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Dracochelys, a New Cryptodiran Turtle from the Early Cretaceous of China

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ABSTRACT

A turtle skull from the Early Cretaceous Tugulu series in the Wuerho district of Xinjiang province, People's Republic of China, is a new genus of eucryptodiran turtle. *Dracochelys bicuspis* is unique among cryptodires in possessing a very narrow maxillary triturating surface with paired cusps on the labial ridge at the premaxilla-maxilla suture. The very large foramen palatinum posterius, large internal nares, pterygoid forming a cleft-shaped opening for the palatine artery, and flattened skull show a close similarity to *Hangaiemys*, usually placed in the Sinemydidae/Macrobaenidae. However, we place *Dracochelys* as Eucryptodira incertae sedis, recognizing that the "Macrobaenidae" is presently diagnosed only by characters primitive for Eucryptodira.

INTRODUCTION

In 1973, Ye figured and briefly mentioned an "amphichelydian skull" from the Early Cretaceous Tugulu series in the Wuerho district of Xinjiang province, People's Republic of China. Further preparation and study of this specimen shows that it is a new genus of cryptodire. The purpose of this paper is to describe and name this new taxon.

The new genus, *Dracochelys*, is known from a single well-preserved skull that is most similar to *Hangaiemys*, described by Sukhanov and Narmandakh (1974) from the Early Cretaceous (Aptian-Albian) of Mongolia (Mongolian People's Republic). *Hangaiemys* is known from well-preserved skulls and shells, and, on the basis of the shell morphology, has been placed in the family Macrobaenidae (Sukhanov, 1964). Macrobaenidae has been synonymized with the family Sinemydidae by some authors (e.g., Ckhikvadze, 1987),

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but current work (Brinkman, in progress) suggests that the Sinemydidae can be defined with synapomorphies while the Macrobaenidae or Macrobaenidae plus Sinemydidae cannot, at least as currently diagnosed (see discussion). Although the purpose of this paper is not to determine the relationships of *Dracochelys,* it is certainly prudent to compare *Dracochelys* with possible near relatives. We have chosen four taxa (table 1) for these comparisons, based on similarity to *Dracochelys,* purported relationships, and availability of skull material.

Our knowledge of *Hangaiemys* and *Macrobaena* is based solely on the papers describing and figuring them, Sukhanov and Narmandakh (1974) and Tatarinov (1959), respectively. Information on *Sinemys* sp. is derived primarily from skulls (IVPP V9532-11 from Laolonghuoze, and IVPP V9538 from Otog Qi, Inner Mongolia, of undescribed species of that genus; Brinkman, personal commun.). The fourth skull, TMP 87.2.1, represents an undescribed genus from the Late Cretaceous of Dinosaur Provincial Park, Alberta, probably similar to but not the same as "*Clemmys*" *backmani* Russell, 1934 (Hutchison, personal commun.). While our knowledge of *Hangaiemys* and *Macrobaena* is based only on the literature, one of us (ESG) has had the opportunity to examine the *Sinemys* skulls and TMP 87.2.1.

Some regions of the skull in *Dracochelys* cannot yet be determined in the fossil taxa; therefore, comparisons are also made with chelydrids. *Dracochelys* is most similar to *Chelydra* among the Recent fauna, and skulls of that genus are widely available.

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Abbreviations

Anatomical

bo	basioccipital
bs	basisphenoid
epi	epipterygoid
ex	exoccipital
fr	frontal
ju	jugal
mx	maxilla
na	nasal
op	opisthotic
pa	parietal
pal	palatine
pf	prefrontal
pm	premaxilla
po	postorbital
pr	prootic
pt	pterygoid
qj	quadratojugal
qu	quadrate
so	supraoccipital
sq	squamosal
vo	vomer

Institutional

IVPP	Institute of Paleontology and Paleoanthropology, Beijing
PRC	People's Republic of China
TMP	Royal Tyrrell Museum of Paleontology, Drumheller

SYSTEMATICS

ORDER TESTUDINES

GIGAORDER CASICHELYDIA

MEGAORDER CRYPTODIRA

PARVORDER EUCRYPTODIRA INCERTAE SEDIS

cf. FAMILY "MACROBAENIDAE"

Dracochelys, new genus

TYPE SPECIES: *Dracochelys bicuspis,* new genus and species.

KNOWN DISTRIBUTION: Wuerho district, Xinjiang province, People's Republic of China, Early Cretaceous, Tugulu Series.

ETYMOLOGY: *Draco,* dragon; *chelys,* turtle.

