Note on the ossified ligaments of Dinosaurs of Bernissart,

BY

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(BOARDS VIII AND IX).

When the skeletons are examined, for the majority of specimens, of Iguanodons collected in Bernissart, in particular those of the individuals Q (*Iguanodon bernissartensis* (1), Blgr.) and T (*Igua-*

(1) I believe that there is doubt about the identity of *I. Seelyi,* Hulke (J. W. Hulke. *Description of some Iguanodon remains indicating a new species, I. Seelyi*. Quarter. Journ. Geol. Soc. London, 1882, p. 135) and of *I. bernissartensis,* Blgr. (L. Dollo. *Première note sur les Dinosaurs de Bernissart.* Bull. Roy. Hist. nat. Belg. T. 1, 1882, p, 175). I took many measurements that show most perfect agreement between these two forms. There is divergence, as I announced before (L. Dollo. *Première note,* etc. p. 170), in the supposed presence of a dermal armor for *I. Seelyi,* Hulke (J. W. Hulke, *I. Seelyi,* etc. p. 143), that is missing in *I. bernissartensis,* Blgr. I will endeavor to prove that this difference is illusory and that the plates found with the dinosaur of the erudite English paleontologist cannot belong to it.
I. Initially, *I. bernissartensis,* Blgr., did not have undoubtedly an osseous carapace, because:
1. If it had one, it is certain that one would have seen some trace of it among the remaining 29 individuals, for the majority specimens, collected in Bernissart.

2. On the contrary, we see, in various places, a structure indicating a skin naked or furnished with epIDEMal scales.
3. One could not object, moreover, that the dermal armor would not have been preserved at Bernissart (and for which reason?), when one sees preserved, in this layer, a carapace as delicate as that of *Bernissartia Fagesi,* Dollo (L. Dollo. *Première note sur les Crocodiliens de Bernissart.* Bull. Roy. Hist. nat. Belg. t. II, 1883, p. 309).
4, *Diclonius mirabilis,* Cope (E. D. Cope. *One the Characters of the Skull in the Hadrosauridae* Proc. Acad. Nat. Sc. Philadelphia, 1883, p. 97), an Ornithopod not distantly related to Iguanodons, with which it has the bone présymphysien in common (L. Dollo, *Quatrième note sur les Dinosaurs de Bernissart,* Bull. Roy. Hist. nat. Belg. l, II, 1883, p. 226) and exhibit the sternal apparatus (E. D. Cope. *The Sternum of the Dinosauria.* American Naturalist, 1886, p. 153), according to the famous professor of Philadelphia (E. D. Cope. *The Ankle and Skin of the Dinosaur* Diclonius mirabilis. American Naturalist, 1885, p. 1208 and pl. XXXVII, fig. 1), of the integument is reminiscent of those of the Rhinoceros. Though one can think of the comparison, one should not think, with this description, that an osseous coating exists in the American type.
Iguanodon bernissartensis, Blgr. thus positively lacked dermal armor.
II. 1. Consequently, if the plates found with the bones of *I. Seelyi,* Hulke, were really from this specimen, it should not be diagnosed as *L. bernissartensis,* Blgr, because it is, it seems, impossible to me to for one specie to be equipped with an osseous coating and the other not. But, the bones of *I. Seelyi,* Hulke, resemble, until examined in detail, astonishingly similar to those of *I. bernissartensis,* Blgr. How can this coincidence be explained, other than by supposing that the plates discovered with the remains are distinct from the other remains?

2. Moreover, *I. Seelyi,* Hulke, hardly remained in the order of *Ornithopoda,* until all the following kinds have been known;

1. *Agathaumas,* Cope.	7. *Hypsilophodon,* Huxley.
2. *Camptonotus,* Marsh.	8. *Iguanodon,* Mantell.
3. *Cionodon,* Cope.	9. *Laosaurus,* Marsh,
4. *Craspedodon,* Dollo.	10. *Nanosaurus,* Marsh.
5. *Diclonius,* Cope.	11. *Orthomerus,* Seeley.
6, *Hadrosaurus,* Leidy.	12. *Vectisaurus,* Hulke.

