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Small, enigmatic alligatoroid from the Middle Eocene Clarno Formation, John Day Fossil Beds, Oregon

Jeremy B. Stout[1], Tobias Massonne[2], Joshua X. Samuels[3], Blaine W. Schubert[3]

1 *The Nature Center at Steele Creek Park, Bristol, TN, USA*

2 *Department of Geosciences, Eberhard-Karls-Universität Tübingen, Tübingen, Germany*

3 *Center of Excellence in Paleontology and Department of Geosciences, East Tennessee State University, Johnson City, TN, USA*

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Corresponding author: Jeremy B. Stout (biostout@gmail.com)

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Abstract

Alligatoroidea is the crocodylian superfamily that includes extant alligators, caimans and many related extinct taxa. Palaeogene North America offers a rich record of alligatoroid diversity representing more than a dozen forms. The Eocene-aged Hancock Mammal Quarry (HMQ, Clarno Formation, John Day Fossil Beds National Monument, central Oregon, USA) has yielded two crocodylian fossils, a right humerus and the anterior portion of a left lower jaw from an unknown alligatoroid. Though fragmentary, discrete morphological traits of the HMQ alligatoroid are shared with several contemporaneous alligatoroids, but the suite of character states is unique. Though its phylogenetic placement is uncertain, the presence of an alligatoroid in north-western North America, along with the biostratigraphic record of other Palaeogene alligatoroids and Asian floral and faunal associations of the HMQ suggest that an Asian origin for the taxon is plausible.

Key Words

Alligatoroidea, Alligatoridae, Alligatorinae, Caimaninae, dentary, Orientalosuchina

Introduction

Alligatoroidea is the eusuchian superfamily encompassing alligators, caimans and all taxa more closely related to them than to either *Crocodylus* Laurenti, 1768 or *Gavialis* Oppel, 1811 (Brochu 1999) and is restricted in extant distribution to the tropical, subtropical and temperate regions of the Americas (caimans and *Alligator mississippiensis* [Daudin, 1802]) and central China (*A. sinensis* Fauvel, 1879) (Taplin and Grigg 1989). Originating in Cretaceous North America (Brochu 1999), the group had a much larger distribution in the past that included several dispersals into Europe (Martin et al. 2014) and South America during the earliest Cenozoic or before (Brochu 2011) and two dispersals into Asia (Iijima et al. 2016; Shan et al. 2021). European alligatoroids include the alligatorines *Arambourgia* Kälin, 1939 and *Hassiacosuchus* Weitzel, 1935 (Wassersug and Hecht 1967) and the Diplocynodontidae, an exclusively European clade usually recovered in phylogenetic analyses as alligatoroids (e.g. Brochu (1999); Piras and Buscalioni (2006); Martin et al. (2014); Rio et al. (2020)), but more recently recovered as outside of Alligatoroidea (e.g. Walter et al. (2025)).

Coincident with global hothouse conditions of the Eocene Thermal Maximum (McInerney and Wing 2011; Westerhold et al. 2020), the early Cenozoic was marked by higher worldwide crocodylian diversity compared to that observed in the modern world (Markwick 1998; Scheyer et al. 2013; Mannion et al. 2015; de Celis et al. 2020) and some Eocene environs contained higher crocodylian diversity than observed in modern ecosystems (Stout 2012; Hastings and Hellmund 2017; Cossette and Tarailo 2024). Alligatoroid biodiversity was similarly high at this time (Stout 2024) and North America appears to have been a global biodiversity hotspot for the clade

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(Cossette and Tarailo 2024). The Eocene Epoch of North America held several taxa each of caimanines (Brochu 2010; Stocker et al. 2021; Cossette and Tarailo 2024) and alligatorines (Brochu 2004), several forms of unknown relationship within Alligatoroidea (Cossette and Tarailo 2024) and may have given rise to the genus *Alligator* itself (Whiting and Hastings 2015). Most of the alligatoroid record from Palaeogene North America is confined to the American Great Plains (Brochu 1999, 2004; Whiting and Hastings 2015; Cossette and Tarailo 2024), Southwest (Brochu 1999, 2010; Stocker et al. 2021) and Saskatchewan (Whiting and Hastings 2015). Alligatoroid remains from central Oregon are disjunct from other North American occurrences (Fig. 1) and, while they have been mentioned (Brochu 2003; Stocker et al. 2021), these records were not described until the current report.