DIAGNOSIS: Member of Eucryptodira, known only from skull, with canalis caroticus internus only partially floored by bone and foramen caroticum basisphenoidale completely formed by basisphenoid and visible in ventral view as in *Sinemys,* but in contrast to most eucryptodires in which canalis caroticus internus is completely floored by bone and foramen caroticum basisphenoidale is formed at least in part by pterygoid; skull most similar to those of *Chelydra* and *Hangaiemys* in shape but relatively flatter and wider, with fossa orbitalis and apertura narium externa opening dorsally to a much greater extent; frontal bone enters orbit in contrast to that of chelydrids; degree of temporal emargination similar to that in *Hangaiemys* and *Chelydra*; degree of cheek emargination as in *Chelydra*; triturating surfaces distinct from those of all chelydrids, *Sinemys, Hangaiemys, Macrobaena,* and Macrobaenidae (sensu Hutchison and Archibald, 1986) in being very narrow with paired cusps at the premaxilla-maxilla suture; foramen palatinum posterius relatively large in comparison with that of *Chelydra* but similar to that of *Hangaiemys*; vomerine ridge extending length of bone as in *Hangaiemys* but in contrast to *Chelydra*; processus trochlearis oticum relatively small in contrast to that of chelydrids; incisura columellae auris narrow and containing only stapes but not completely closed by bone as in chelydrids; vertical plate of processus pterygoideus externus larger than in any other turtle; pterygoid-basioccipital contact seen in chelydrids and most cryptodires greatly reduced in *Dracochelys* by posterolateral process of basisphenoid; deep concavity on quadrate process of pterygoid as in *Hangaiemys* but in contrast to that of *Sinemys,* TMP 87.2.1, and chelydrids; differs from *Sinemys wuerhoensis* in being more than twice the size and having a much wider skull.

Dracochelys bicuspis

TYPE SPECIMEN: Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) V4075 (figured in Ye, 1973, pl. 1, figs. 3, 4, as "amphichelydian skull"), collected 1964 by IVPP expedition.

LOCALITY: Wuerho district, northwestern part of Dzungar (Junggar) Basin, north Xinjiang province, People's Republic of China (see Dong, 1973).

HORIZON: Upper part (possibly equivalent to the Lianmuxin Fm.) of the Tugulo series of lacustrine sediments, thought to be Early Cretaceous. *Dracochelys* and "*Sinemys*" *wuerhoensis* both come from the Upper Tugulu series but from different horizons and localities (Dong, 1973).

DISCUSSION: *Dracochelys* is clearly a cryptodire: it has the otic trochlea synapomorphy of that group (Gaffney and Meylan, 1988; Gaffney et al., 1991), and it is here interpreted as a eucryptodire. The critical synapomorphy for eucryptodires is that the posterior portion of the pterygoid encloses the internal carotid artery. In *Dracochelys* the bone forming the floor of the canalis caroticus internus is very thin, much as in plesiochelyids, and does not seem to extend for most of the length of the groove containing the internal carotid. However, this is not definite, as the bone making up the floor is broken and missing in many places, so the floor could be more extensive than shown in the restoration (fig. 5). The limited amount of bone in the floor of the canalis could be interpreted as primitive within Eucryptodira, but nonetheless *Dracochelys* would be a eucryptodire.

Within the Eucryptodira the relationships of *Dracochelys* are more uncertain. It is most similar to a series of Asian and North American eucryptodires that have come to be referred to the family Sinemydidae and/or Macrobaenidae. The Sinemydidae was created by Ye in 1963 and Macrobaenidae by Sukhanov in 1964. The perturbations and usage of these two names is beyond the scope of this paper, and we will refer only to the most recent diagnosis by Ckhikvadze (1987). Ckhikvadze proposed the most inclusive definition, uniting the two families in Sinemydidae. He included only Asian taxa, but Hutchison *in* Hutchison and Archibald (1986) and *in* McKenna et al. (1987) has identified spec-

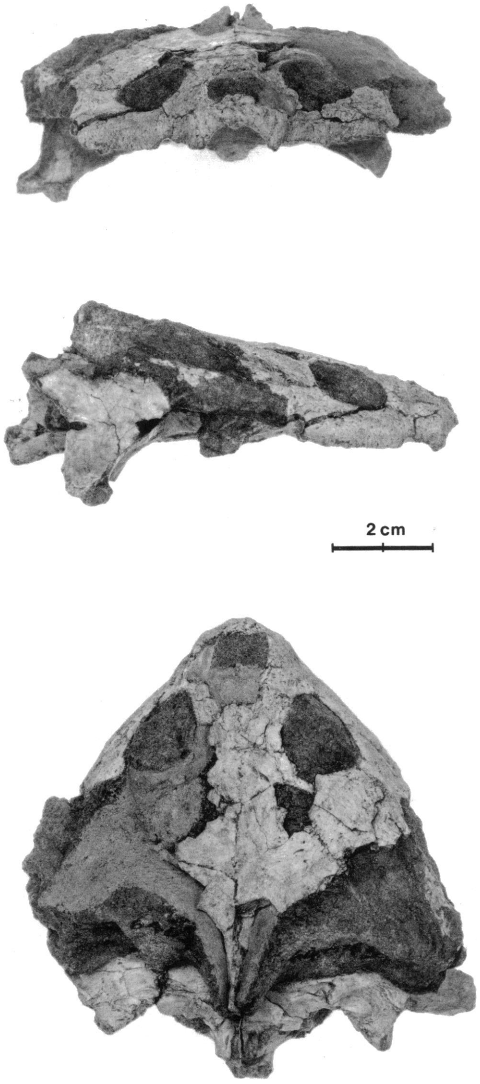

Fig. 1. *Dracochelys bicuspis,* described and diagrammed under figure 2.

