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THE LOWER JAW OF DRYPTOSAURUS INCRASSATUS (COPE).*

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(With three plates.)

The following remarks on the lower jaw of *Dryptosaurus incrassatus* are the partial result of the examination of the remains of two skulls of that species in the collection of the Geological Survey of Canada, and are offered in advance of a more detailed description of the specimens in course of preparation by the writer at the present time.

The two skulls are from the Edmonton series** of the Cretaceous system of the North-West Territory, and were collected by Mr. J. B. Tyrrell and Mr. T. C. Weston in 1884 and 1889 respectively. The first specimen, figure 1, was obtained two miles from the mouth of Knee Hills creek, a tributary of Red Deer river, in the District of Alberta. The second, figure 2, was found on the east bank of Red Deer river, about twenty-one miles above the mouth of Knee Hills creek.

A preliminary description of these specimens by Professor E. D. Cope appeared, in 1892, in the Proceedings of the American Philosophical Society.***

* Communicated by permission of the Acting Director of the Geological Survey of Canada.

** Regarded by Tyrrell as comprising the uppermost beds of the Cretaceous system in Alberta. Geological and Natural History Survey of Canada, Annual Report, new series, vol. II, part E, 1886.

*** "On the skull of the Dinosaurian *Laelaps incrassatus*, Cope." Proc Amer. Philos. Soc., vol. XXX, p. 240.

The skull discovered in 1884, figure 1, is somewhat larger than the one found in 1889, figure 2. In both, the right ramus of the mandible is displaced downward so as to reveal its inner surface. In the 1884 specimen both halves of the mandible are preserved almost in their entirety. The left ramus lies against the lower left half of the cranium so as to conceal its inner surface in the vicinity of the anterior half of the surangular, and the corresponding part of the right ramus is hidden by some of the bones of the palate. In both rami, unfortunately, a considerable part of the lower border is missing below the front part of the surangular. The 1889 specimen consists of the anterior parts of the skull, the lower jaw lying against the palate so that the inner surface of the left ramus and the outer side of the right one is hidden. The left ramus is preserved for about three-fourths of its entire length from the front but the right ramus is broken off at about its mid-length.

In comparing the mandible of *Dryptosaurus incrassatus* with that of the Jurassic *Ceratosaurus nasicornis* of Marsh, it is seen, that the former is deeper, in proportion to its length, than the latter, otherwise the general contour in both species is somewhat similar.

In the Canadian specimens the following elements of the lower jaw are more or less clearly exhibited:—the dentary, the surangular, the angular, the articular and the splenial, with a presplenial. The coronoid is in both specimens either not preserved or is covered by other bones of the skull.

The dentary is a large and robust bone extending backward to beneath the articular cotylus. Its greatest depth is attained at about its mid-length, where it meets the surangular and narrowing rapidly passes backward below that element, overlapping it posteriorly as a thin plate terminating in an acute point, figure 3. On the inner surface the dentary occupies about one-half of the lower depth of the jaw anteriorly, narrowing backward gradually until it passes to the outer surface. In the amount of its backward extension it equals that of the dentary of *Sphenodon* as described by Günther in the Philosophical Transactions of the Royal Society of London in 1868.*

* "Contribution to the Anatomy of Hatteria (*Rhynchocephalus*, Owen)." Philos. Trans. Royal Soc., vol. 157, p. 595, pl. xxvi, fig. 7.

The surangular is broadly arched above, as seen in side view, and almost completes the remainder of the outer surface of the mandible, the posterior end of the angular being visible inferiorly to a limited extent. The surangular is strengthened exteriorly, near its upper border, by a prominent rounded ridge extending for some distance forward from the articular cotylus into the composition of which this bone enters. It embraces the articular anteriorly and passing beneath it extends as far back as the posterior limit of that element. It is pierced by a large foraminal opening at about one-fourth its length in advance of its back termination and at about its mid-depth; its inner surface in this region is deeply concave (figure 4). Below the foramen the bone becomes gradually thinner, where it is overlapped by the dentary, and is continued forward with a thickness inferiorly of only a few millimetres, although posteriorly and along its upper border it is a strong and robust bone.

The articular is small and compact, roughly triangular in shape, and is scarcely seen except when viewed from above. It forms about two-thirds of the cotylus and is overlapped on its inner side by the angular, which extends nearly as far back as either the surangular or the articular. Its breadth exceeds its antero-posterior diameter.