The earliest record of alligatoroid dispersal into Asia is represented by Orientalosuchina, a unique clade unrelated to the branch leading to the modern Chinese Alligator, *Alligator sinensis* (Massonne et al. 2019). Orientalosuchina was well-established early in the Cenozoic (Shan et al. 2021) and includes several Eocene taxa (Fig. 2): *Orientalosuchus naduongensis* Massonne et al., 2019 from Vietnam, *Krabisuchus siamogallicus* Martin & Lauprasert, 2010 from Thailand and *Dongnanosuchus hsui* Shan et al., 2021 from China. These taxa are recovered with *Protoalligator huiningensis* Wang et al., 2016 and *Eoalligator chunyii* Young, 1964 from the Palaeocene of China (Wu et al. 2018) and *Jiangxisuchus nankangensis* Li et al., 2019 from the late Cretaceous of China as a monophyletic group (Massonne et al. 2019; Shan et al. 2021).

Geologic setting

The Clarno Formation is represented throughout central Oregon and includes early to middle Eocene age volcanic rocks, debris-flow conglomerates, lahars and volcaniclastic sedimentary rocks interpreted as having been deposited within an extensional basin or series of basins located near sea level at the time (Rogers and Novitsky-Evans 1977; Rogers and Ragland 1980; Noblett 1981; White and Robinson 1992; Bestland et al. 1999; Dillhoff et al. 2009; McClaughry et al. 2009). The source for the Clarno volcanics was a broad local arc of volcanoes resulting from 'flat slab' subduction of oceanic crust beneath western North America, occurring from the Cretaceous through the Eocene (White and Robinson 1992). The ash from these eruptions ultimately became the claystone and siltstone deposits that characterise the Clarno Formation, including the repeated palaeosol units near the top of the formation (Bestland et al. 1999). These Clarno Formation deposits were formed prior to the shift of arc magmatism and the formation of the well-known Cascades arc to the west (Fisher 1967; McBirney 1978; Taylor 1990; Bestland et al. 1999).