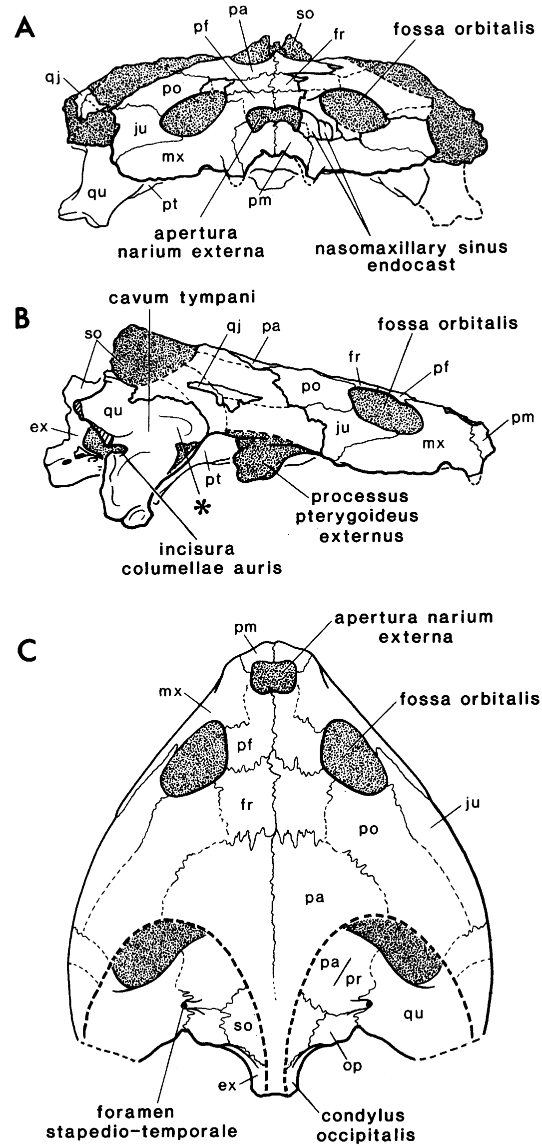

Fig. 2. *Dracochelys bicuspis,* new genus and species, IVPP V4075, Early Cretaceous, Xinjiang province, PRC. **A,** Anterior view; **B,** right lateral view; **C,** dorsal view.

imens as belonging to the Sinemydidae and Macrobaenidae (using the names as synonyms) in North America, one of which was earlier described as "*Clemmys*" *backmani* (Russell, 1934). There has been no diagnosis of this family/families including the North American taxa, but Ckhikvadze (1987) diagnosed the combined families consisting of the Asian taxa. His diagnosis consists of characters that can best be interpreted at the present time as mostly, if not solely, primitive at the level of Eucryptodira. The characters are all shell features and primarily refer to the cruciform plastron without medially extending buttresses. This shell pattern also occurs in more advanced eucryptodires, and has been retained in the chelonioids in such derived

TABLE 1
Comparison of *Dracochelys* with Similar Genera

Character	*Dracochelys*	*Hangaiemys*	TMP 87.2.1	*Sinemys*	*Macrobaena*
Skull relatively flat and wide	yes	?no	no	yes	no
Nasals present	indet	indet	yes	yes	indet
Fossa orbitalis opens dorsally	yes	yes	no	yes	no
Fossa nasalis opens dorsally	yes	no	?no	no	no
Prefrontals meet on midline	yes	?yes	yes	no	yes
Frontal enters orbit	yes	indet	yes	yes	?no
Extent of temporal emargination	moderate	moderate	moderate	greater than *Dracochelys*	much less than *Dracochelys*
Postorbital widely exposed on temporal margin	yes	indet	no	yes	?no
Maxillary triturating surface relatively narrow	yes	yes	?no	no	no
Paired cusps on premaxilla-maxilla suture	yes	no	no	no	no
Foramen palatinum posterius relatively large	yes	yes	no	yes	no
Processus trochlearis oticum and otic chamber relatively small	yes	no	no	no	no
Processus pterygoideus externus very large	yes	no	no	no	no
Canalis caroticus internus only partially floored by bone	yes	yes	yes	yes	indet
Foramen carotico-pharyngeale	absent	absent	present	absent	indet
Path of palatine artery exposed ventrally	yes	yes	no	yes	yes
Foramen caroticum basisphenoidale completely formed by basisphenoid and visible in ventral view	yes	?yes	no	yes	indet
Pterygoid-basioccipital contact small or absent	yes	indet	no	yes	indet
Basisphenoid with posterolateral processes	yes	indet	no	yes	indet
Deep concavity on quadrate process of pterygoid	yes	yes	no	no	?no

cheloniids as *Osteopygis* (phylogeny based on skull features in Gaffney and Meylan, 1988). Recently, Don Brinkman (personal commun.) has discovered specimens that may show Sinemydidae to be a monophyletic group (consisting of *Sinemys, Manchurochelys,* and newly discovered taxa). The remaining "macrobaenids," once skulls, vertebrae, etc., are described, may prove to be monophyletic or, more likely, a mixture of taxa, some monophyletic and some belonging to more advanced eucryptodiran groups. *Dracochelys* does not have obvious synapomorphies in common with known eucryptodiran taxa, and is best identified as Eucryptodira, incertae sedis.

DESCRIPTION

PRESERVATION: IVPP V4075 consists of a partial skull with well-preserved bone. The palate is almost complete but the skull roof is extensively damaged. However, the matrix underlying the missing bone retains the impression of the internal surface of the bone in many places and provides information on bone shape and limits. Although the skull has been subjected to a certain degree of dorsoventral compression, the generally flattened appearance is most likely the original shape. The crista supraoccipitalis shows no signs of dorsoventral telescoping and the ear region does not appear to be crushed, supporting this interpretation. The right quadrate articulation appears to have been pushed laterally but not to a great extent.