Which do not show an osseous coating. And, moreover, the osteology of Dinosaurs of the eminent English naturalist does not leave the slightest doubt on its correct incorporation in the above mentioned group.
3. Since the bones of *I. Seelyi,* Hulke, were not assembled, like in Bernissart, to constitute a whole individual, but scattered and disjoined like they would have been after death under the action of water, by lack of immediate burial, it is not incredible that fragments of the dermal armor from another contemporary animal, were also in decomposition

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nodon Mantelli, Owen)(1) (this last represented on board VIII according to a photograph, without final improvements in photolithography), currently exposed in the Court of the Museums of Brussels, the attention is immediately called on a system of small osseous cords that traverse the spinal column in almost all its extent: these cords are known under the name of ossified ligaments (ligaments ossifiés). I propose to devote to them a significant chapter in my future monograph of Dinosaurs of Bernissart and I intend in the meantime to write a special memoire in *the Bulletin of the Royal Museum of natural History,* intended to attract criticism on my interpretation before introducing it into a final work. However, as I will not be able execute this project soon, I wish, in the present note, which does not offer, consequently, that character of a preliminary communication, to report

in the vicinity, and were welded to the Iguandon later on by sediment.

4. Lastly, I owe with kindness to Mr. Hulke a molding of the dermal armor of *I. Seelyi,* Hulke, currently deposited in the collections of the Museum of Brussels. However, its examination causes me to say, because of the shape of the plates and their pitted surface, that is similar to what one sees in Crocodilians the osseous coatings observed, until now, in the dinosaurs. I thus identify it to a representative of the first of these groups.

I conclude, consequently, that *I. Seelyi,* Hulke. did not have dermal armor and that one can write: *I. Seelyi,* Hulke, = *I. bernissartensis,* Blgr. I exposed elsewhere (L. Dollo. *Première note,* etc. p. 171) how the name of *I. bernissartensis,* Blgr, had priority and was to be preserved.

(1) Mr. H. WOODWARD, *(Iguanodon Mantelli,* Meyer, Geol. Magazine, 1885. p. 10) known as: *I. Mantelli,* Meyer, 1832. But, since Mr. J. W. Hulke, (*I. Seelyi,* etc. p. 137 and 144), Mr. G. A., Boulenger (L. Dollo *Première note,* etc. p. 168), and myself (L Dollo. *First note,* etc. p. 168) adopted, without protest, the block of Maidstone type of *I. Mantelli,* so that this type consisted of a wide and homogeneous series of bones, and since this block was not discovered until 1834 (H. Woodward, *Iguanodon Mantelli,* etc. p. 10) and described in 1851 (R. Owen. *Monograph one the Fossil Reptilia of the Cretaceous formations*. Paleontographical Sociely, 1851, p. 105) would it be worth it to admit: *I. Mantelli,* Owen, 185l? Would this not be, moreover, justice for the eminent English naturalist who published so much on Dinosaurs?

briefly the results at which I arrived at so far.

That said, I will divide what I have to say of the ossified ligaments in the manner hereafter:

I Description.
II Morphological value.
III Physiological significance.

I.

DESCRIPTION,

1. First, *Are the ossified ligaments are well ossified? Or are they petrified?* Though the answer to this question does not have any influence on the determination of the morphological value of these ligaments, it is not necessary less worrisome, because we will need this information later on, as I will show in convenient time.

While reserving histological study for later, I believe that we can affirm, as of now, that the ossified ligaments are well ossified and not petrified. Indeed:

1. If they were only petrified, I do not see the reason why other ligaments, using the composition of the body of Iguanodons and who were fossilized under conditions identical to those undergone by the ligaments of the spinal column, would not be also petrified. However, this is never the case. In the second place, for the same reason (identity of fossilization), I do not understand why the ligaments of the spinal column of the Crocodilians of Bernissart would not also have been petrified and, moreover, they always disappear without leaving a trace.

2. Because of the nature of the sediment, if the ossified ligaments were petrified, this petrifaction would certainly have occurred by the means of pyrite which is very abundant, over other agents of petrifaction. But, though ossified ligaments are considerably pyritous, one must acknowledge that a great quantity does not contain the least trace of above-mentioned mineral.

3. Lastly, examination with the naked eye of longitudinal and transverse sections of the ossified ligaments clearly proves that it is not a question here of the homogeneous structure, everywhere extremely compact, of a petrified fossil; on the contrary, we meet an aspect absolutely similar to that of the bone, tight with periphery and cellulous tissue in the center.

II. *Which provision the ossified ligaments present?*

This is the second point to be examined.