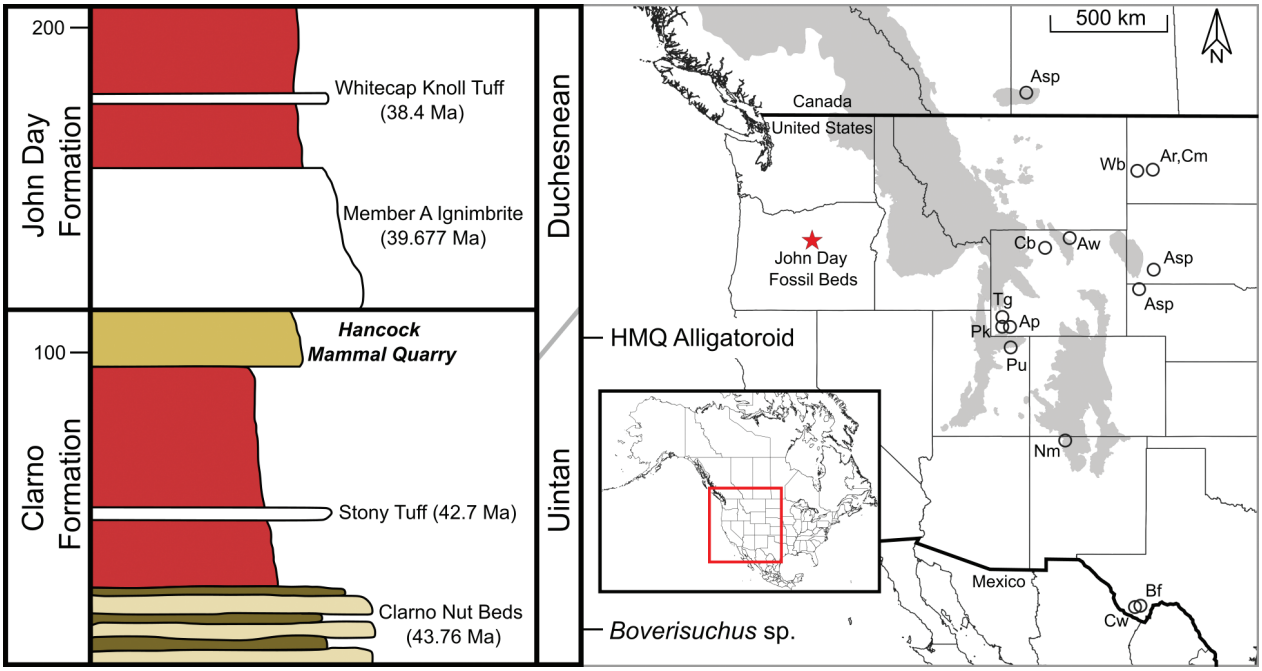

Figure 1. Stratigraphic position of crocodylians known from John Day Fossil Beds, central Oregon (left). Alligatoroid occurrences in the early Palaeogene (Palaeocene and Eocene) of western North America (right). Grey shaded area represents the Rocky Mountains present during the early Cenozoic (North American Level III ecoregions 6.2.1–6.2.4, 6.2.6, 6.2.10, 6.2.13–6.2.14, Wiken et al. (2011)). Abbreviations for taxa are Ap (*Allognathosuchus polyodon*), Ar (*Ahdeskatanka russlanddeutsche*), Asp (*Alligator* sp.), Aw (*Allognathosuchus wartheni*), Bf (*Bottosaurus fustidens*), Cb (*Ceratosuchus burdoshi*), Cw (*Chinatichampsus wilsonorum*), Cm (*Chrysochampsa mlynarskii*), Nm (*Navajosuchus mooki*), Pk (*Procaimanoidea kayi*), Pu (*Procaimanoidea utahensis*), Tg (*Tsoabichi greenriverensis*) and Wb (*Wannaganosuchus brachymanus*).

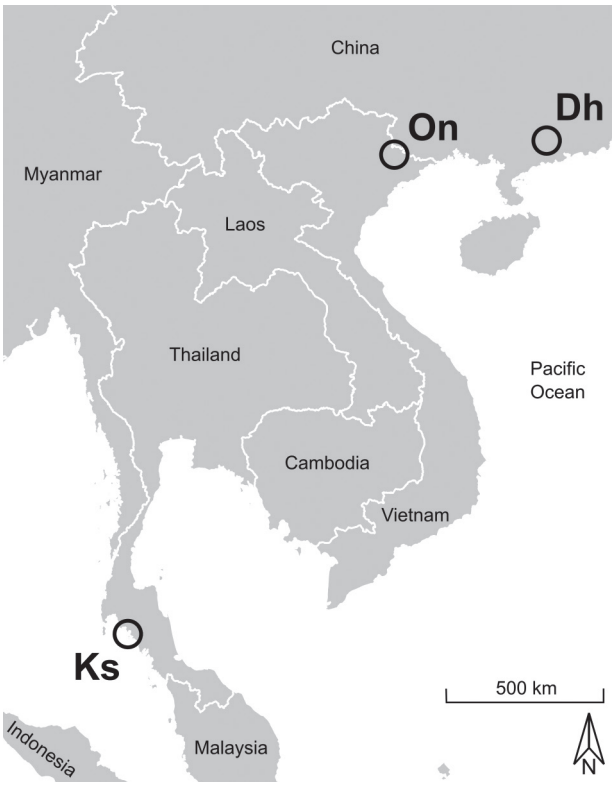

Figure 2. Orientalosuchin alligatoroid occurrences in the Eocene of south-eastern Asia. Abbreviations for taxa are Dh (*Dongnanosuchus hsui*), Ks (*Krabisuchus siamogallicus*) and On (*Orientalosuchus naduongensis*).

The fossils described here come from the Hancock Mammal Quarry (HMQ, Fig. 1), which lies within the uppermost strata of the Clarno Formation in the Clarno area. The well-known and stratigraphically lower, Clarno Nut Beds are part of the conglomerates of Hancock Canyon. Multiple radiometric dates published from the Nut Beds itself (Manchester 1994; Bestland et al. 1999) are all approximately 44 Ma. Overlying those units are a series of red and lavender claystone units with deeply weathered palaeosols, including a stony tuff bed dated to 42.7 ± 0.3 Ma (Bestland et al. 1999). That date provides an approximate maximum age for the overlying tan and orange clayey siltstones found in the vicinity of Red Hill, as well as the Hancock Mammal Quarry (Pratt 1988; Hanson 1996; Bestland et al. 1999). Clarno Formation strata are disconformably overlain by the basal units of the John Day Formation (Peck 1964; Robinson 1975; McClaughry et al. 2009). Rocks of the John Day Formation are interpreted as being derived from a caldera complex distributed across central and eastern Oregon (Ferns et al. 2001; McClaughry and Ferns 2007; McClaughry et al. 2009), with the Wildcat Mountain caldera (41.50 to 39.35 Ma) serving as the likely source of some upper Clarno Formation rocks and the John Day Member A ash-flow tuff (McClaughry et al. 2009). The Member A ash-flow tuff, within the Big Basin Member and at the base of the John Day Formation (Peck 1964; Robinson 1975), has been $^{40}Ar/^{39}Ar$ dated at 39.22 ± 0.03 Ma in the Clarno area (Bestland and Retallack 1994) and U/Pb dated at 39.677 ± 0.014 Ma from Clarno (Mohr et al. 2025). Based on these radiometric dates, the age of the Hancock Mammal Quarry is latest Uintan or Duchesnean NALMA (late Lutetian or Bartonian).