DERMAL ROOFING ELEMENTS: The bone in the anterior portion of the snout is missing in most of the area where nasals would occur, and small ones could have been present. There is nothing interpretable as nasals. The underlying matrix forms a good impression of the ventral surface of the missing bone, and there is no sign of a suture separating nasal and prefrontal. *Sinemys* sp. has nasals, *Macrobaena* is described as having nasals, and chelydrids lack nasals. The other fossil taxa are indeterminant.

The prefrontal is preserved in part on both sides. Both prefrontals are missing much of their anterior region but the right one shows most of the contacts. Assuming nasals are absent, the prefrontal forms the dorsal margin of the apertura narium externa, contacts the maxilla anterolaterally, forms the anterodorsal margin of the orbit, and contacts the frontal posteriorly. The prefrontal appears to contact its mate for the entire length of the bone. The prefrontal of *Dracochelys* is less extensive than in living chelydrids due to the larger dorsal process of the maxilla, but otherwise the prefrontals are very similar. *Dracochelys* differs significantly from *Sinemys* sp. in the degree of prefrontal exposure dorsally. In *Sinemys* sp. the prefrontal is only a relatively small lappet bordering the fossa orbitalis and separated on the midline by the frontal. This is similar to the condition in baenids, but the lappet is smaller in baenids. In *Dracochelys* the prefrontals meet on the midline for their entire length and are not separated by the frontals. The prefrontals in *Macrobaena* are figured as meeting on the midline for their length. TMP 87.2.1 is indeterminant.

The anterior expansions of the sulcus olfactorius that form the roof of the fossa nasalis are preserved as molds in the matrix filling the skull of IVPP V4075. These expansions are similar to those in chelydrids. The apertura narium externa in *Dracochelys* faces dorsally to a much greater extent than in chelydrids where it opens almost directly anteriorly. The type skull of *Dracochelys* is probably flattened slightly but this would not cause the apertura opening to be so different from that of chelydrids.

The ventral process of the prefrontal reaches the vomer. The prefrontal and the other bones forming the fossa orbitalis are not visible in IVPP V4075 because both orbits are entirely filled with matrix. The orbits open dorsally a bit more in *Dracochelys* than in *Sinemys* and a great deal more dorsally than in *Macrobaena*, and much as in *Hangaiemys*.

The frontal of *Dracochelys* is roughly rectangular and similar in shape to that of chelydrids and in contrast to the triangular frontal of *Sinemys* sp. Only the medial half of the left frontal is preserved but on the right side only the posterolateral corner is missing. In *Dracochelys* the frontal enters the orbit as in TMP 87.2.1, and *Sinemys* sp., but in contrast to *Macrobaena* and chelydrids. In *Protochelydra*, a primitive chelydrid, the prefrontal and postorbital meet to exclude the frontal from the orbit.

The parietal of IVPP V4075 is incomplete on both sides. The lateral third is missing on the left side, but only a small part of the lateral limits are missing on the right. The posterior margin is preserved for a limited section on the right side, but the edge of the skull roof emargination is seen clearly on the matrix impression of the ventral surface of the parietal (fig. 1). The parietal in *Dracochelys* is very similar to that bone in *Chelydra* and *Sinemys* sp. The temporal emargination of *Dracochelys* is restored from the matrix imprint. The precise limits of the parietal and postorbital are not determinable but we have confidence in the approximate position of the skull roof margin. As restored, *Dracochelys* has a relatively well-developed temporal emargination with the parietal and postorbital well exposed. *Sinemys* sp. is more emarginate, *Macrobaena* has virtually no emargination, and TMP 87.2.1 is less emarginate than *Dracochelys*. In TMP 87.2.1 there is a parietal-squamosal contact, very different from the exposed postorbital as restored in *Dracochelys*.

The jugal is incomplete on both sides of IVPP V4075, the posterior portions being lost in both. The jugal widely enters the orbital margin between maxilla and postorbital, to a slightly greater extent than in *Chelydra* but similar to that in *Sinemys* and TMP 87.2.1. Based on the position of a fragment of the quadratojugal and postorbital suture, it is likely that the jugal in *Dracochelys* extended posteriorly to some extent as in *Chelydra* and *Protochelydra* rather than being restricted as in *Sinemys* sp. and TMP 87.2.1. However, this cannot be determined definitely. The extent of cheek emargination is also unclear, but the matrix on the left side shows an impression that strongly suggests that it was relatively extensive as in *Protochelydra* and *Chelydra.* The medial process of the jugal is only visible as a small area adjacent to the maxilla-pterygoid contact in ventral view.

The quadratojugal is entirely absent on the left side and preserved only as a fragment on the right. The fragment contains the postorbital-quadratojugal suture and is in a position consistent with a relatively small, C-shaped quadratojugal, the generalized cryptodiran condition found in primitive chelydrids.

Squamosals are lacking in IVPP V4075, except for a possible fragment in what appears to be the quadrate-squamosal suture on the right side.