The cotylus is transverse, strongly bifossate and evidently points to a strictly upward and downward motion of the jaw, as the distal end of the quadrate fits closely into it. The movement of the jaw is, therefore, apparently restricted, and differs from that of *Sphenodon* in which the articulating surface is nearly four times as great antero-posteriorly as the condyle of the quadrate and admitted of a backward motion of the mandible.

The slender bone meeting the surangular below the articular, and embracing the latter element on its inner surface, is regarded as the angular. It passes forward on the inner surface of the ramus in contact with the inferior edge of the posterior extension of the dentary but is, unfortunately, broken in both rami of the 1884 specimen at a point slightly behind the mid-length of the surangular. The break in both halves of the jaw at this point is unfortunate as it is here that the junction of the angular with the splenial would have been looked for. It is probable, however, that

anteriorly the angular increases considerably in depth reaching the coronoid above and the splenial in front.

The broad lamellar bone immediately above the dentary on the inner surface of the ramus (figure 2) is the splenial. It is misplaced in the specimen figured in plate I, and it is seen in section in its proper position in both skulls at the points *e* and *f* in figures 1 and 2 respectively. It is perforated near its anterior end and close to its lower border by a large oval foramen. At a short distance behind this foramen a well marked emargination of the bone occurs, visible in both specimens but shewing more decidedly and to a greater extent in the skull figured in plate I. The outline of this emargination bears a strong resemblance to the anterior end of a second foraminal opening, which if it did exist, may have been partly formed by the angular as in *Crocodylus*.

Continuing forward from the splenial is a narrow presplenial that apparently reaches to, or almost to, the front limit of the dentary.

Above the presplenial the inner alveolar plate of the dentary, of about the same depth as the presplenial, forms the inner wall of the dental chamber and completes the inner anterior surface of the ramus. It meets the splenial posteriorly and narrows rapidly upward, but its relation to the dentary and the splenial, behind the dental series, has not been ascertained. Its upper border is at a lower level than the outer alveolar border of the dentary.

In *Megalosaurus* the bony partitions dividing the alveoli from each other are described* as springing from the inner alveolar wall and projecting outward to the inner surface of the outer wall. The reverse of this seems to be the case in *Dryptosaurus*, in which the principal alveolar grooves are apparently formed on the inner surface of the outer dentary wall with little or no development of grooves in the alveolar plate. In this particular the alveoli of *Dryptosaurus* are somewhat similar in general plan of structure to those of the dental chamber of the mandible of the Cretaceous

* "Notice on the Megalosaurus or great Fossil Lizard of Stonesfield," by the Rev. William Buckland. Trans. Geol. Soc., London, second series, vol. 1, p. 395, pls. XL and XLI, 1824; and "On the Skull of Megalosaurus," by Professor Owen. Quart. Jour. Geol. Soc., London, vol. XXXIX, p. 339, pl. XI, 1883.

species of *Trachodon** (and possibly also of the genera *Monoclonius* and *Triceratops* and their allies), in which the teeth move upward in well defined grooves in the inner surface of the outer wall of the dental chamber, whilst the surface of the inner wall of the chamber is comparatively even and smooth. The partitions between the alveoli in *Dryptosaurus* seem to form part of, and to be continuations or extensions of, the inner surface of the outer dentary wall inward toward the dentary plate with which they are apparently not connected. In the left ramus of the specimen shewn in figure 1, the crowns of all the teeth except the twelfth are broken off close to the alveolar border leaving sections of their bases exposed at this level, so that the exact position of the teeth is definitely determined. In the right ramus of the same specimen, however, seven of the teeth (seen only in the right aspect of the specimen) are preserved intact. In the specimen figured in plate II fourteen teeth of the left ramus are preserved, whilst in advance of the anterior full-sized tooth a small tooth partially protudes at a lower level. This tooth is apparently an additional one in the series and not a successional tooth, making the total number, in the complete dental series, fifteen. It is truncated posteriorly so as to be similar in shape to some of the teeth described by Leidy, under the name *Deinodon horridus*,** as being peculiar in form, and to a tooth referred to by the writer in his description of *Ornithomimus altus**** as being from the anterior portion of the jaw. No successional teeth have been observed in either of the specimens of *Dryptosaurus* from the Edmonton series. The teeth of this species (without reference to such as may be considered to be incisors) are carinated on their anterior and posterior edges, the carinations being minutely serrated, with about ten to twelve denticulations in a space of 5 mm. They are lenticular in section above (figure 7), but in passing downward a

* Contributions to Canadian Palæontology, vol. III (Quarto), part II, "On Vertebrata of the Mid-Cretaceous of the North West Territory," by Henry Fairfield Osborn and Lawrence M. Lambe, pp. 73 and 78. 1902.