As we indicated earlier, they are kinds of osseous cords embracing, on the right and on the left, the dorsal spinal column with the diapophyses and generally starting at the end of the cervical region to continuing, without interruption, to the dorso-lumbar and caudal regions, stopping only when the transverse processes cease (pl. VIII).

The position of the ossified ligaments being, in this way, determined, let us seek what their relations are between them. They are grouped primarily according to two systems differently formed from several superimposed layers:

1. Longitudinal masses of tightened cords, confusedly interlaced, inextricable run along the axial skeleton in the above-mentioned parts.
2. Lattice with rhomboidal mesh (pl. IX, fig. 1).

Which, of these two provisions, is normal and which is accidental? Because one of them is necessarily accidental, since one encounters them both on the same animal (for example, the first on the left profile and the second on the right profile of the individual L, - *Iguanodon bernissartensis,* Blgr., - series of the Museum of Brussels), which excludes interpretation of specific variation, of race or individual. But, the accidental structure is obviously the result of a postmortem slip of the ligaments on one another, coming from, contrary to what occurs to other Sauropsides about which we will further speak, the ligaments that are not

coosified with the subjacent vertebrae (1). However, under these conditions, the lattice must be the normal form, since:

1. It is incredible that such a regular network can be the result of an accident. Inversely, a formless mass can come very easily from this.
2. The lattice with the rhomboidal mesh is a constant structure, observed in several individuals and that, moreover, is always made up the same way, the cords directed dorso-ventral and cranial being invariably lateral compared to the cords going dorso-ventral and caudal, who are to them, reciprocally, medial. In addition, the formless mass presents most varied aspects.

The structure of lattice is thus normal and it is, consequently, the only one that we will have to interpreted in herafter.

II.
MORPHOLOGICAL VALUE.

Before going further, it is necessary to raise this question: were the ossified ligaments present in Dinosaurs other than Iguanodons? Answer: No, as much as I know.

Has one observed their equivalent in the other Vertebrates? This is what remains to be examined. But, to determine more safely the morphological value of our ossified ligaments, various natures of ligament to which one can deal with will be specified.

The ligaments, in general, are suitable to be classified (in the following table:

(1) It is probably because of that circumstance that the ossified ligaments were never observed, at least to my knowledge, on the remainders of Iguanodons extracted English Wealdien. There, indeed, as we already pointed out, the bones are not in whole skeletons,

but are disjoined, and it is quite possible that, during their burial, the ligaments, did not coossify with the subjacent vertebrae, will have been broken in small fragments and will have been dispersed

I. Primitive, i.e. to which one does not know a different ligamentous origin.
  1. **Not ossified**. Example: *Transverse ligament of the atlas*, in man (1).
  2. **Ossified**. Example: Osseous bridge separating the spinal canal from the lateral apophysis in certain birds (*Cacatua sulphurea*, *Picus tridactylus*) (2).

II. Derived, i.e. to which one knows an origin other than ligamentous.
  1. Coming from bone.
    - **I. Not ossified**. Example: *Ligament stylohyoid muscle* at the man.
    - **II. Ossified**.
      - A. Normally. Example: anterior horns of the hyoid of the dog (3).
      - B. By atavism. Example: *Ligament stylohyoid muscle*, in certain individuals of mankind (4).
  2. Coming from muscles.
    - I. Tendons of muscles, by separation form the muscular part
      - **A. Not ossified**. *Round ligament*, which represents the tendon of origin of *the M. pectineus* (5).
      - **B. Ossified**. Example: ?
    - II. Whole muscles, by disappearance of muscle fibers.
      - A. Ligaments themselves.
        - **I. Not ossified**.
          - A. Examples: In the state of muscle: *M. péronéo-tibial* (6) of *Hatteria Punctata*.
          - B. Examples: In the state of ligament: Interosseous ligament of the leg of the man (7).
        - **II. Ossified**. Example: Osseous area of the leg of the tailless Batrachians joining together the tibia and the fibula.
      - B. Aponeuroses.
        - **I. Not ossified**.
          - A. Examples: In the state of muscle: Inferior fibers of *M. latissimus dorsi* of *Phocaena communis* (8).
          - B. Example: In the state of aponeurosis: lumbar aponeurosis of the man. (9)
        - **II. Ossified**. Example: Dorsal shield of *Tragulus kanchil* (10) [male].