Clarno Formation Fossils

The Clarno Formation is well-known for the incredibly diverse array of plant fossils found there, with the Clarno Nut Beds renowned as one of the best palaeobotanical sites of any age on the planet (Scott 1954; Manchester 1981, 1990, 1994; Scott and Wheeler 1982; Wheeler and Manchester 2002; Dillhoff et al. 2009). In addition to fossil plants, several Clarno sites preserve isolated pockets of vertebrate and invertebrate fossils, which represent the oldest Cenozoic records of animals from the Pacific Northwest. The only reptiles known from the Nut Beds are a few specimens of the planocraniid crocodylian *Boverisuchus* Kuhn, 1938 and a single peripheral of the tortoise *Hadrianus* Cope, 1872 (Hanson 1996; Brochu 2013).

The Hancock Mammal Quarry is the only vertebrate quarry deposit published from the John Day Basin (Pratt 1988; Hanson 1996; Fremd 2010). While typically discussed as a single entity, the quarry actually contains a series of strata, including some leaf bearing shales that contain fish and amphibians (Bestland and Retallack 1994; Fremd 2010). The fauna from the quarry was primarily described by Hanson (1996), with most material coming from a few abundant large mammals. The quarry beds include a concentration of disarticulated large mammal skeletons, probably having been deposited in a point bar of a meandering river channel (Pratt 1988). Of fourteen known species, the most common mammals in the quarry are an early rhino, *Teletaceras* Hanson, 1989 and a large brontothere, *Eubrontotherium* Mihlbachler, 2007. Other commonly represented mammals in the quarry include a ‘marsh rhino’ (*Zaisanamynodon* Belyaeva, 1971), tapir (*Plesiocolopirus* Schoch, 1989) and ‘clawed oreodont’ (*Diplobunops* Peterson, 1919) (Hanson 1996; Lucas 2006; Emery et al. 2016). A few rare specimens of a ‘running rhino’ (*Hyracodon* Leidy, 1856), early horses (*Epihippus* Marsh, 1875 and *Haplohippus* McGrew, 1953) and several other artiodactyls (*Achaenodon* Cope, 1873 and *Heptacodon* Marsh, 1894) are recognised from the quarry (Hanson 1996; Lucas et al. 2004). Other rare mammals from the quarry include predators: a hyaenodontid creodont *Hemipsalodon* Cope, 1885 (Mellett 1969), a mesonychid *Harpagolestes* Wortman, 1901 (Robson et al. 2019) and an unidentified nimravid (Hanson 1996). Small mammals are uncommon in the quarry; to date, only a few rodent incisors have been recovered and described by Samuels and Korth (2017). Coincidentally with the Nut Beds mentioned earlier, the only reptiles recovered from the site are a crocodylian and a turtle: the fragments of the alligatoroid described herein and a chelydrid (Hanson 1996).

The Hancock Quarry shares taxa considered characteristic of multiple land mammal ages and has been referred to both the Uintan and Duchesnean North American Land Mammal Ages (Hanson 1996; Lucas 2006; Robinson et al. 2004). *Epihippus* is considered a Uintan taxon, while *Hemipsalodon*, *Haplohippus* and *Plesiocolopirus* are considered Duchesnean taxa (Robinson et al. 2004) and the agriochoere *Diplobunops* and mesonychid *Harpagolestes* are known from both ages (Emery et al. 2016; Robson et al. 2019). Fortunately, the Hancock Quarry has a well-constrained age, based on radiometric dates, between 42.7 and 39.677 Ma (Bestland and Retallack 1994; Mohr et al. 2025), which would place the site within the latest Uintan (Ui3) or early Duchesnean (Lucas et al. 2004; Samuels and Korth 2017). This age range, straddling the Uintan–Duchesnean boundary, might explain the mixture of taxa from multiple land mammal ages. Interestingly, *Harpagolestes*, *Eubrontotherium*, *Zaisanamynodon*, *Plesiocolopirus* and *Teletaceras* known from the Hancock Quarry also occur in parts of Asia at the same time (Radinsky 1963; Lucas 1992; Hanson 1996; Lucas 2006; Mihlbachler 2007, 2008).