** Trans. Amer. Philos. Soc. Extinct Vertebrata from the Judith River and Great Lignite Formations of Nebraska, by Joseph Leidy. 1860, p. 144, plate 9, figs. 37-40.

*** Contributions to Canadian Palæontology. 1902, pp. 53, pl. XIV.

flattening of the anterior and posterior borders takes place and becomes more pronounced near the base of the crown, a slight flattening of the sides of the teeth also becoming more decided in the lower portion of the crown. The anterior carina passes gradually to the inner side of the crown whilst the posterior one is well over toward the outer side for the greater part of its length. The posterior keel extends downward for the whole length of the crown but the anterior one stops at about one-fourth the height of the crown from its base.

The anterior part of the external surface of the dentary of the smaller specimen is rough, and exhibits a number of small foramina, near its lower front margin, with others in a line at some distance below and parallel to the alveolar border. In the larger specimen a few openings of corresponding size are also apparent near the anterior lower border of the dentary but the general surface of the bone is smoother. In this specimen also a somewhat obscure row of shallow depressions extends upward and backward in an oblique curve (above *e* in figure 1) across the dentary at about its mid-length. This feature is suggested in the dentary of the smaller specimen, but it is too indistinct to be spoken of with certainty. The front portion of the surangular is striated as shewn in figure 1.

MEASUREMENTS.

Of larger specimen, collected in 1884 (plate I).

	MM.
Extreme length of left ramus of mandible	970
Greatest depth of same (approx.).....	227
Length of dentary	905
Depth of dentary at its mid-length, at <i>a</i> , figure 1 (approx.)....	185
Thickness of ramus at mid-height anteriorly, at <i>b</i> , figure 1A	52
Length of surangular above.....	490
Thickness of surangular through the ridge near its upper border, at <i>c</i> , figure 1	33
Thickness of surangular above the ridge, at <i>c</i>	23
" " below " "	14
Height of surangular foramen	38
Width of posterior portion of angular near its distal end, figure 4	50
Width of same at <i>g</i> , figure 4.....	30
Thickness of same at <i>g</i>	23
Transverse diameter of articular cotylus	112
Thickness of ramus from upper surface of cotylus, at its mid-length, to lower surface of dentary	4

Combined thickness of dentary and surangular at <i>h</i> , figure 3	10
Length of crown of fifth tooth of right ramus.....	54
Breadth of base of crown of same	28
Thickness of ,, ,,	18
Of smaller specimen, collected in 1889 (plate II).	
Length of dentary, above, to its junction with the surangular	380
Depth of dentary at its junction with the surangular.....	160
Length of angular foramen ..	50
Length of crown of sixth tooth.....	38
Breadth of crown of same at base ..	18
Length of crown of seventh tooth	55
Breadth of crown of same at base ...	21
Length of crown of eighth tooth.....	46
Breadth of crown of same at base	21
Length of splenial foramen	52

EXPLANATION OF PLATES OF FIGURES ILLUSTRATING THE MANDIBLE OF
Dryptosaurus incrassatus (COPE).

PLATE I.

- Figure 1. Mandible of the larger of the two specimens, as seen from the left; two-fifteenths, or slightly more than one-eighth, the natural size.
- Figure 1A. Section of left ramus of same, through the sixth tooth from the front ; similarly reduced.

