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New Materials of a Cretaceous Coelacanth, *Mawsonia lavocati* Tabaste from Morocco

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Abstract New materials of coelacanth, *Mawsonia lavocati* and cf. *Mawsonia lavocati* from the Albian beds in Morocco are described here. They are a part of the cranium, palate, lower jaw, lachrymojugal, and operculum. The almost complete ethmosphenoid portion of the braincase, postparietal, and dentary of *M. lavocati* are described here for the first time.
Key words : coelacanth, *Mawsonia lavocati*, Mawsoniidae, Morocco.

Introduction

Six species of the coelacanth genus *Mawsonia* have been found from the Cretaceous beds of South America and Africa (Forey, 1998; Yabumoto, 2002), of which, *M. lavocati* was described on the basis of an angular from the Albian bed in Morocco (Tabaste, 1963). Further fragmentary cranial materials were described from the Albian of Algeria (Wenz, 1981) and Morocco (Cavin and Forey, 2004). The National Science Museum, Tokyo obtained some newly found specimens of *M. lavocati* and cf. *M. lavocati* from Morocco, including an almost complete ethmosphenoid portion of the braincase, postparietal, palate, lateral ethmoids, dentary and operculum which have not been previously described. In the present study these specimens are described in detail, and the emended diagnosis for *M. lavocati* is presented.

Systematic description

Order Coelacanthiformes Huxley, 1861

Suborder Latimeroidei Schultze, 1993

Family Mawsoniidae, Schultze, 1993

Genus ***Mawsonia*** Woodward, 1907

Mawsonia lavocati Tabaste, 1963

Materials. — NSM (National Science Museum, Tokyo)-PV 20994, an almost complete ethmosphenoid portion of braincase; NSM-PV 20995, a postparietal; NSM-PV 20996, a dentary; NSM-PV 20997, an angular.

Locality. — Kem-Kem, Morocco.

Age. — Albian, Cretaceous. Sereno *et al*. (1996) regarded the Kem Kem beds as Cenomanian in age on the basis of a shark assemblage, but Cavin and Forey (2004) followed them with a question mark. Forey (1998) and Wenz (1981) considered the age of *M. lavocati* from Morocco and Algeria as Albian. The age of the present materials is probably Albian, because all congeners of *Mawsonia* have been found from Early Cretaceous beds.

Emended diagnosis. — The ornamentation of the angular and the postparietal is vermiform with heavy ridges. The large anterior apophysis for the intracranial joint of the postparietal heads forward, and is located at the middle of the anterior margin. There are three pairs of nasals and at most three supraorbitals.

Description of the specimens. — The estimated length of the parietonasal shield (NSM-PV 20994) is 292 mm. The posterior portion, maximum width 96.6 mm is broader than the anterior

portion, which abruptly narrows at the middle of the most posterior tectals.

Both parietals are almost same in length, but the posterior one is wider and its width at the posterior end about 2.4 times its anterior width. Both posterior parietals are almost same in shape and size. There are three pairs of nasals. The posterior ones are larger than the anterior ones, but the second ones are slightly broader. (Fig. 1a and b).

There are three tectals on the right side and two on the left, of which the posterior one is long (probably the second and third are fused). Three right supraorbitals contact with both parietals. The first supraorbital is largest and the second one is smallest. The first and second supraorbitals are fused on the left side. The left third supraorbital is almost same in shape and size as the right one (Fig. 1a and b). The ornamentation of the parietonasal shield is vermiform except for the posterior portion of the anterior parietal and most of the posterior parietals, which have ridged ornamentation (Fig. 1a).

In the ventral view, each lateral ethmoid has a hook-like shape with an almost flat, but slightly convex ventral surface. In the lateral view, the bone has the long dorsal limb contacting with tectals, and the short ventral limb contacting with the parasphenoid (Figs. 1c and d, and 2). The parasphenoid is relatively wide with the anterior deep wing. The toothed area of the parasphenoid is longer than a half of the parasphenoid (Fig. 1c and d).

The basisphenoid is deep and narrow with the well-developed sphenotic condyles, which are slightly expanded laterally (Fig. 3). The antotic process is located under the end of the posterior most supraorbital and bear strong ridges (Figs. 1c and d, and 3). The processus connectens forms a protuberance from the sphenotic condyle. There is a long cranial cavity in front of the oval concavity before the sphenoid condyles (Fig. 3).

The left postparietal (NSM-PV 20995) has the large anterior apophysis and the facet for the intracranial joint on the ventral face at the middle of the anterior margin (Figs. 4a and b and 5). The portion behind the facet is thick with three small pores on the ventral surface. The otic canal of the postparietal is shown as a groove in the lateral view, because the lateral part of the anterior portion is missing. The anterior opening of the branch of the otic canal is located at the anterior part of the otic canal (Fig. 4c and d). The ornamentation of the dorsal surface is vermiform with radial heavy ridges being similar to that of the angular (Fig. 4a).

The dentary (NSM-PV 20996) is hook-like in shape with a lateral swelling, curving medially at the anterior part. In lateral view, there is a concavity behind the lateral swelling which has a small pore at the ventral portion. The dorsal limb is shorter than the ventral limb (Fig. 6). There are several ridges on the medial surface of the dorsal limb for the suture with the prearticular. The ridges on the medial surface of the ventral limb and the anterior portion are for the suture with the angular (Fig. 6c).