The postorbital in IVPP V4075 is absent except for an impression of its ventral surface on the left side, and present on the right side for about half of its length anteriorly. The postorbital is a large element forming the posterodorsal margin of the orbit between frontal and jugal. Most of the parietal-postorbital suture is preserved but a small section of its posterior end is missing. Nonetheless, the medial edge of the postorbital in *Dracochelys* seems to have had a shape very similar to that of *Chelydra.* The lateral and posterior limits of the postorbital, however, are much more ambiguous and it is only the small fragment of quadratojugal-postorbital contact that allows some idea of its extent. At least some of the temporal emargination was formed by the postorbital but how far posteriorly it extended cannot be determined. As restored, the postorbital is most similar in size and extent to that in *Chelydra.*

PALATAL ELEMENTS: Both premaxillae are preserved in IVPP V4075 and are seen in anterior and ventral views (figs. 1, 3). In anterior view the labial ridge has paired ventrally projecting "teeth" formed by the premaxillae plus maxilla. Medially, the premaxillary labial ridge rises higher than the level of the maxillary labial ridge to form a midline notch. Two labial cusps are uncommon in turtles but do occur in some forms, such as *Dermochelys* and *Pseudemys nelsoni* (Ernst and Barbour, 1972). However, this morphology does not occur in *Hangaiemys, Sinemys* sp., TMP 87.2.1, *Macrobaena,* chelydrids, plesiochelyids, or any non-eucryptodire. On the ventral surface both premaxillae form the anterior half of a circular concavity or commissural depression on the midline of the triturating surfaces, similar to that seen in other chelydrids and suggesting that *Dracochelys* may have had a midline "hook" or process on the lower jaw. The foramen praepalatinum is formed almost entirely by the premaxilla with a small contribution from the vomer.

Both maxillae of IVPP V4075 are preserved almost completely; only a small portion of the labial ridge is missing. The vertical part of the maxilla is an anterodorsal process forming the anterior rim of the orbit and reaching dorsally to meet the prefrontal. This process is somewhat more extensive in *Dracochelys* than in *Sinemys* sp. and chelydrids, being visible in dorsal view in *Dracochelys* but not in chelydrids. The general flattening of the skull in *Dracochelys* accentuates this condition but the maxilla still extends dorsally more than in chelydrids.

The posterolateral corner of the fossa nasalis has a shallow but distinct sinus that can be seen in the matrix on the left side. The dorsal part of the maxilla seems to form this sinus.

The horizontal part of the maxilla bears the triturating surfaces. In *Dracochelys* the labial and lingual ridges are parallel and very close to each other, being separated by a shallow but distinct trough. The narrowness of the triturating surface in *Dracochelys* is extreme, and among the taxa being compared here, only *Hangaiemys* approaches it. The triturating surface of *Dracochelys* is relatively narrower than the narrow-jawed batagurids and any other turtle. The labial ridge forms a large cusp or "tooth" at the maxilla-premaxilla suture and extends posteriorly as a straight ridge that ends at the posterior edge of the maxilla. The labial ridge of *Dracochelys* is comparable in relative height and sharpness to the labial ridge in *Chelydra*. The lingual ridge in *Dracochelys* is lower than the labial ridge. The lingual ridge begins near the maxilla-premaxilla suture at the margin of the midline concavity formed just posterior to the labial ridge, but it trends away from the labial ridge along the palatine-maxilla suture.

Anteromedially the maxilla has a long suture with the premaxilla, and medially a short suture with the vomer just behind the premaxillary contact, as in most turtles. The short process of the maxilla that curves posteriorly to reach the vomer forms the anterior margin of the apertura narium interna. In *Dracochelys* the apertura is unusually large, comparatively much larger than in chelydrids but similar to the size of the apertura in *Hangaiemys*. The position and shape of the palatine-maxilla contact is similar to those in *Chelydra* and most turtles. The foramen palatinum posterius is formed laterally and posterolaterally by the maxilla. The foramen in *Dracochelys* is unusually large, much larger than in *Sinemys* sp., *Macrobaena*, TMP 87.2.1, and chelydrids, but similar in size to that in *Hangaiemys*. Posteriorly the maxilla has a roughly transverse suture with the pterygoid.

The vomer is complete in IVPP V4075 but it is visible only in ventral view. The vomer is generally similar to that in *Chelydra* in having the normal chelonian anterior expansion with premaxillary and maxillary contacts, and a posterior extension separating the palatines and reaching the pterygoids posteriorly. In *Dracochelys* as well as in *Hangaiemys* and TMP 87.2.1, the ventral midline ridge of the vomer is relatively deep and continues for the length of the bone, rather than being shallow and restricted to the anterior portion as in chelydrids. The former condition also occurs in plesiochelyids and may be primitive for eucryptodires. Anterodorsally the lateral contacts of the prefrontals with the vomer can be seen in the roof of the apertura narium interna.

The palatines on both sides of IVPP V4075 are preserved almost entirely. Anteriorly the palatine forms the roof of the apertura narium interna, contacts the prefrontal, and forms the medial margin of the foramen orbito-nasale. Anterolaterally the palatine has a process that contacts the maxilla between the apertura narium interna and the foramen palatinum posterius. The palatine forms the medial half of the margin of the large foramen palatinum posterius. The entire width of the palatine posteriorly is a transverse suture with the pterygoid. Medially the palatine has a long suture with the vomer. The palatine of *Dracochelys* agrees in most of its features with that of *Chelydra* but it is relatively wider, more like that of *Hangaiemys*.