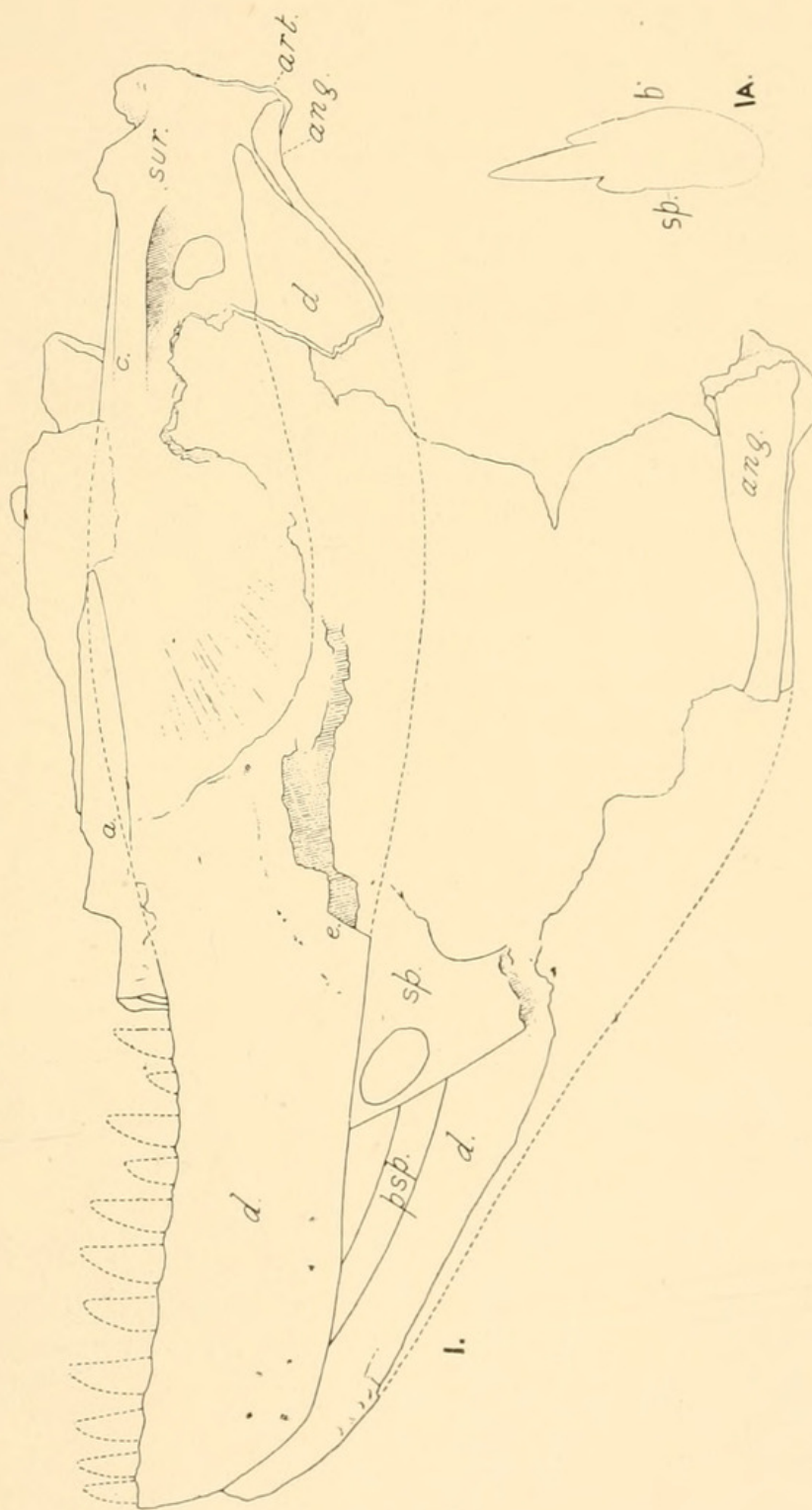
PLATE II.

- Figure 2. Side view of mandible of specimen collected in 1889 ; one-sixth natural size.
- Figure 3. Exterior aspect of posterior end of left ramus of mandible shewn in plate I ; one-fourth natural size.
- Figure 4. Interior view of same ; similarly reduced.