The anterior and posterior tips and the ventral margin of the angular (NSM-PV 20997) are missing (Fig. 6). The ornamentation on the lateral surface is almost the same as that of the holotype of *M. lavocati*. Several strong ridges run almost parallel with the dorsal margin of the posterior portion of the angular, and the strong radial ridges run forward from the middle of the posterior portion. The deepest point is about the middle of the angular (Fig. 6). The medial surface of the angular is concave at the anterodorsal portion. The contact surface with the prearticular has a triangular shape located below the facet for articular which forms a large concavity facing dorsally. The groove for the external mandibular ramus runs just under the contact surface with the prearticular (Fig. 6c).

cf. ***M. lavocati*** Tabaste, 1963

Materials. — NSM-PV 20998, a right principal coronoid; NSM-PV 20999, a left principal coronoid; NSM-PV 21000, a palate; NSM-PV 21001, a lachrymojugal; and NSM-PV 21002, an operculum.

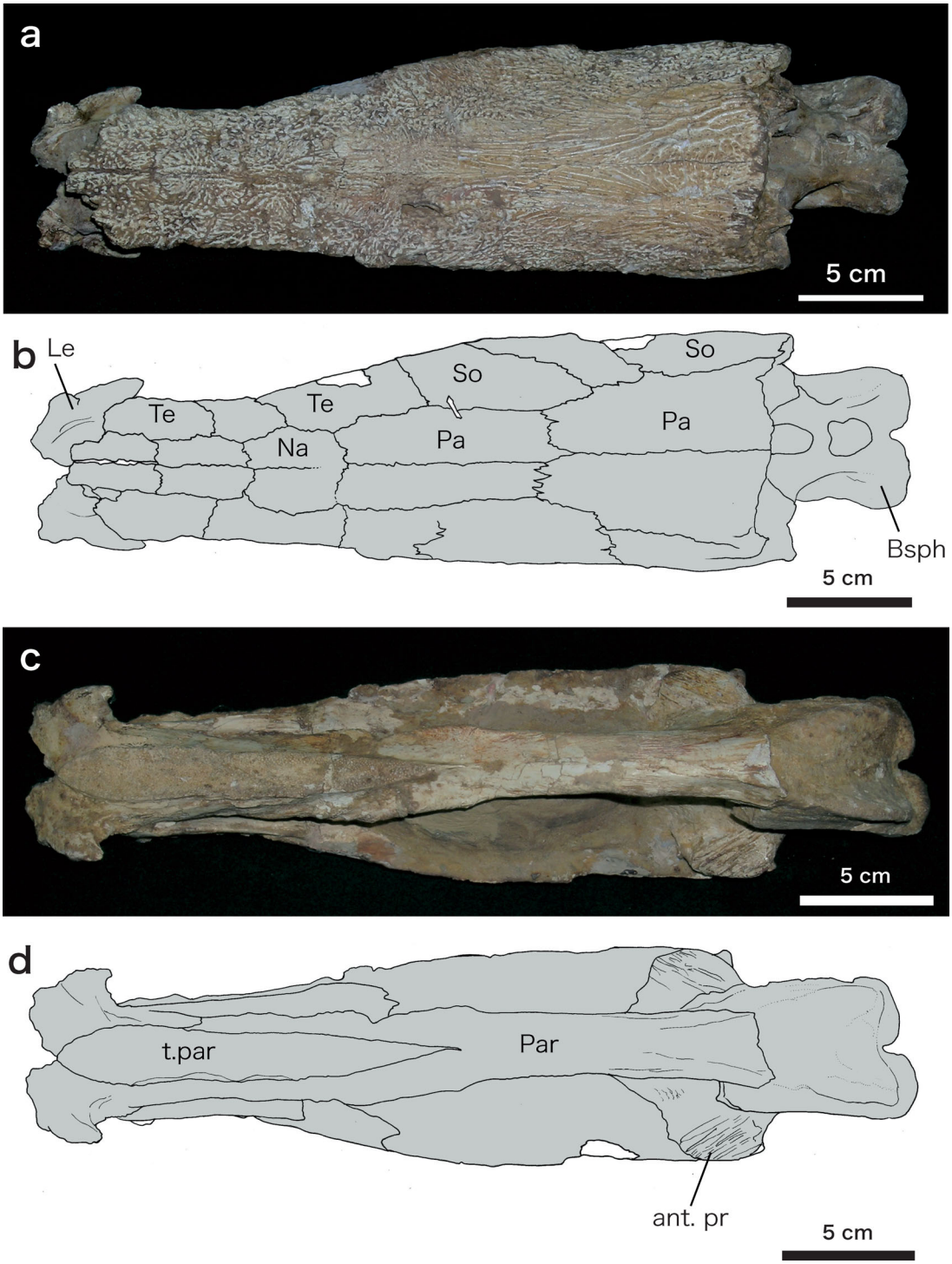

Fig. 1. The ethmosphenoid portion of braincase of *Mawsonia lavocati*, NSM-PV 20994, a and b, dorsal view, c and d, ventral view. Abbreviations: ant. pr=antotic process; Bsph=basisphenoid; Le=Lateral ethmoid; Na=nasal; Pa=parietal; Par=parasphenoid; So=supraorbital; Te=tectal; t. par=toothed area of parasphenoid.