Palatoquadrate Elements: The left quadrate is represented only by the medialmost portion of that bone, but the right quadrate has much of the cavum tympani and processus articularis. The quadrate of *Dracochelys* is similar to that bone in *Chelydra*. The medial part contacts the pterygoid ventrally and the prootic dorsally. As in *Chelydra*, the quadrate forms most of the processus trochlearis oticum, but in contrast to the large processus characteristic of chelydrids, this structure is unusually low and hardly delimited from the surrounding bone in *Dracochelys*. The processus is indeterminant in the published figures of *Hangaiemys* but appears large in TMP 87.2.1 and in *Sinemys* sp. On the dorsal surface the quadrate contacts the prootic anteriorly and the opisthotic posteriorly. As in *Chelydra* the foramen stapediotemporale is formed in the prootic-quadrate suture close to the opisthotic contact. Posteromedially the opisthotic would be expected to extend a process posterolaterally along the quadrate but this process is broken off on both sides, exposing the quadrate sutural surface.

The pterygoid has a process that extends along the ventral surface of the quadrate posterolaterally in *Dracochelys* as in all selmacryptodirans. The position of the pterygoid-quadrate suture in *Dracochelys* is the same as in TMP 87.2.1, *Sinemys* sp., and *Chelydra*. The processus articularis of the quadrate is positioned slightly farther posteriorly in *Dracochelys* than in *Chelydra*, resembling *Macroclemys* to a certain extent. Only the right condylus mandibularis is preserved and it is the same as in *Chelydra*.

The cavum tympani of IVPP V4075 is preserved only in part on the right side. The dorsal section, including all of the squamosal, and the anteroventral parts are missing. One section of the rim of the cavum tympani is preserved anterodorsally and this provides an idea of the size. The cavum tympani in *Dracochelys* is relatively larger than in *Chelydra.* A small outward-facing concavity (indicated by an asterisk in fig. 2) lies at its anterior margin; this concavity is absent in *Chelydra* and *Sinemys* sp. *Sinemys* does have a deep concavity in the ventral part of the cavum tympani, but the cavum in *Sinemys* is smooth in the region of the concavity in *Dracochelys.* The cavum tympani is not visible in *Hangaiemys.* Although the upper part of the incisura columellae auris is broken posteriorly, it can be seen from the lower area that the incisura was not closed as in chelydrids. The incisura does not seem to have been widely open in *Dracochelys* and this condition seems close to *Sinemys* sp. and TMP 87.2.1. The area of the antrum postoticum formed by the quadrate is visible on the right side of IVPP V4075, and it is very similar in *Chelydra.*

The ethmoid region of IVPP V4075 is not well prepared but the ventral part of the region is visible. An epipterygoid can be seen, best on the left side, and with ventral limits very similar to those of *Chelydra.* The anterodorsal-posteroventral ridge found below the foramen nervi trigemini in most turtles is very well developed in *Dracochelys,* and is much more pronounced than in *Chelydra.* The foramen nervi trigemini of IVPP V4075 is visible completely on the left side but only ventrally on the right. It is relatively small compared with that in *Chelydra,* about one-third the width. It is possible that crushing has reduced the width slightly. Although the sutures around the foramen nervi trigemini are not clear dorsally, it appears that the epipterygoid forms the anteroventral margin and the prootic the posterior margin. The entry of the parietal and the extent of the pterygoid in the margin are not determinable.

Both pterygoids are preserved in IVPP V4075 and they have the general form of selmacryptodiran pterygoids. Anteriorly the pterygoid has a roughly transverse margin, meeting the maxilla anterolaterally, the palatine anteriorly, and the vomer anteromedially. The processus pterygoideus externus is very large in *Dracochelys* with a huge vertical plate. The size of the processus and extent of the plate are greater than in any other turtle. It is possible that the large size of the processus pterygoideus externus and the very narrow triturating surface are correlated because the processus bears the mundplatte and guides the lower jaw. A narrow triturating surface may require a more restricted area of lateral movement when the jaws are closed.

Medially both pterygoids in *Dracochelys* are in contact anteriorly, but for a much shorter length than in *Chelydra* and most other eucryptodires. This is because the basisphenoid in *Dracochelys* is exposed ventrally to a much greater extent. Posteriorly the pterygoid-basisphenoid suture runs into an area of broken bone and then emerges posterolaterally showing that the basisphenoid has a posterolateral extension not seen in chelydrids, *Sinemys* sp., and TMP 87.2.1 (indeterminant in *Macrobaena* and *Hangaiemys*).

The anterior part of the pterygoid-basisphenoid suture shows a vertical separation of the basisphenoid to form a cleftlike opening on each side. This opening would appear to be for the palatine artery which in most eucryptodires runs between the pterygoid and basisphenoid to emerge lateral to the rostrum basisphenoidale. In *Dracochelys* the palatine artery would appear to have branched at or near the foramen basisphenoidale. Although it is hard to be sure from the published photographs, it appears that *Hangaiemys* has a posteromedial flange on the pterygoid, essentially an extension of the cleft seen in *Dracochelys* that nearly covers the path of the palatine artery. *Sinemys* sp. could be interpreted as being intermediate in this area with more of the palatine artery path exposed. TMP 87.2.1 has no exposed path of the palatine but has a relatively small foramen in the pterygoid as well as a eucryptodiran pterygoid entrance of the internal carotid artery. The condition of this pterygoid flange in *Dracochelys* is similar to that postulated for the meiolaniid *Crossochelys* by Gaffney (1983) and may be primitive for cryptodires.