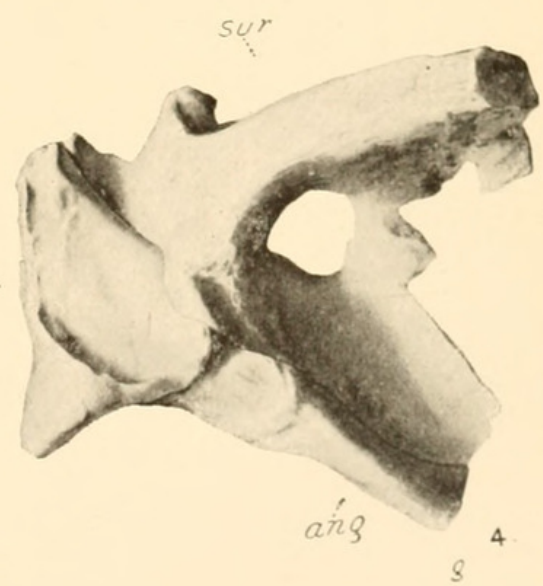
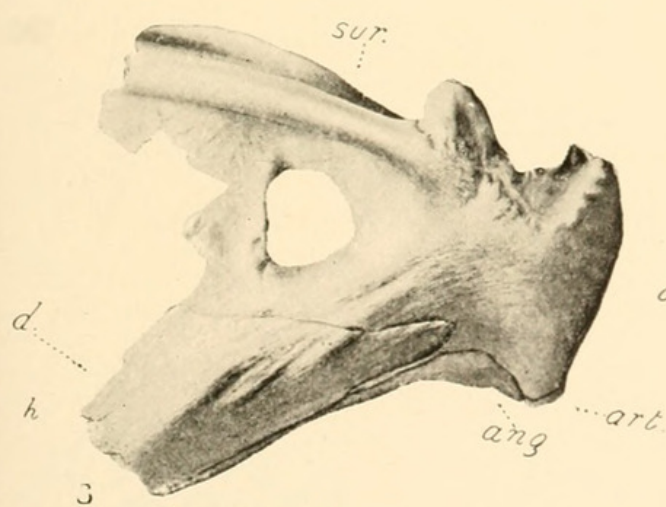
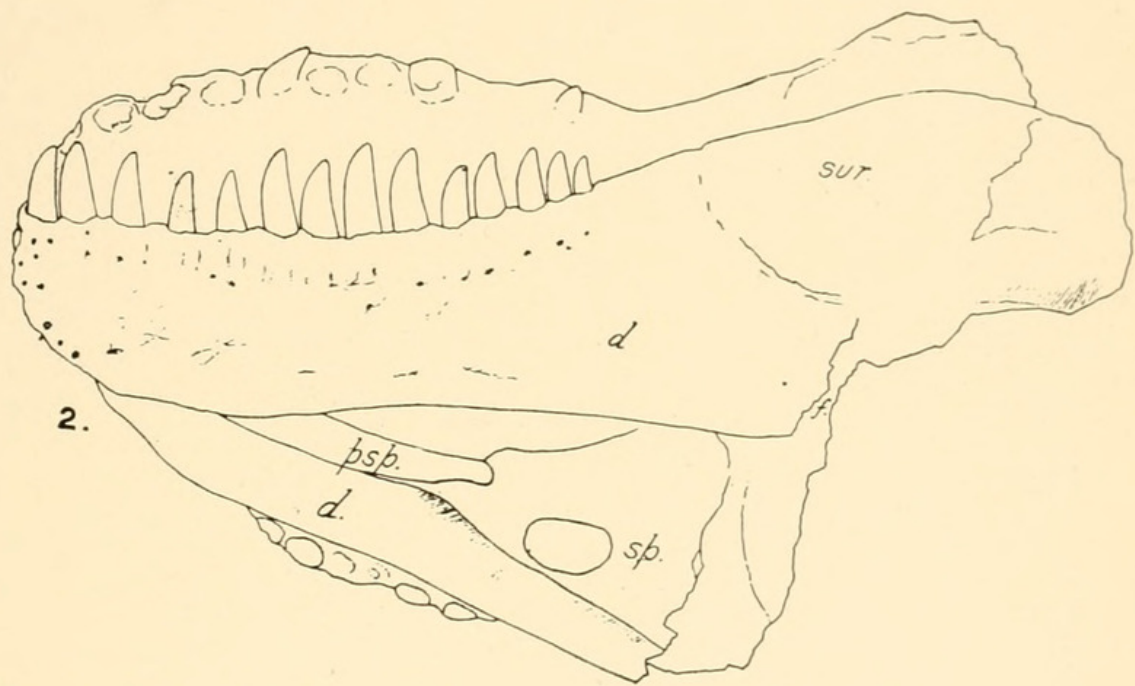
PLATE III.

- Figure 5. Exterior of left ramus.
- Figure 6. Interior of the same.
- Figure 7. Outlines of transverse sections of a tooth ; the upper section is taken at about one-third the height of the crown below its apex ; the middle section from a little below the mid-height of the crown ; the lowest section from near the base of the crown ; in the figures the upper side corresponds with the outer surface of the tooth and the portions on the right to the anterior border of the crown.