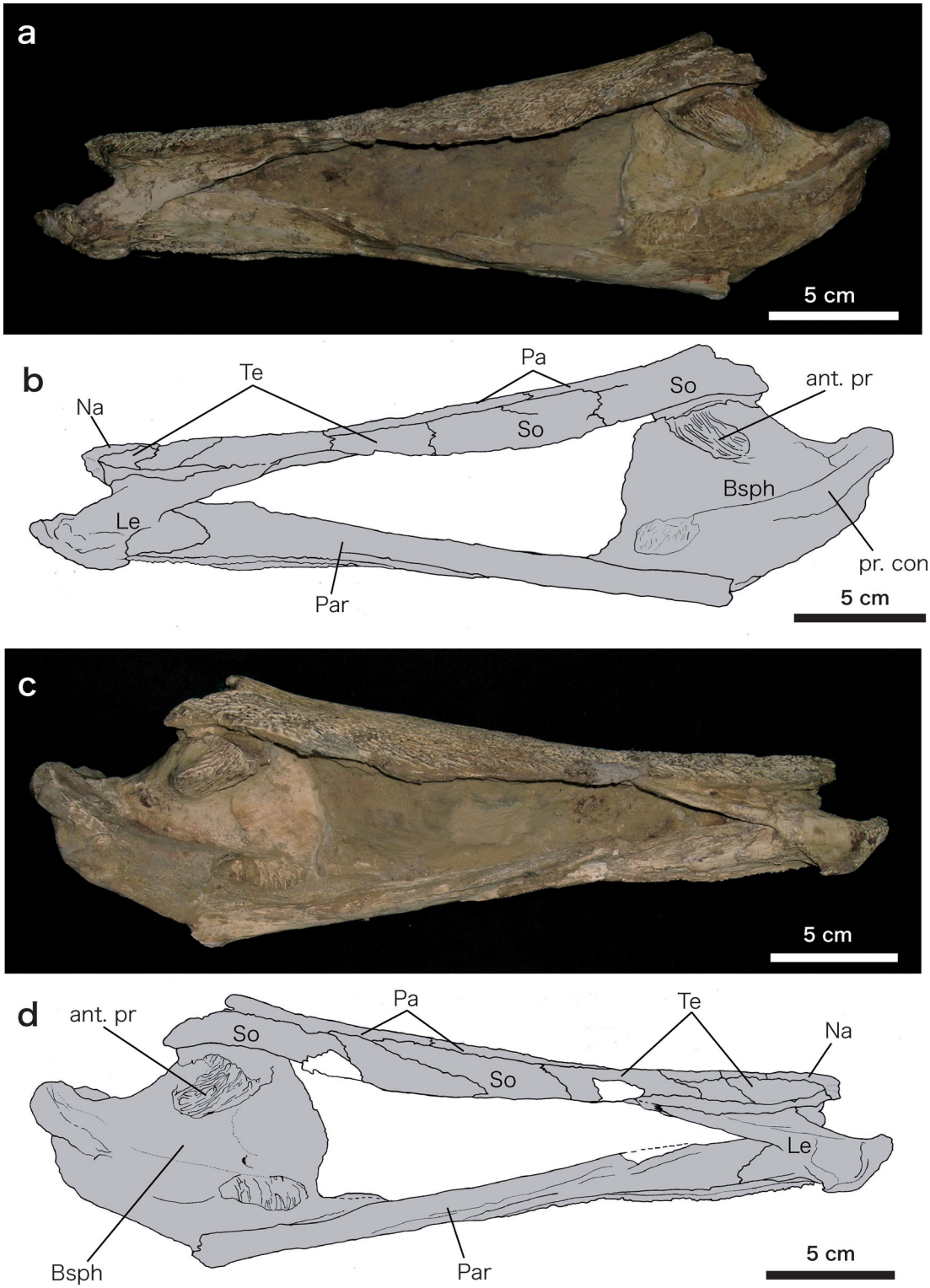

Fig. 2. The ethmosphenoid portion of braincase of *Mawsonia lavocati*, NSM-PV 20994, a and b, left lateral view, c and d, right lateral view. Abbreviation: pr. con=processus connectens; for other abbreviations see Fig. 1.