A careful examination of the basisphenoid-pterygoid contact area in IVPP V4075 shows that there is a eucryptodiran foramen posterior canalis carotici interni and its associ-

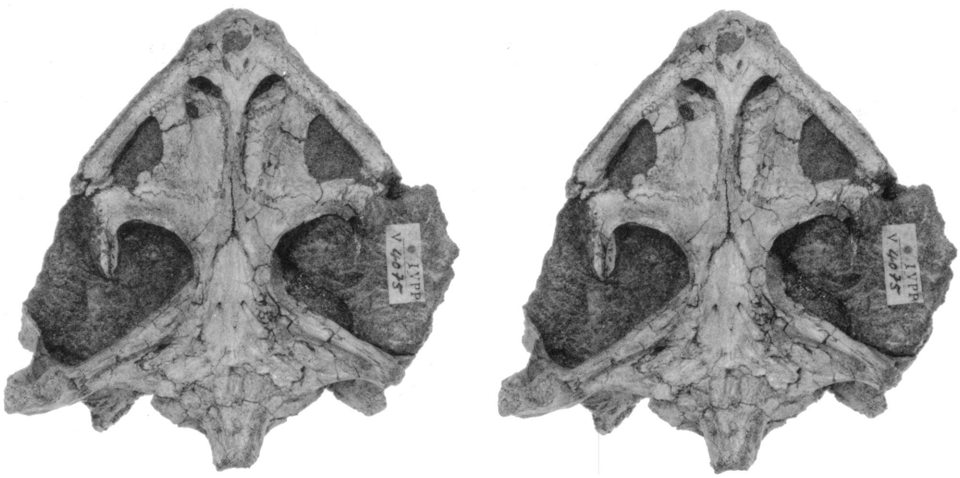

Fig. 3. *Dracochelys bicuspis,* new genus and species, IVPP V4075, Early Cretaceous, Xinjiang province, PRC. Stereophotograph of ventral view.

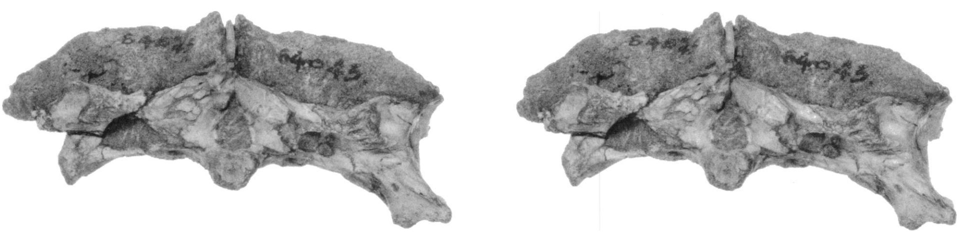

Fig. 4. *Dracochelys bicuspis,* new genus and species, IVPP V4075, Early Cretaceous, Xinjiang province, PRC. Stereophotograph of occipital view.

ated canal. The ventral floor of the canal is very thin and broken but its presence is established. The canal is relatively short, however, and does not seem to extend all the way to the foramen caroticum basisphenoidale, similar to the condition in *Sinemys* sp. Although the canalis caroticus internus seems to be formed mostly by the pterygoid, the sutures are not clear and it is possible that the basisphenoid forms some part of it. Because of the broken condition of the canalis caroticus internus, the exact position of the foramen posterior canalis carotici interni in *Dracochelys* could be more posterior than indicated.

Due to the posterolateral processes of the basisphenoid in *Dracochelys,* the pterygoid-basioccipital contact seen in most cryptodires is very small or absent. A process of the pterygoid curves medially around the basisphenoid to nearly reach the exoccipital.

The posterolateral or quadrate process of the pterygoid in *Dracochelys* has a well-developed concavity (indicated by an asterisk in fig. 5) opening ventrally and partially overhung medially. This concavity lies in an area usually occupied by the attachment of part of the pterygoideus muscle in recent cryptodires and this may have been the case in *Dracochelys.* A similar concavity is present in *Hangaiemys* but not in chelydrids, *Sinemys* sp., or TMP 87.2.1.

BRAINCASE ELEMENTS: The supraoccipital is visible only on the midline just above the foramen magnum in IVPP V4075. Most of the crista supraoccipitalis is broken off, but

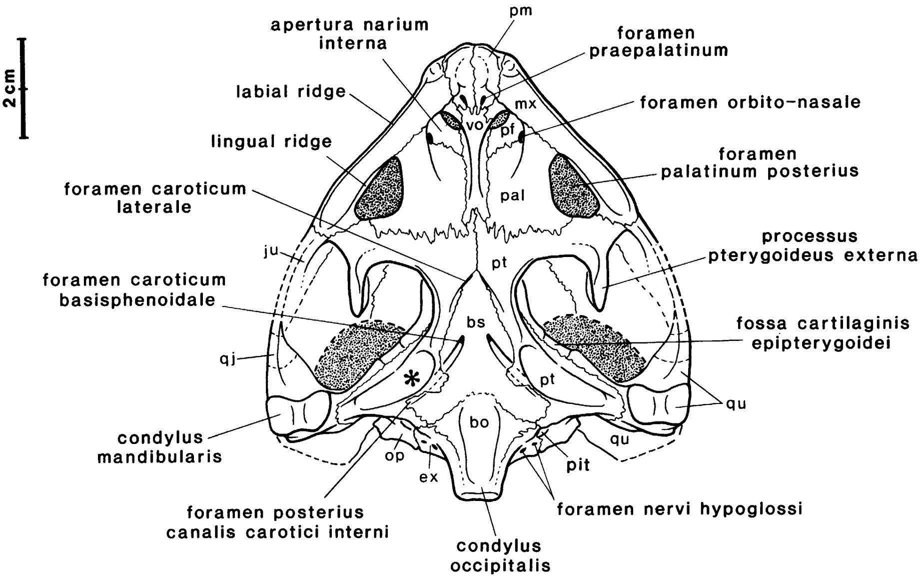

Fig. 5. *Dracochelys bicuspis,* new genus and species, IVPP V4075, Early Cretaceous, Xinjiang province, PRC. Ventral view, partially restored. Asterisk is concavity referred to in text.