While known primarily for the vertebrates preserved at the site, there is also a small flora that has been identified from the Hancock Mammal Quarry units (McKee 1970; Bestland and Retallack 1994). All plants from the quarry are angiosperms and the lack of thermophilic species, which dominate the Nut Beds and the palaeosols from this interval may indicate seasonally cooler and drier conditions at the time (Bestland et al. 1999; Dillhoff et al. 2009).

Institutional abbreviations

UCMP, University of California Museum of Paleontology, Berkeley, California; **YPM VPPU**, Yale Peabody Museum Princeton University Vertebrate Paleontology Collection, New Haven, Connecticut, all USA.

Systematic palaeontology

Eusuchia Huxley, 1875

Alligatoroidea Gray, 1944

Type species. *Alligator mississippiensis* [Daudin, 1802] from "les bords du Mississipi".

Referred specimen. UCMP 164865, anterior portion of left dentary.

Description. UCMP 164865 (Fig. 3) is the anterior-most portion of a reconstructed left dentary that measures 6.3 cm in length. The mandibular symphysis measures 2.4 cm long and extends posteriorly to the fourth dentary alveolus. UCMP 164865 does not preserve the alveoli immediately posterior to the first, though they are assumed to be alveoli two and three, as the next preserved tooth is the largest of the preserved dentary and spatially consistent with other known alligatoroids (Brochu 2004; Cossette and Tarailo 2024) and most members of Crocodylia as a whole (Brochu 1999). Furthermore, the assumed fourth alveolus is preserved along its anterior extent and is not confluent with another. Pursuant to the aforementioned assumption, counting anterior to posterior, the first and fourth through twelfth alveoli are preserved. Similar to other small-bodied alligatoroids of the time (Cossette and Tarailo 2024), the dentary curvature between the fourth and twelfth alveoli is deep, with a noticeable dorsal rise between the eleventh and twelfth alveoli. The height of the dentary at the first and fourth alveoli is approximately equal to the dorsal extent at the twelfth alveolus.

The lingual side of UCMP 164865 is better preserved than the lateral. Though the splenial is not preserved, its presence can be inferred as a scar (Stout 2021) along the mandibular ramus and is well preserved. The splenial had a robust presence constituting the medial wall along the entirety of the anterior mandibular ramus. When present, the splenial appears to have reached and participated in the mandibular symphysis. The angle that the lingual margin of the mandibular ramus reaches the symphysis is exceptionally shallow. The Meckelian groove is preserved across most of the mandibular ramus and attenuates as it approaches the symphysis. In life, it may have been completely enclosed along its mesial margin by the splenial. With the exception of the mandibular symphysis and the inferred presence of the anterior portion of the splenial, no articulation with other bones of the mandible is preserved. Several openings of the mandible preserve important phylogenetic information in alligatoroids (Brochu 1999), but are not preserved in UCMP 164865: the mandibular fenestra and posterior foramen intermandibularis oralis existed posterior to the preserved portion and the anterior foramen intermandibularis oralis, if present, would be located on the splenial.

Seven teeth are partially or wholly preserved in UCMP 164865: the first, fourth through sixth, seventh and ninth (partial) and twelfth. The largest tooth and its associated alveolus is the fourth, which is separated from the (not preserved) third. All teeth project dorsally or anterodorsally and each are pointed, except for the distinctly globidontan twelfth. All are unserrated, but possess anterior and posterior carinae. All possess some degree of labiolingual compression. A portion of the thirteenth alveolus is preserved at the posterior-most extent of UCMP 164865 and may have been much larger than the preceding eight. The teeth possess smooth carinae and robust basiapical ridges on their lingual margins.

Comparison. In comparison with contemporaneous North American alligatoroids, UCMP 164865 differs from late Eocene *Alligator* sp. (Whiting and Hastings 2015) and from *Allognathosuchus* Mook, 1921 spp. in possessing a mandibular symphysis reaching only the fourth or fifth alveolus (Mook 1921; Brochu 2004). It differs from *Procaimanoidea* Gilmore, 1946 species in possessing a splenial that participates in the mandibular symphysis (Wassersug and Hecht 1967). From *Tsoabichi greenriverensis* Brochu, 2010, it differs in that its largest