The ossified ligaments of Iguanodons can thus have a varied morphological value. It is now a question of identifying it as exactly as possible, not in detail (this will be the subject of a later work), but as a unit. Let us study, for now, the dorso-lumbar region. It is clear that, the ossified ligaments offering an interlaced condition identical in all the portions of the axial skeleton where they are found, if we manage to determine their homologues in other vertebrates in a given area, their significance in the fossil animals will be appreciated easily using homology. It goes without saying, moreover, that we will precede, by manner of checking, in a different way in our monograph, for which we propose to remove, layer by layer, ossified ligaments and to establish separately, for each area of the spinal column and each layer of these ligaments, the morphological value. But, once again, this method is not appropriate in the present note, which is, a simple preliminary communication.

I. In order to facilitate the discussion, still let us give, according to

(1) J B SUTTON. *One the Natural of certain ligaments*. Journ. Anat. and Phys. vol. XVIII, p. 228 and 237.
(2) E SELENKA.*Aves*. Bronn' S Klass. U. Ord. D. Thier. Leipzig and Heidelberg, 1868, p. 50.
(3) W H. FLOWER. *Year Introduction to the Osteology of the Mammalia*. 3rd edition(H. Gadow). London, 1883, p. 117 and 114.
(4) RAMBAUD and RENAULT *Origin and development of the bones*. Paris, 1864, p. 179.
(5) J B SUTTON. *One the Natural*, etc, p. 229 and 237.
(6) J B SUTTON. *One the Natural*, etc, p. 232 and pl. XIII, fig. 8.
(7) IDEM. *One the Natural*, etc, p. 232.
(8) IDEM. Sutton. *Natural The of Ligaments* (Share III). Journ. Anat. and Phys. vol. XIX, p. 246 and 250.
(9) IDEM. *Natural The*, etc, p. 246.
(10) J E GRAY. *One the Dorsal Bony Shield of the Male* Tragulus kanchil. Proc. Zool. Ploughshare. London, 1869, P. 226 and fig. D. 1. text.

Barkow (1), the enumeration of the ligaments in the dorso-lombaire region of the spinal column in the Birds, with which ornithopods Dinosaurs offer so many ratios in the structure as in the pace. These ligaments are:

1. Ligamenta capsularia corporea thoracica, s. L caps. corporum vertebrarum.
2. Ligamenta capsularia obliqua, s. L C process obliquorum.
3. Membrane interspinales thoracicæ internæ.
4. Ligamenta longitudinalia spinosa thoracica.
5. Ligamenta apicum dorsalia.
6. Ligamenta interspinalia dorsalia elastica, s. flava.
7. Ligamenta elastica interspinalia profunda, s. propria.
8. Ligamenta elastica interspinalia superficialia.
9. Ligamenta intertransversaria.

II In addition, in Iguanodons, the ossified ligaments

(1) H. BARKOW, *Syndesmologie der Vogel.*Breslau, 1856, fol. p. 25, 28, 32. 33, We extract from this work the following passage which appears to us likely to throw a certain light on *the physiological significance* of considerable change that occurs in the spinal canal, in *Stegosaurus,* in the sacral region (O. C. Marsh. *Principal Characters of American Jurassic Dinosaurs,* Part VI, *Spinal cord, Pelvis and Limbs of Stegosaurus.* Amer. Journ. Sc. (Silliman). 1881, vol. XXI, p. 167 and pl. VI.
… in humans the lower part of the spinal cord only gets developed to a lesser degree, not reaching the sacral channel… in most other vertebrates, the lower part of the spinal cord reaches a far higher degree, in birds the rostral part of the *Pars sacralis* the highest degree of development in the animal kingdom. This is why the rear branch of the lumbar plexus originates in this part, while in humans all sacral nerves originate from the lumbar region… this peculiar feature is developed to the highest degree at the upper part of the sacrum (Kreuz- oder Heiligenbeinwirbel) and is in accord with the mentioned divergence of the lateral strands of the spinal cord, which form the so called *Sinus rhomboideus*. Grirgensohn points to the fact that in this area the spinal cord approaches the nature of the *Medulla oblongata*… The fluid enclosed in this cavity is the cerebrospinal fluid. The function of the *Sinus rhomboideus* is the preservation of the equilibrium of the animal when it is sitting on branches or clasping and also during walking and standing (p. 8 and 9).

of the dorso-lumbar region can be divided into three groups:

1. Dorsal group, which is obviously identified with *Ligamenta apicum dorsalia.*
2. Ventral group, which homologize without difficulty with *Ligamenta intertransversaria.*
3. Intermediate Group, most importantly, that I then recognized in the ligaments described by

Barkow, even in *Ligamenta elastica interspinalia superficialia,* which however seem to deviate some less than the others.