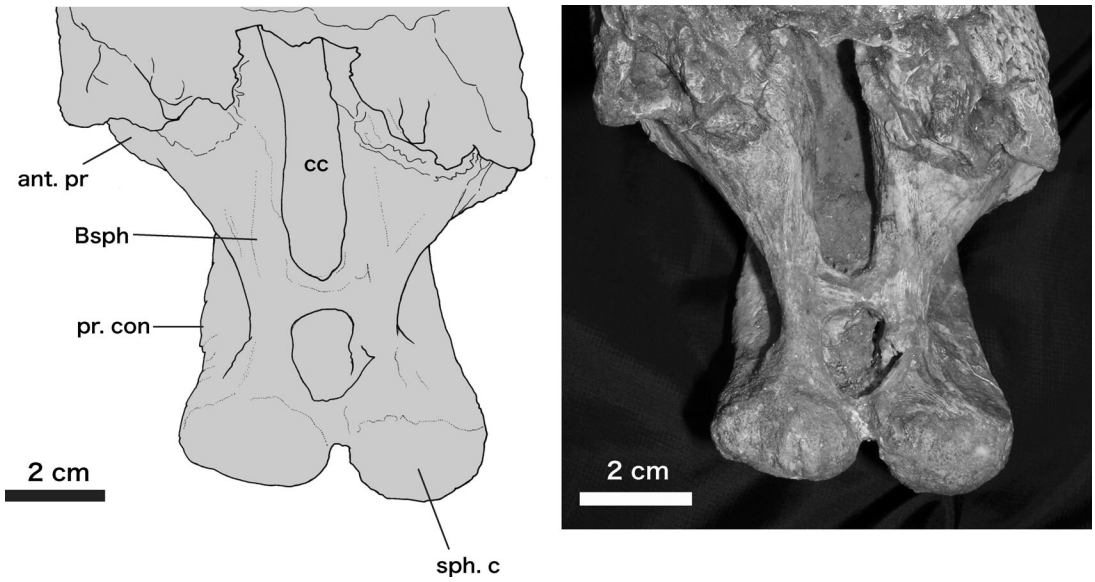

Fig. 3. The dorsal view of the basisphenoid (Bsph) of *Mawsonia lavocati*, NSM-PV 20994. Abbreviations: cc＝cranial cavity; sph.c.＝sphenotic condyle; for other abbreviations see Figs. 1 and 2.

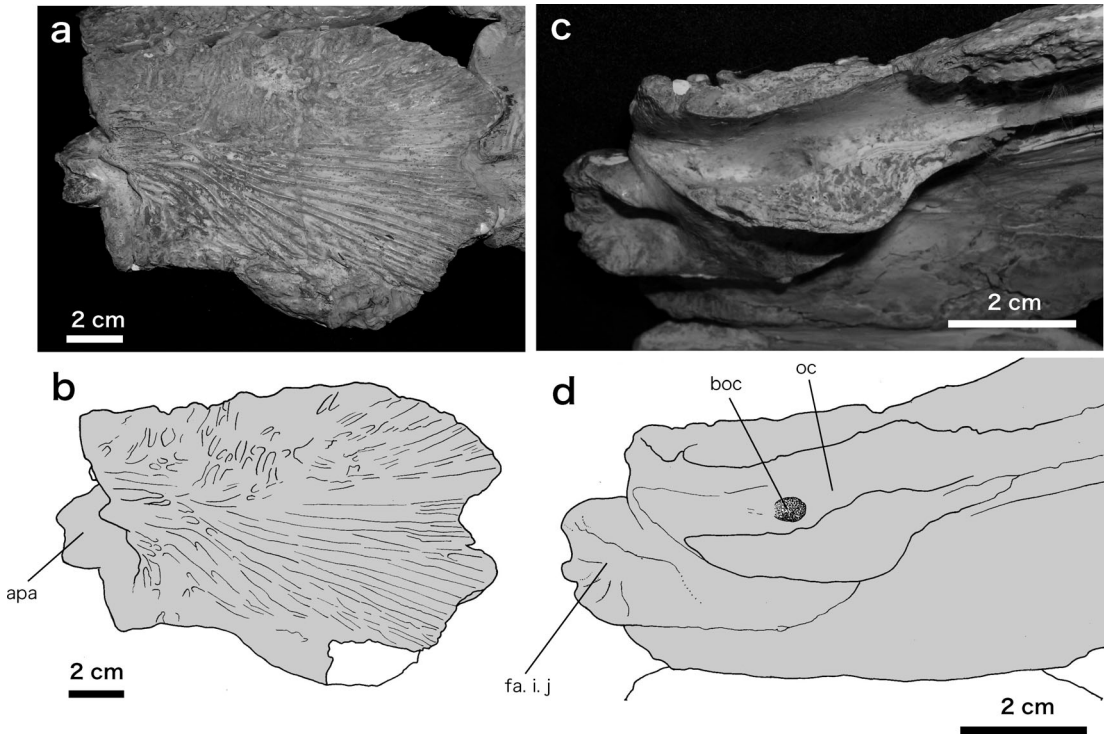

Fig. 4. The postparietal of *Mawsonia lavocati*, NSM-PV 20995, a and b, dorsal view, c and d lateral view. Abbreviations: apa＝anterior apophysis; boc＝branch of the otic canal; oc＝otic canal; fa. i. j＝facet for the intracranial joint.

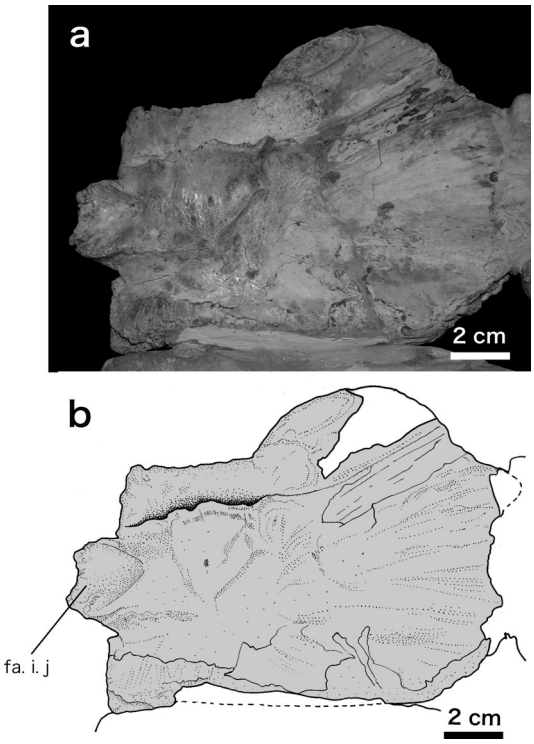

Fig. 5. The postparietal of *Mawsonia lavocati*, NSM-PV 20995, a and b, ventral view. Abbreviation see Fig. 3.