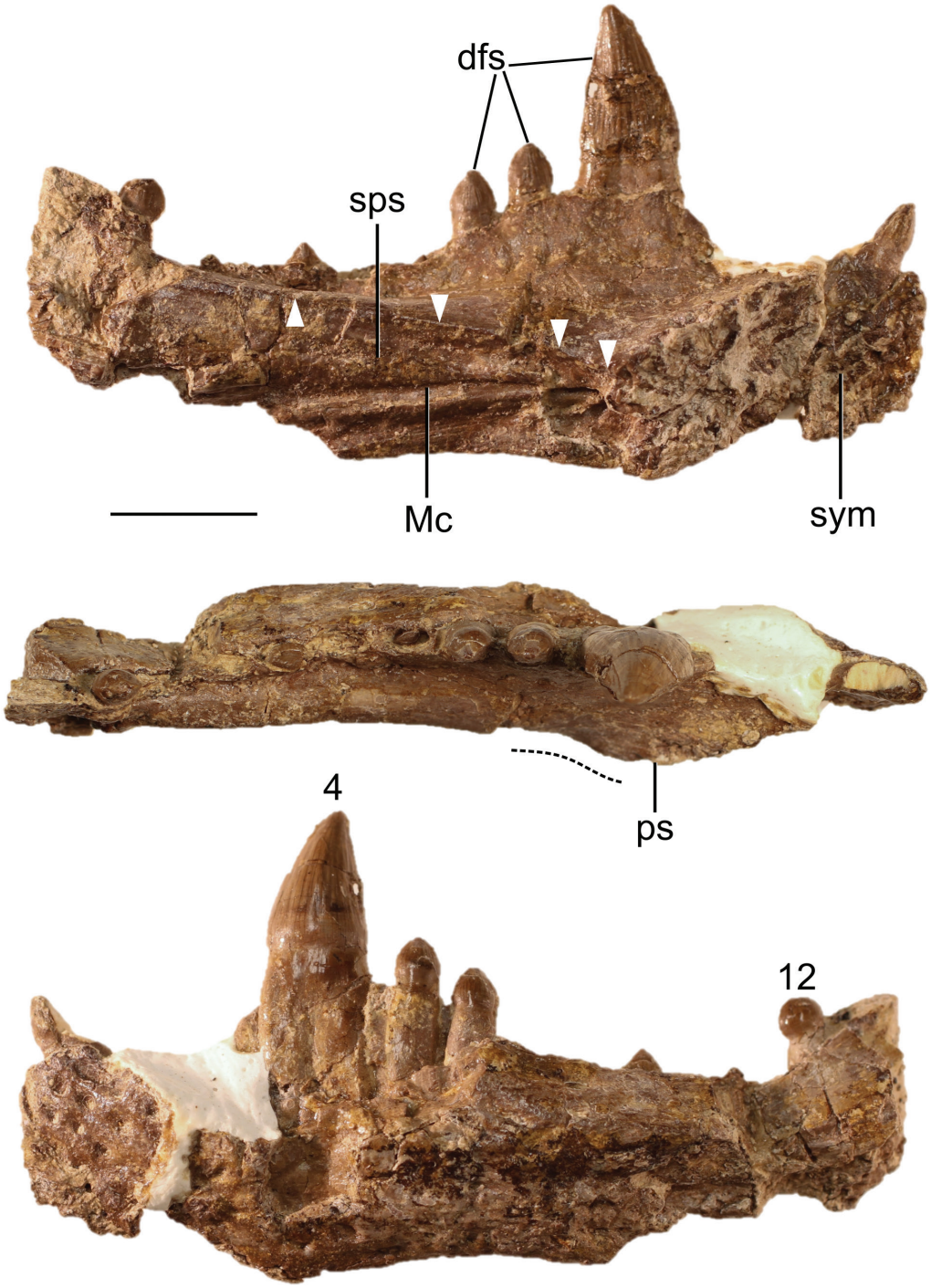

Figure 3. UCMP 164865, anterior left dentary of an alligatoroid from the Eocene age Hancock Mammal Quarry (Clarno Formation, John Day Fossil Beds National Monument) in lingual (top), occlusal (middle) and lateral (bottom) views. Abbreviations: dfs (deeply furrowed striations), Mc (Meckelian canal), ps (posterior extent of the symphysis), sps (splenial scar), sym (mandibular symphysis). Numbers indicate dental alveoli (as counted from anterior to posterior). White arrows denote dorsal margin of splenial scar. Dotted line follows the angle that the mandibular ramus contacts the symphysis. Anterior is to the right (top and middle) and left (bottom). Scale bar: 1 cm.

alveolus posterior to the fourth is probably not the eleventh or twelfth (Brochu 2010). The preserved portion of its mandibular ramus exhibits deeper curvature than that observed in *Ceratosuchus burdoshi* Schmidt, 1938 (Bartels 1984). It is unlike *Ahdeskatanka russlanddeutsche* Cossette & Tarailo, 2024 in not possessing a long and robust symphysis reaching the ninth alveolus. It differs from YPM VPPU.017369 in its deep dentary curvature, globidontan tooth at the twelfth alveolus (which also marks the steep dorsal rise) and the other "Golden Valley crocodylian" taxa that all possess more robust mandibular symphyses (Cossette and Tarailo 2024). From *Chrysochampsa mlynarskii* Estep, 1988, it differs in the small alveolus located as position twelve (Cossette and