Let us take again each one of these groups to say some words about them.

1. I do not know another ligamentous origin for *Ligamenta apicum dorsalia,* which is obviously the continuation of *Ligamentum nuchae* (1); these are thus placed in the category of the primitive ligaments. One knows them under three states:

A. *Ligamentous.* The majority of the SAUROPSIDES.
B. *Ossified:* and not coossifies with the subjacent vertebrae - IGUANODON.
and coossifies with the subjacent vertebrae - a great number of BIRDS. (2)

2. According to Mr. Sutton (3), *Ligamenta intertransversaria* represents, in the dorso-lumbar region, *M. intertransversales* of the cervical area. These ligaments thus exhibit the stages according to us:

A. *Muscular* stage. Detected by the existence of their homologous *M. intertransversales* of the neck.
B. Ligamentous stage. Majority of the SAUROPSIDES.

(1) H. BARKOW.*Syndesmology,* etc p. 32.
(2) IDEM.*Syndesmology,* etc p. 28.
(3) J B, SUTTOMr.*Natural The,* etc p. 257.

C. Osseous Stage.
I. not coossifies with the subjacent vertebrae: IGUANODON
II. coossifies with the subjacent vertebrae
1. Without an increase in volume and giving rise to consequently physiological kind of presacrum with holes combined between the transverse apophyses. : PLATALEA LEUCORODIA (1).

Example: with obliteration of the combined holes, forming a genuine continuous osseous presacral shield. : PAVO CRISTATUS (2).

They thus are placed in the category of the ligaments derived from whole muscles by suppression from muscle fibers and subsequent ossification.

3. With what corresponds now the intermediate group? Since *Ratitae* are, of all the Birds, those which present the most affinity with Dinosaurs, let us try to enlighten ourselves by the study of their structure. However, if we refer to the monograph of *Apteryx* of sir R. Owen (3), we are forced to recognize that there is the greatest resemblance between the musculature represented in his figure 2, board XXXIII and what we find on the right profile in *Iguanodon bernissartensis,* Blgr. individual L of the series of the Museum of Brussels. Indeed:

A. On the two sides, we find the lattice with rhomboidal mesh.

B. On the two sides still, we see that osseous cords, or the fascicule of muscle fibers, directed dorso-ventral and cranial are lateral compared to the cords, or beams, going dorso-ventral and caudal, which are reciprocally medial to them.

(1) H. BARKOW. *Syndesmology,* etc. pl. II, fig. 3.
(2) IDEM. *Syndesmology,* etc. pl. II, fig. 2.
(3) R. OWEN. *One the Anatomy of the* Apteryx australis, *Shaw.* Part II (Myology). Trans. Zool. Soc. London. Vol. III. Part. IV. 1842.

What is, now, this musculature illustrated by the eminent English anatomist? It is *M. sacro-lumbalis.* Where does it take its origin and its insertion? On the ilium, transverse apophyses and the ribs. Oh well, though the ossified ligaments of the dorso-lumbar region of Iguanodons are generally not preserved as perfectly on these parts as on the neural spines, because they are less better supported there, we however found portions of these ligaments going to the fore-mentioned parts. It thus seems that the intermediate group of the ossified ligaments of the dorso-lumbar area are only one transformation of *M. sacro-lumbalis.* But are they from only this muscle? Obviously not, because, according to sir R. Owen, this *M. sacro-lumbalis* would be composed of two layers of beams superimposed: one directed dorso-ventral and cranial, the other dorso-ventral and caudal, while the ossified ligaments of the right profile of the dorso-lumbar area of the individual L show a greater number of layers. They are equivalent, consequently, probably, at the same time with the *M. sacro-lumbalis* and with the deeper muscles, i.e. *M. spinalis dorsi*, *M. multifidus spinae, M. obliquo-spinales* (1).

In short: the intermediate group of the ossified ligaments of the dorso-lumbar area of Iguanodons appears to be more than only *M. sacro-lumbalis* and the subjacent muscles became ligamentous, then ossified.