Locality. — Kem-Kem, Morocco.

Age. — Albian, Early Cretaceous.

Description of the specimens. — The anterior, posterior and ventral portions of the right principal coronoid (NSM-PV 20998) are missing and incorrectly attached to the angular in Figures 6. The 112 mm long left principal coronoid (NSM-PV 20999) is almost complete (incorrectly attached to the reconstructed angular), and consists of the anterior and posterior portions separated by a narrow section at the middle where it attaches to the angular (Fig. 7). The anterior portion has an almost triangular shape, and its antero-ventral margin forms a facet for the prearticular. The posterior portion is rectangular. The ventral parts of both portions form flanges (Fig. 7c and d). The angular inserts into the ventral portion of the principal coronoid, because the principal coronoid has two facets at the ventral surface. The medial surface of the ventral portion at the narrow part forms a facet with many ridges for the prearticular. There are minute teeth on the medial surface of the principal coronoid (Fig. 7a).

The left palate (NSM-PV 21000) is preserved without the autopalatine, missing the anterior portion of the pterygoid. In lateral view, the metapterygoid has an almost triangular shape with the wide dorsal margin, which has a wide flat surface for the cranial articulation at the middle. The process points antero-dorsally, and laterally becomes thin toward the posterior edge.

The most part of the medial surface of the pterygoid except for the dorsal portion is covered with minute teeth (the part bordered by the broken line in Fig. 8b). The anterior portion of the pterygoid is thin and slightly twisted. The ventral margin of the pterygoid is swollen immediately in front of the quadrate.

The quadrate is a robust bone ending as a large double condyle. The larger medial condyle lies anterior to the lateral condyle. The dorsal part from the lateral condyle forms the stout ridge. The anterior margin of the quadrate from the medial condyle forms a ridge (Fig. 8c and d).

Whereas the medial surface of the lachrymojugal (NSM-PV 21001) is flat, the ventral part of the lateral surface is convex for the sensory canal with a flange along the dorsal margin and the expanded anterior end, which turns abruptly dorsally (Fig. 9).

The operculum (NSM-PV 21002) is subsemicircular with the swelling dorso-posterior margin and the dorso-anterior corner forming the short process. The ornamentation on the lateral surface consists of the radial ridges, which are finer than those of the angular and the postparietal (Fig. 10). The medial surface is smooth.

Remarks. — The holotype of *M. lavocati* Tabaste, 1963 is a left angular missing most part of the anterior portion. Wenz (1981) described an anterior part of the parietonasal shield, parts of the lateral ethmoids, an anterior part of parasphenoid, incomplete angular and basisphenoid from the Albian of Algeria. Cavin and Forey (2004)