Tarailo 2024). The labiolingual compression of the teeth is similar to *Paleosuchus* and *Bottosaurus*, but unlike other alligatoroids (Cossette and Brochu 2018). Preserved teeth and alveoli immediately posterior to the inferred fourth are unlike most contemporaneous alligatoroids in their relatively large size and wide spacing (pers. obs. e.g. *Allognathosuchus*, Brochu (2004): Eocene *Alligator*, Whiting and Hastings (2015)), but similar to *Ahdeskatanka* (Cossette and Tarailo 2024). The middle Eocene caimanine *Chinatichampsus wilsonorum* Stocker et al., 2021 from southern Texas does not preserve a dentary and, thus, cannot be compared.

The following phylogenetic characters were observed or inferred on UCMP 164865 (character numbers and states from Walter et al. (2025)) and could prove useful in future analyses: 46 (1) alveoli size of dentary tooth four is larger than the third and separated from it, 47 (1) anterior dentary teeth project anterodorsally, 48 (0) dentary symphysis extends to fourth or fifth alveolus, 49 (1) deep dentary curvature between fourth and tenth alveoli, 53 (0) splenial participates in mandibular symphysis, 79 (0) maxillary and dentary teeth with smooth carinae, 195 (0) anterior maxilla and dentary teeth without or weak dorsoventral ridges on the lateral surface, 219 (1) the level of the first and fourth dentary alveoli are equal to or higher than the level of the eleventh and twelfth dentary alveoli. None of these characters alone is apomorphic for Alligatoroidea (Brochu 1999; 2004; Walter et al. 2025), but the suite of character states taken together and the distinctly globidontan posterior tooth (Brochu 1999), supports inclusion into the clade.

Eusuchia Huxley, 1875

Type species. Indeterminate.

Referred specimen. UCMP 164866, right humerus.

Description. UCMP 164866 is a right humerus from the Hancock Mammal Quarry that represents the only crocodylian postcranial element recovered from the upper section of the Clarno Formation (Fig. 4). It measures 10.5 cm in straight-line length. The proximally projecting deltopectoral crest offers some phylogenetic information (Brochu 1999), but it is not preserved in UCMP 164866. It is figured herein only as representative eusuchian postcranial material and is not assumed to be associated with the taxon or individual of UCMP 164865, though the relative size of each does not negate the possibility.

Discussion

HMQ Alligatoroid

UCMP 164865 from the Clarno Formation shares traits with several alligatoroid taxa, but exhibits a unique suite of character states. Discrete morphological data are shared amongst several taxa of alligatorids, alligatorines, caimanines and orientalosuchins and offers some insight into possible taxonomic relationships. The combination of three phylogenetic characters (a short dentary symphysis, a deeply curved dentary and a splenial that participates in the lower jaw symphysis) unites the HMQ alligatoroid with *Dongnanosuchus hsui* and *Alligator olseni* (Walter et al. 2025). Further similarity can be made with *D. hsui* in the deeply-furrowed lingual dental striations. With the alligatorid *Ahdeskatanka* and the caimanines *Paleosuchus* and *Bottosaurus*, it shares labiolingually compressed teeth, anterior and posterior carinae and relatively large and widespread teeth caudal to the fourth.

The basiapical striations on the lingual surface of the teeth of UCMP 164865 may also offer some phylogenetic information. Basiapical striations are common in the teeth of many crocodylians and may serve a purpose towards prey manipulation (MacKenzie et al. 2024). While lateral striations are common on many crocodylians (MacKenzie et al. 2024), deeply furrowed basiapical striations are especially present in several Eocene orientalosuchin taxa: *Krabisuchus* (Martin and Lauprasert 2010), *Orientalosuchus* (Massonne et al. 2019) and on the lingual margins of *Dongnanosuchus* (Shan et al. 2021). It is possible that this condition is synapomorphic in Orientalosuchina.