As for the ossified ligaments of the intermediate group of the other areas, they correspond obviously to the homologous muscles of the above-mentioned musculature.

Like the precedents, the ossified ligaments of the intermediate group may thus be placed in the category of the ligaments derived from whole muscles by suppression from muscle fibers and subsequent ossification.

(1) R. OWEN, One the Anatomy, etc p. 284 and pl. XXXIII: fig. 1, p and Q figure 3, R.

III.
PHYSIOLOGICAL SIGNIFICANCE.

Muscle, is known as organ of movement. The removal of the muscles thus involves the suppression of the movement and the ossified ligaments indicate to us that the spinal column of Iguanodons was of a great rigidity, except in the cervical area. This structure is, moreover, perfectly comprehensible, especially in the dorso-lumbar region, it was necessary that the thorax of these animals adapted to the right station represented a solid complex strongly fixed on the sacrum. For the same reason, a similar provision was not less essential in the Birds; also seen in the majority of them, but the average investigators to arrive at the desired result are different. One has indeed:

IGUANODONS.
1. Separate dorso-lumbar vertebrae.
2. Musculature of the back becomes ligamentous and ossified.

BIRDS.
1. Frequently coosify dorso-lumbar vertebrae [notarium].
2. Musculature of the rudimentary, sometimes ligamentous, rarely ossifies.

Thus, in the Birds, it is the ossification of the vertebrae [notarium] which returns the musculature, become useless, rudimentary, then ligamentous, then ossified; it is obviously the trend in this group of Sauropsides. On the contrary, in Iguanodons, the rudimentary musculature develops, then ligamentous, then ossified, which constitutes the bonds intended to ensure rigidity; the notarium, which is not yet observed in Dinosaurs, is certainly the way in which this subclass would have advanced if the extinction had not prevented it.

One can thus write:

Dinosaurs: Transformation of the musculature preceding the Coosification.

Birds: Coosification preceding the transformation by the musculature into ossified ligaments.

An interesting detail, from the physiological point of view, is that the ossified ligaments are continuous across the sacrum on the tail. Consequently, it would be deprived of lateral movements at the base, without which the ligaments that embrace its skeletal axis on the right and on the left would have been broken with each displacement. It is to establish this characteristic that we endeavored to show that the ossified ligaments were well ossified and not petrified; otherwise, one could have objected that the ligaments were elastic during the life, allowing, consequently, the inflection of the caudal appendix, and had become rigid only by fossilization. But, if this enormous tail could not move laterally for what it was thus used? We can answer that initially it was employed like counterweight with the portion former of the body, in what it was helped by the caudo-femoraux muscles (1), because those, when they act simultaneously, at rest or during walk, draw the tail down (2). Moreover, when the animal was on the ground, the caudal appendix was likely to be moved of a part with the thorax and the blows of tail of Iguanodon were terrible for its enemies. I acknowledge that, for the moment, I have not explained well how its owner used it in water.

(1) L. DOLLO. *Note on the presence, at, the Birds, of* the "*third trochanter* " *of Dinosaurs el on the function of this one.* Bull. Mus. Roy. Hist. Nat. Belg. l. II. 1883. p. 13.

(2) F TIEDEMANN. *Anatomy und Naturgeschichte der Vögel.* Bd. 1, p. 294. Heidelberg. 1810.

EXPLANATION OF BOARD VIII.

Iguanodon Mantelli, Owen (Individual T of the series of the Museum of Brussels). - Restoration and assembly of Mr. L F De Paaw, controller of the Workshops. - Approximate Scale: 1/20.

(to show the general distribution of the ossified ligaments).

To Mr. E. Dupont, Director of Royal Museum of Natural History, the authorization to reproduce this board, already published in *the Bulletin* of re-establishment that it manages. That he enables me well to express here my thanks to him for his kindness.

EXPLANATION OF BOARD IX.

Fig 1. *Iguanodon bernissartensis,* Blgr. (Individual L of the series of the Museum of Brussels). - Group of lumbar vertebrae, to show the detail of the ossified ligaments. Right profile.

a.= Ligamenta apicum dorsalia.

b.= Ligamentum intertransversarium.

c.= Lateral Cords, or dorso-ventro-cranial, of the rhomboidal network.

d. Medial Cords, or dorso-ventro-caudal, of the rhomboidal network.

e.= Centrum.

f. = Diapophysis.

g.= Neural spine.

h.= Postzygapophysis.

i.= Mass of ossified ligaments located on the profile left and seen between the neural spines of two consecutive vertebrae.