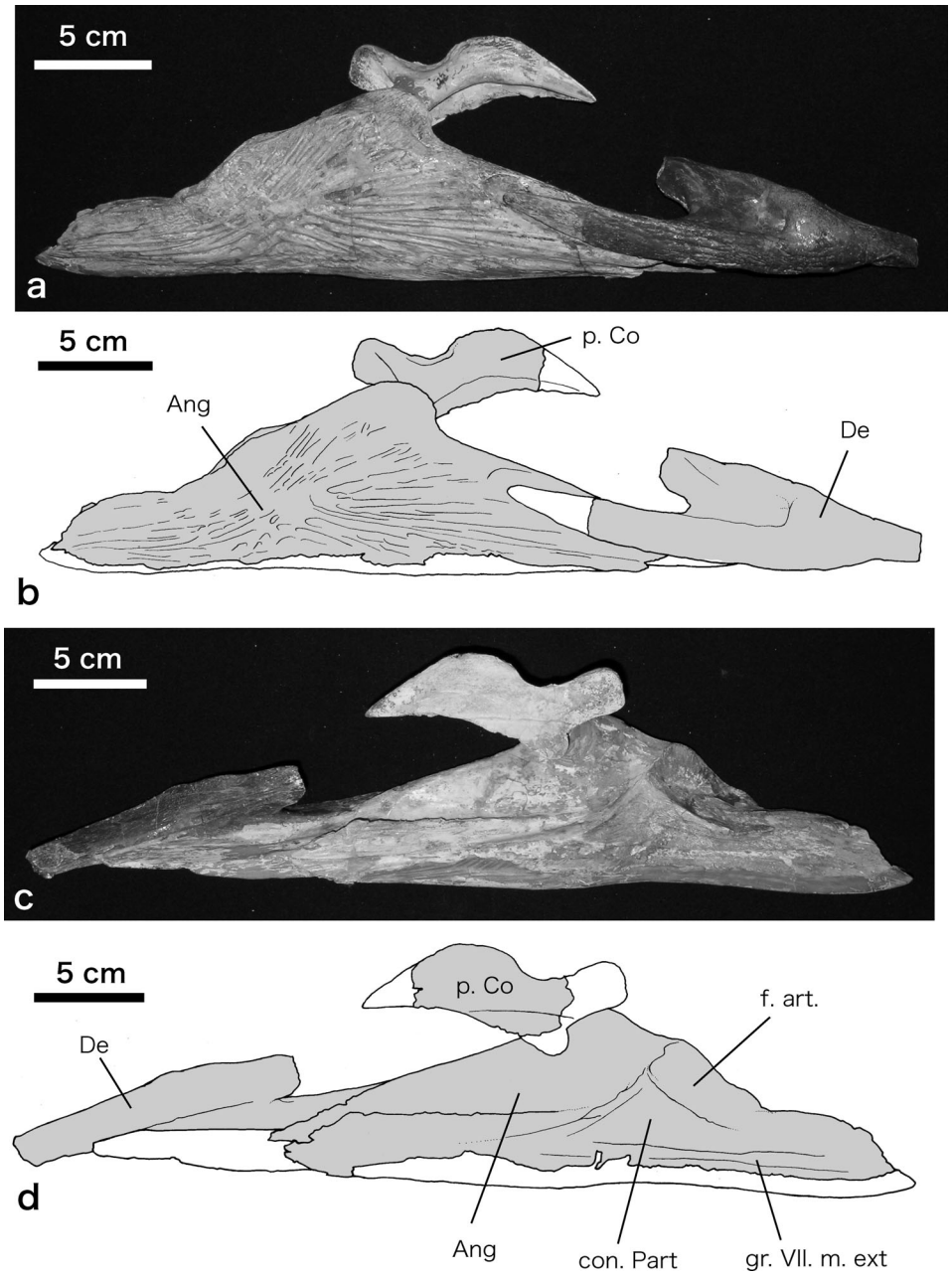

Fig. 6. The right composite lower jaw with the dentary (NSM-PV 20996) and the angular (NSM-PV 20997) of *Mawsonia lavocati* and the principal coronoid (NSM-PV 20998) of cf. *M. lavocati*, a and b, lateral view; b and c, medial view. Abbreviations: Ang, angular; con. Part=contact surface with prearticular; De=dentary; f. art=facet for articular; gr. VII. m. ext=groove for external mandibular ramus; p. Co=principal coronoid.

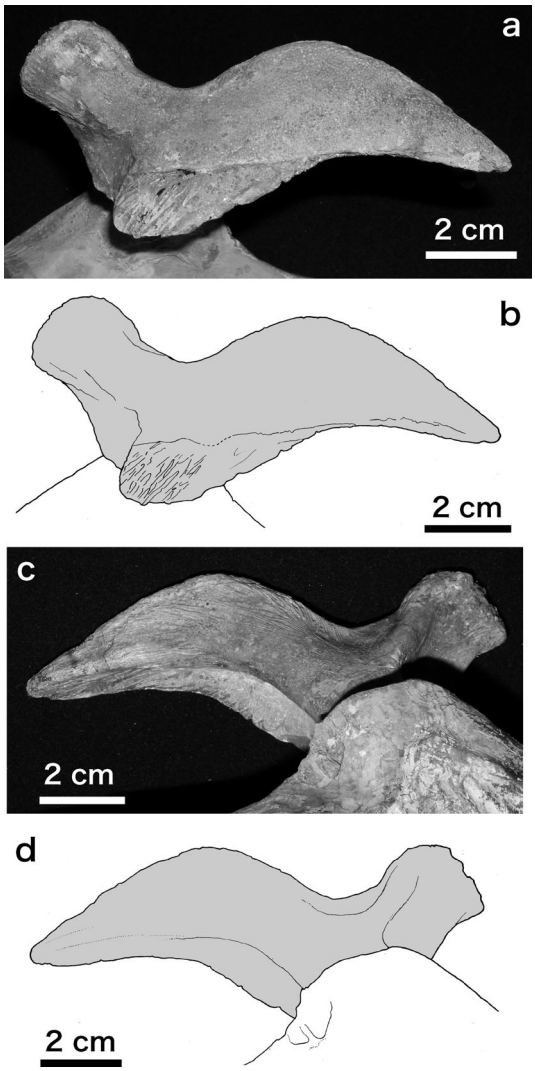

Fig. 7. The left principal coronoid of cf. *Mawsonia lavocati*, NSM-PV 20999, a and b, medial view; b and c, lateral view.

described a complete basisphenoid, the posterior part of the parieto-ethmoid shield and an undetermined length of the parasphenoid as cf. *M. lavocati* from the same beds of the present new materials. Although the present specimens are a composite from several individuals, the angular, postparietal, dentary and the ethmosphenoid portion of the braincase are identifiable as *M. lavocati*, because the ornamentation and the dorsal outline of the angular (NSM-PV 20997) are almost the same as those of the holotype, the ornamentation of the postparietal (NSM-PV 20995) and the dentary (NSM-PV 20996) have similar ridges of the angular, and the ethmosphenoid portion of the braincase (NSM-PV 20994) has similar ornamentation on the parietonasal shield to the specimens described as *M. lavocati* by Wenz (1981) and Cavin and Forey (2004).

The right principal coronoid (NSM-PV 20998), the left principal coronoid (NSM-PV 20999), the palate (NSM-PV 21000), the lachrymojugal (NSM-PV 21001) and the operculum (NSM-PV 21002) appear to belong to the genus *Mawsonia*, because the principal coronoids are similar to those of *M. brasiliensis* (see Yabumoto, 2002, fig. 3), the palate resembles that of *M. brasiliensis* (see Maisey, 1986, fig. 10; 1991, p. 321; Yabumoto, 2002) , the lachrymojugal has the expanded anterior end turning dorsally, which is observed in *M. tegamensis* (see Wenz, 1975, fig, 1) and the operculum has the same type of ridged ornamentation as that of congeners excepting *M. tegamensis*. These bones are possibly identifiable as *M. lavocati*, because of the same locality with *M. lavocati* and the corresponding size and ridged ornamentation, although the ridges are weaker than those of the angular. But these bones are described here as cf. *M. lavocati*, because these bones of *M. lavocati* have not been found and their ornamentation dose not exactly correspond to that of the holotype.