While UCMP 164865 can be confidently assigned to Alligatoroidea based on preserved characters, more exclusive taxonomic assignment cannot be made at this time. Though the earliest assignable members of *Alligator* are late Eocene (Chadronian), they possess a mandibular symphysis extending to nine alveoli (Whiting and Hastings 2015) and exhibit anterior dentary morphology inconsistent with that of the HMQ alligatoroid, precluding its assignment to *Alligator*. *Dongnanosuchus hsui* is known from the Eocene of eastern Asia (China) (Shan et al. 2021) and all representatives of Orientalosuchina originate from East and Southeast Asia (Martin and Lauprasert 2010; Wang et al. 2016; Li et al. 2019; Massonne et al. 2019; Shan et al. 2021; Wu et al. 2023). There is well-documented and repeated faunal exchange between East Asia and North America via Beringia during the Mesozoic and Cenozoic (e.g. Woodburne and Swisher III (1995); Hutchison (2000); Godefroit et al. (2003); Loewen et al. (2013); Farke et al. (2014); Jiang et al. (2019)) and discovering a representative of Orientalosuchina in the western part of North America would not be unexpected. Another reason for this possibility is the location of the specimen described here, in the Clarno Formation itself. The site contains several floral and faunal taxa with eastern Asian connections (Radinsky 1963; Lucas 1992; Hanson 1996; Lucas 2006; Mihlbachler 2007, 2008; Dillhoff et al. 2009). That the HMQ alligatoroid is indeed a North American orientalosuchin similar to *D. hsui* therefore is at least possible, if not plausible.

Figure 4. UCMP 164866, crocodylian right humerus from the Eocene age Hancock Mammal Quarry (Clarno Formation, John Day Fossil Beds National Monument) in posterior (top), anterior (middle) and lateral (bottom) views. Dashed line shows the approximate extent and orientation of the deltopectoral (dp) crest. Scale bar: 1 cm.

Biogeography of Eocene alligatoroids

An interesting correlate to the possible taxonomic relationship of the HMQ alligatoroid is its geographic position in North America: namely, its location west of the Rocky Mountains. The Laramide Orogeny was the primary uplift event forming the Rocky Mountains and occurred between the late Cretaceous through early Eocene (English and Johnston 2004) and, thus, could have posed a potential barrier to crocodylian dispersal by the Uintan. Alligatoroids are common in the early Cenozoic east and south of the Rockies (Brochu 1999, 2004, 2010; Whiting and Hastings 2015; Stocker et al. 2021; Cossette and Tarailo 2024), but virtually absent west of the range (the notable exception being UCMP 164865) (Fig. 1).

Many of the mammalian genera from the Hancock Mammal Quarry are also known from Asia (Radinsky 1963; Lucas 1992; Hanson 1996; Lucas 2006; Mihlbachler 2007, 2008). Amongst the 14 genera known from the site, *Harpagolestes*, *Teletaceras*, *Eubrontotherium*, *Plesiocolopirus* and *Zaisanamynodon* also occur in parts of Asia in the middle Eocene. The tortoise *Hadrianus* from the slightly older Nut Beds, is also known from the early Eocene of Asia (Danilov and Averianov 1997). Approximately 40% of genera from the Nut Beds flora of the Clarno Formation are present in the Eocene floras of Europe and Asia, suggesting there was a mid-latitude Northern Hemisphere circumglobal forest during the Eocene that was connected by Bering and North Atlantic land bridges (Wing 1998; Graham 1999; Tiffney and Manchester 2001; Dillhoff et al. 2009). This combination of faunal and floral connections between the Clarno Formation and biotas of Asia support the idea that an orientalosuchin may have dispersed to North America in the Eocene. The geologic and palaeontologic context lends circumstantial plausibility to the hypothesis that this small, enigmatic alligatoroid from the Clarno Formation of Central Oregon (Fig. 5) is indeed an emigrating orientalosuchin or that the clade occupied a wider distribution than the known fossil record suggests.

Figure 5. Artistic reconstruction of small alligatoroids preparing to bask in the Eocene of central Oregon, as a distant volcano begins to contribute the volcaniclastic sediments that will preserve organisms at the site. Reconstruction is based on the hypothesis that the HMQ taxon is a member of a basally-branching alligatoroid clade. Image created by Cody Rex-Allen Stevenson (2025).

Conclusions

Though fragmentary, UCMP 164865 (Fig. 3) shares traits with several Eocene alligatoroids, but its suite of morphological characteristics differentiates it from other known taxa. All possibilities within Alligatoroidea remain as possible ingroups for the HMQ alligatoroid, including Alligatorinae, Caimaninae or Orientalosuchina. This specimen represents another distinct alligatoroid present in Eocene North America and, only represented by a preserved anterior lower jaw, it adds to the diversity of an increasing list of dentary-only taxa (Cossette and Tarailo 2024). Regardless of its relationship within Alligatoroidea, the HMQ taxon is unique also in its geographic location and adds to an increasing cadre of small-bodied Eocene alligatoroid diversity in the northern latitudes of North America.

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