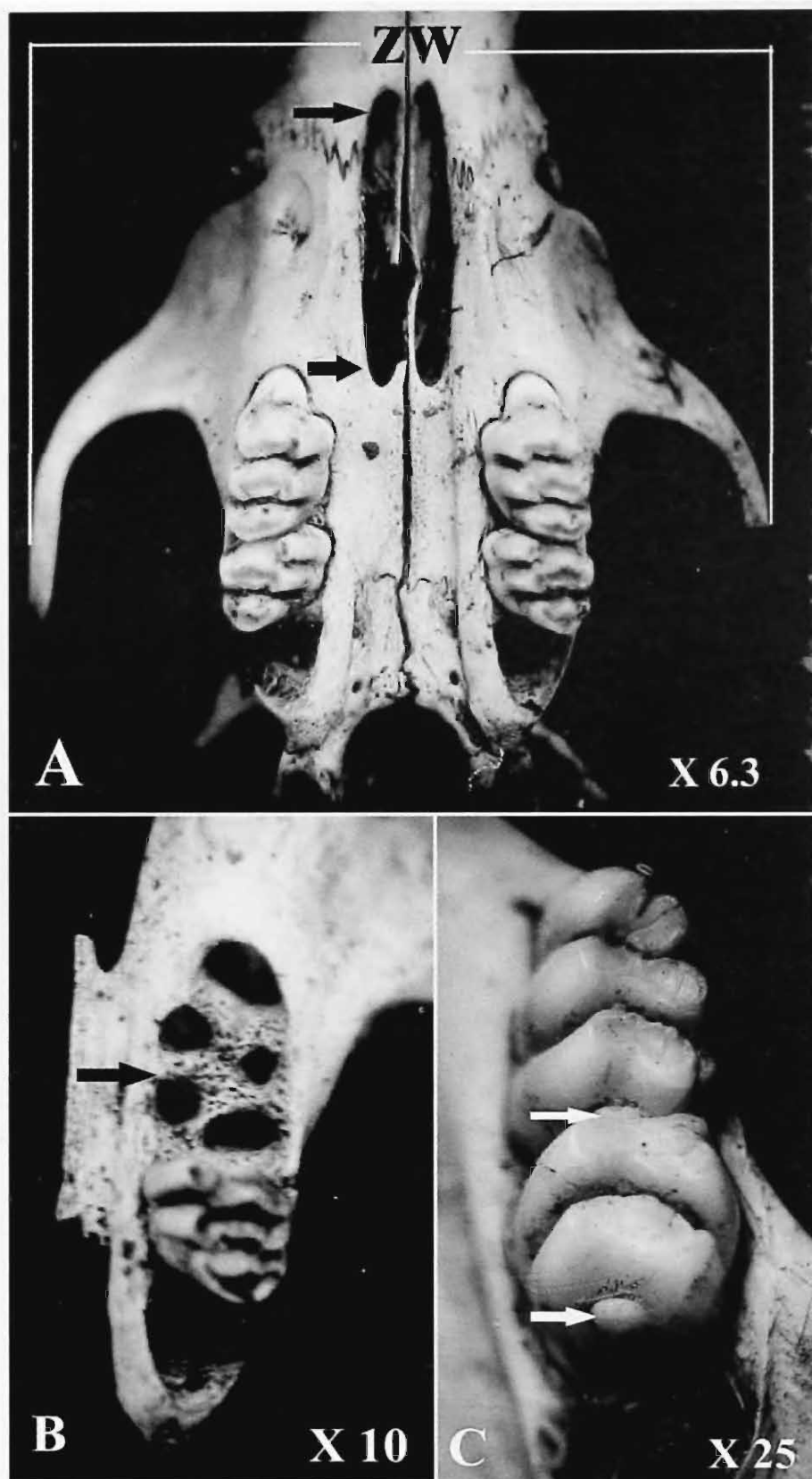


Photo 25 : Skull pieces of *Bandicota bengalensis* (Gray) from owl pellet material.

- A. Ventral view of skull piece : Arrow mark shows anterior palatal foramina long extending posteriorly upto first lamina of first upper molar and narrower at posterior end. (Scale bar = 10 mm)
- B. Mandible : Arrows show : 1. Backwardly curved coronoid process 2. Masseteric process prominently developed and 3. Angular process broad. (Scale bar = 10 mm).
- C. Upper molars : Arrows show : 1. First upper molar (m^1) with three laminae. 2. and 3. Two laminae on second (m^2) and third (m^3) upper molars respectively.
- D. Lower molars : Arrow mark shows no posterior cingulum behind first (m_1) and second (m_2) lower molars.

PLATE 20



- Photo 26** : Skull pieces of *Bandicota indica* (Bechstein) from Owl pellet material.
- A. Ventral view of skull piece : Arrow mark shows Anterior palatal foramina equally broad at both ends.
 - B. Arrow mark shows first upper molar 5-rooted.
 - C. Arrow marks shows posterior cingulum behind first (m_1) and second (m_2) lower molars.