Six species of the genus *Mawsonia* have been found from the Cretaceous beds of South America and Africa (Forey, 1998; Yabumoto, 2002). These are *M. gigas* Woodward, 1907, *M. tegamensis* Wenz, 1975, *M. ubangiana* Casier, 1961, *M. lavocati* Tabaste, 1963, *M. libyca* Weiler, 1935 and *M. brasiliensis* Yabumoto, 2002. The ridged ornamentation on the angular and the postparietal of *M. lavocati* are most pronounced among the congeners.

The dermal bones of the skull roofs have been known in *M. tegamensis* and *M. brasiliensis* (Wenz, 1975; Yabumoto, 2002). In *M. lavocati* the parietonasal shield is longer than that of *M. tegamensis*. In *M. lavocati* the anterior portion of the parietonasal shield abruptly narrows at the

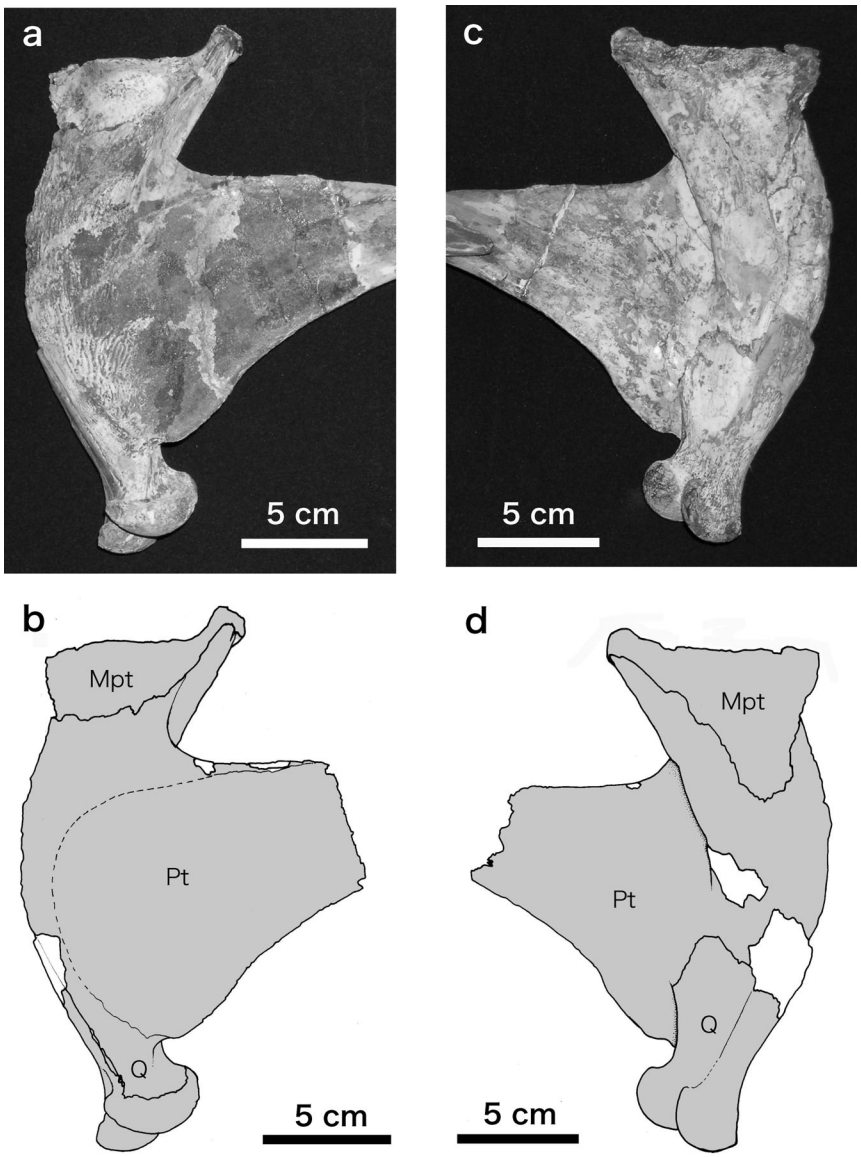

Fig. 8. The left palate of cf. *Mawsonia lavocati*, NSM-PV 21000, a and b, medial view; c and d, lateral view. Abbreviations: Mpt=metapterygoid; Pt=pterygoid; Q=quadrate.

middle of the most posterior tectals, but it gradually narrows in *M. brasiliensis*. There are three pairs of nasals in *M. lavocati*, but two pairs in *M. brasiliensis* and *M. tegamensis*. The reconstruction of the roof of ethmosphenoid portion of the skull made by "hybridising" BMNH P. 64127 and Göttingen 774-1 (from Wenz, 1981) by Cavin and Forey (2004, fig. 7), is shorter than the skull roof of the present new material (Fig. 1a and b). It was probably caused by lacking the anterior two pairs of nasals in Göttingen 774-1. There are at most three supraorbitals in *M. lavocati*, but four in *M. tegamensis*, five in *M. brasiliensis*.