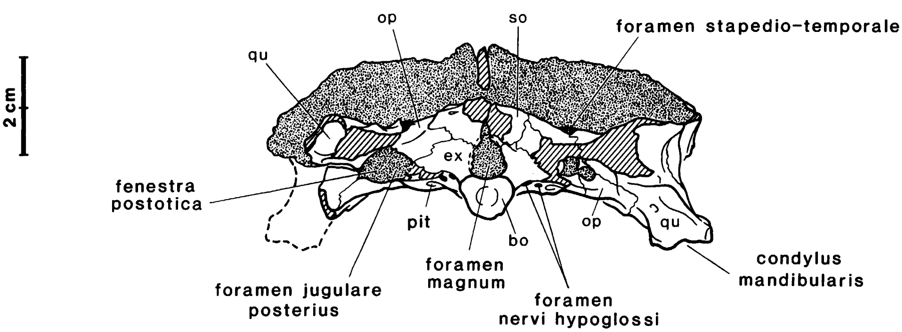

Fig. 6. *Dracochelys bicuspis,* new genus and species, IVPP V4075, Early Cretaceous, Xinjiang province, PRC. Occipital view.

at the position of the foramen magnum it is slightly lower than in *Chelydra.* The ventral expansion of the supraoccipital containing part of the cavum labyrinthicum contacts the opisthotic laterally and the exoccipitals on either side of the foramen magnum in *Dracochelys,* much as in *Chelydra.*

The exoccipitals are preserved on both sides of IVPP V4075, the right one being more complete. Both are broken laterally and it cannot be determined whether or not there was a foramen jugulare posterius entirely formed by bone as in *Chelydra* or whether it was open as in the Tyrrell skull. Two foramina nervi hypoglossi are present close to the base of the condylus occipitalis, much as in *Chelydra.* As in chelydrids, the ventral flange of the exoccipital reaches the pterygoid. In *Dracochelys,* due to the posterolateral processes of the basisphenoid, the exoccipital comes very close and seems to just contact the basisphenoid on the right side.

The basioccipital is complete in IVPP V4075 and forms the condylus occipitalis posteroventrally as in chelydrids. Anteriorly there is a long V-shaped contact with the basisphenoid that differs from the usual transverse contact seen in *Sinemys* sp., TMP 87.2.1, and most turtles.

The prootic is present and apparently complete on both sides of IVPP V4075, but matrix makes it difficult to determine its limits and no internal structures are visible. Dorsally it seems to enter the medial margin of the foramen stapedio-temporale and lies medial to the quadrate. Posteriorly it contacts the opisthotic and medially the supraoccipital. Portions of the opisthotic are present on both sides of IVPP V4075 but neither are complete. The medial parts of the bone are present and contact the supraoccipital, prootic, and exoccipital, but the lateral area, the processus paroccipitalis, is largely missing.

The basisphenoid of IVPP V4075 is present and complete except for the damaged section around the canalis caroticus internus and basisphenoid-pterygoid contact. The basisphenoid is arrow-shaped, pointed anteriorly, and broadening posteriorly to end posterolaterally in a blunt process. The basisphenoid lies between the pterygoids for most of its length and has a posterior contact with the basioccipital for most of its width. Anteriorly, the basisphenoid lies in a plane slightly dorsal to the pterygoids, allowing the formation of the openings discussed above. In the middle of the basisphenoid are paired foramina for the medial branch of the carotid arteries. These foramina are entirely formed by the basisphenoid and are not close to the pterygoid suture. Posterolateral grooves extend from the foramina and are continuous with the canalis caroticus internus of each pterygoid.

RELATIONSHIPS: *Dracochelys* has the otic trochlear synapomorphy of cryptodires and the posterior pterygoid process of selmacryptodires (Gaffney and Meylan, 1988). The eucryptodires are characterized by an internal carotid contained in the pterygoid, but in some eucryptodires the bone flooring the canal may be very thin (plesiochelyids) or only partial. Among the taxa with partial floors to the canalis caroticus internus are *Sinemys, Hangaiemys,* and *Dracochelys. Sinemys* has more extensive flooring than *Dracochelys,* which has the least degree of carotid enclosure in any eucryptodire. Whether or not this represents a character phylogeny, or reflects variation within taxa with partial carotid floors, is hard to test at present. *Sinemys, Hangaiemys,* and other relevant taxa are not yet described in sufficient detail to develop character analyses that could resolve this problem, although this work is underway.

The close similarity of *Dracochelys* and *Hangaiemys,* i.e., narrow triturating surfaces and large foramina palatinum posterius, suggests that they are closely related. The best estimate of the relationships of *Dracochelys* at present is that it is a eucryptodire below the level of Polycryptodira (Gaffney and Meylan, 1988) and probably close to *Hangaiemys.*

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