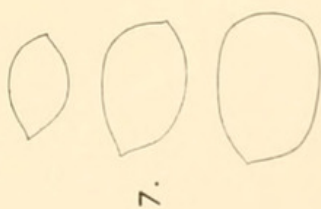
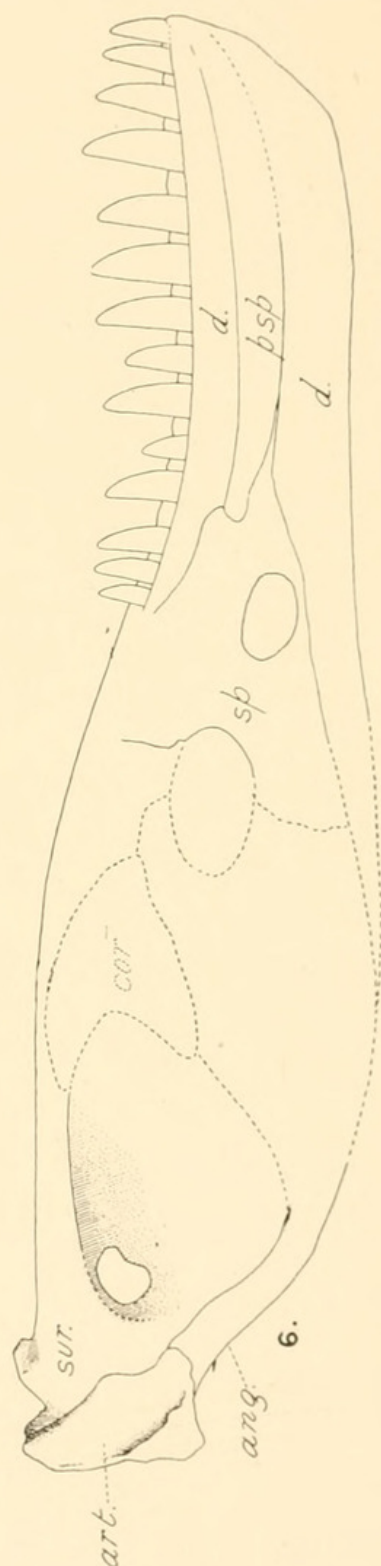
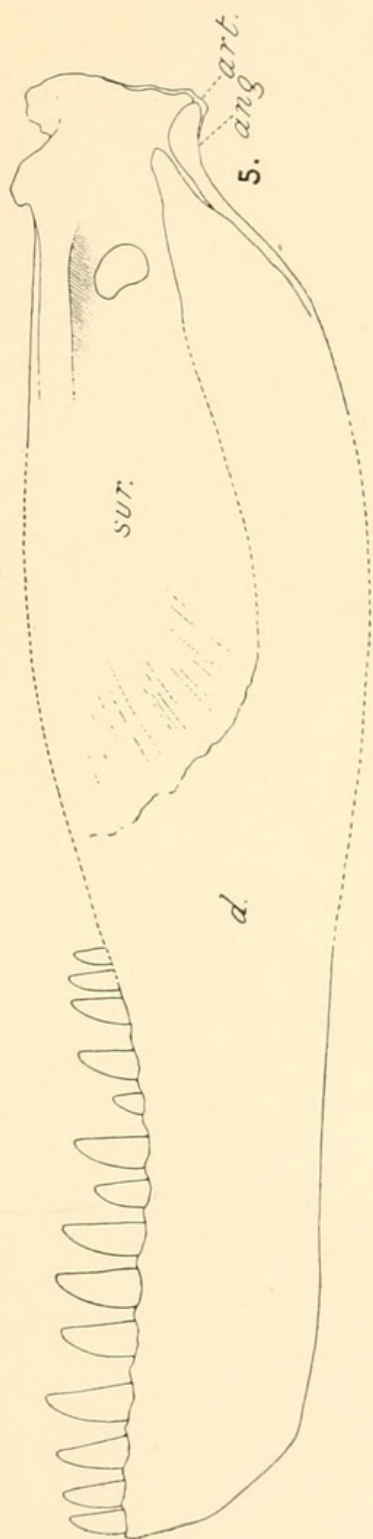
d, dentary ; *ang.*, angular ; *art.*, articular ; *sur.*, surangular ; *sp.*, splenial ; *psp.*, presplenial ; *cor.*, coronoid.



Dryptosaurus incrassatus, (Cope).



Dryptosaurus incrassatus. (Cope)



Dryptosaurus incrassatus, (Cope)



Lambe, Lawrence M. 1903. "The Lower Jaw of Dryptosaurus incrassatus (Cope)." *The Ottawa naturalist* 17(8), 133–139.

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