The ventral margin of the pterygoid in the present specimen NSM-PV 21000 is swollen immediately in front of the quadrate that is similar to those of *M. brasiliensis*, *Latimeria chalumnae* and *Macropoma lewesiensis*. The present palate

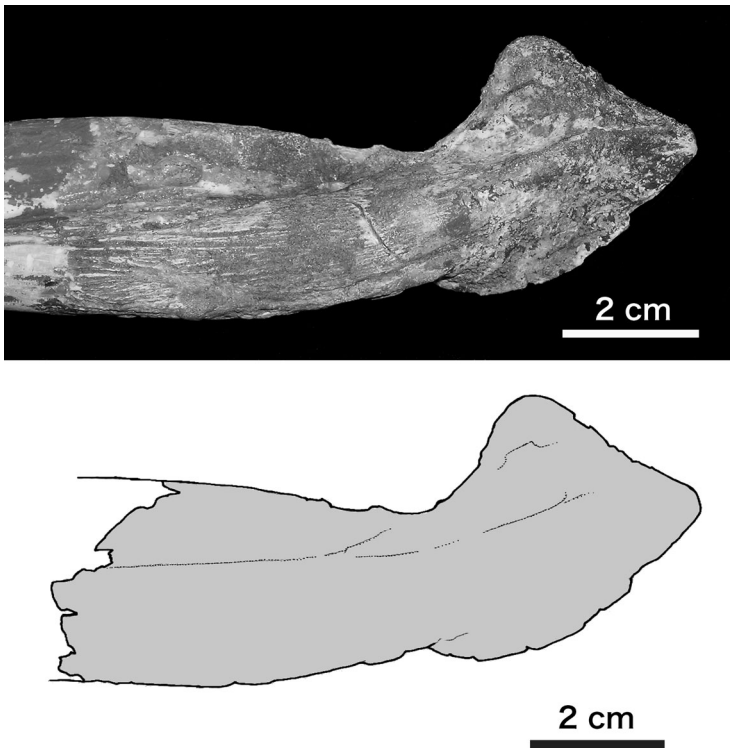

Fig. 9. The lateral view of the lachrymojugal of cf. *Mawsonia lavocati*, NSM-PV 21001.

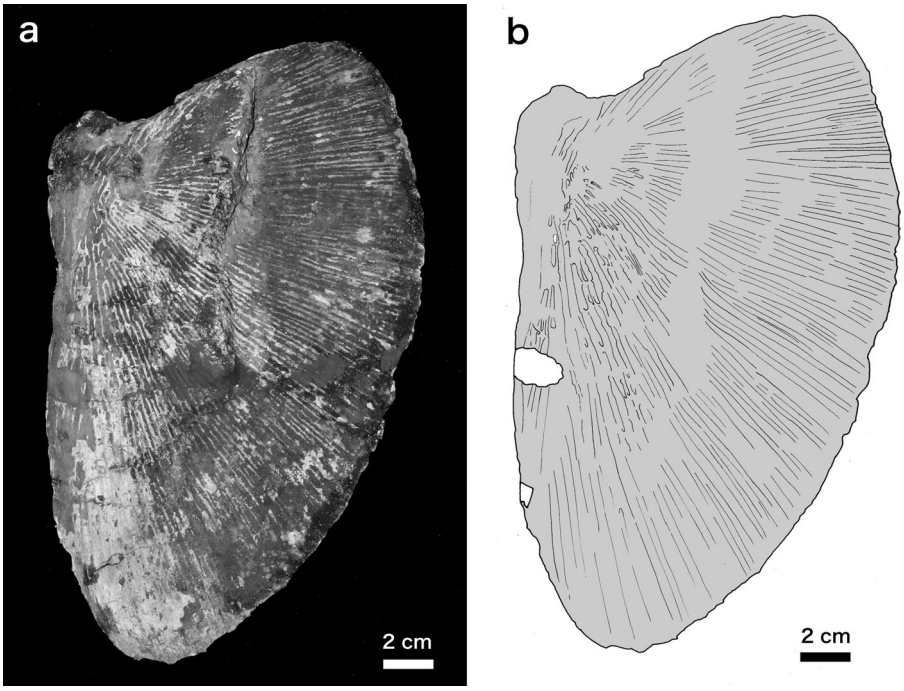

Fig. 10. The lateral view of the operculum of cf. *Mawsonia lavocati*, NSM-PV 21002.

differs from *M. lewesiensis*, which is from Cenomanian England, in having the entirely convex posterior margin of the pterygoid (the swollen middle part in *M. lewesiensis*) and the wide dorsal ridge from the lateral condoyle of the quadrate (the abruptly narrowed one in *M. lewesiensis*).

The incomplete opercula have been known in *M. gigas* and *M. tegamensis*, and the almost complete one in *M. brasiliensis*. The operculum, NSM-PV 21002 differs from those of the three species in having ridged ornamentation on the dorso-anterior portion (reticulated in *M. tegamensis*), finer radial ridges than in *M. gigas*, and the subsemicircular outline (triangular in *M. brasiliensis*) (Fig. 10).

The postparietal had been known in all species except for *M. lavocati*. The anterior apophysis is located at the middle of the anterior margin of the postparietal in *M. lavocati* and *M. libyca*, but it is shorter and smaller in *M. lavocati* than in *M. libyca*. In the other species it is located at the distal corner of the anterior margin.

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