Fig. 2. Vertebra of Bird, to show ossified ligaments.

a.= Ligamenta apicum dorsalia.
b = Ligamentum intertransversarium.
c.= Centrum
d.= Diapophysis
e.= Prezygapophysis.
f .= Postzygapophysis.
g.= Hypapophysis.
h.= Neural spine.

Fig. 3. *M. sacro-lumbalis* of *Apteryx australis,* Shaw (according to Sir R. Owen).

a.= Neural spine.
b.= Ilium.
c.= Lateral beams, or dorso-ventro-cranial, of the rhomboidal network.
d.= Medial beams, or dorso-ventro-caudal, of the rhomboidal network.
e.= Rib.

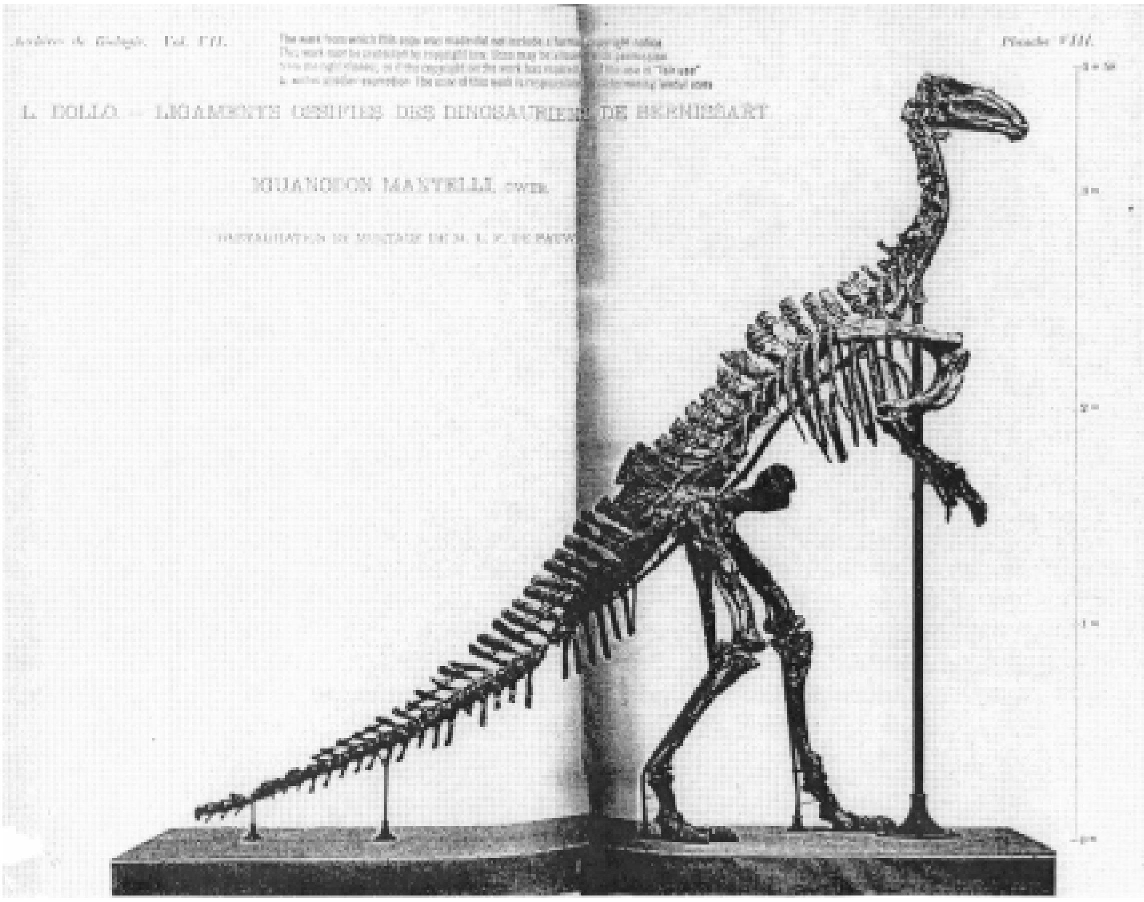
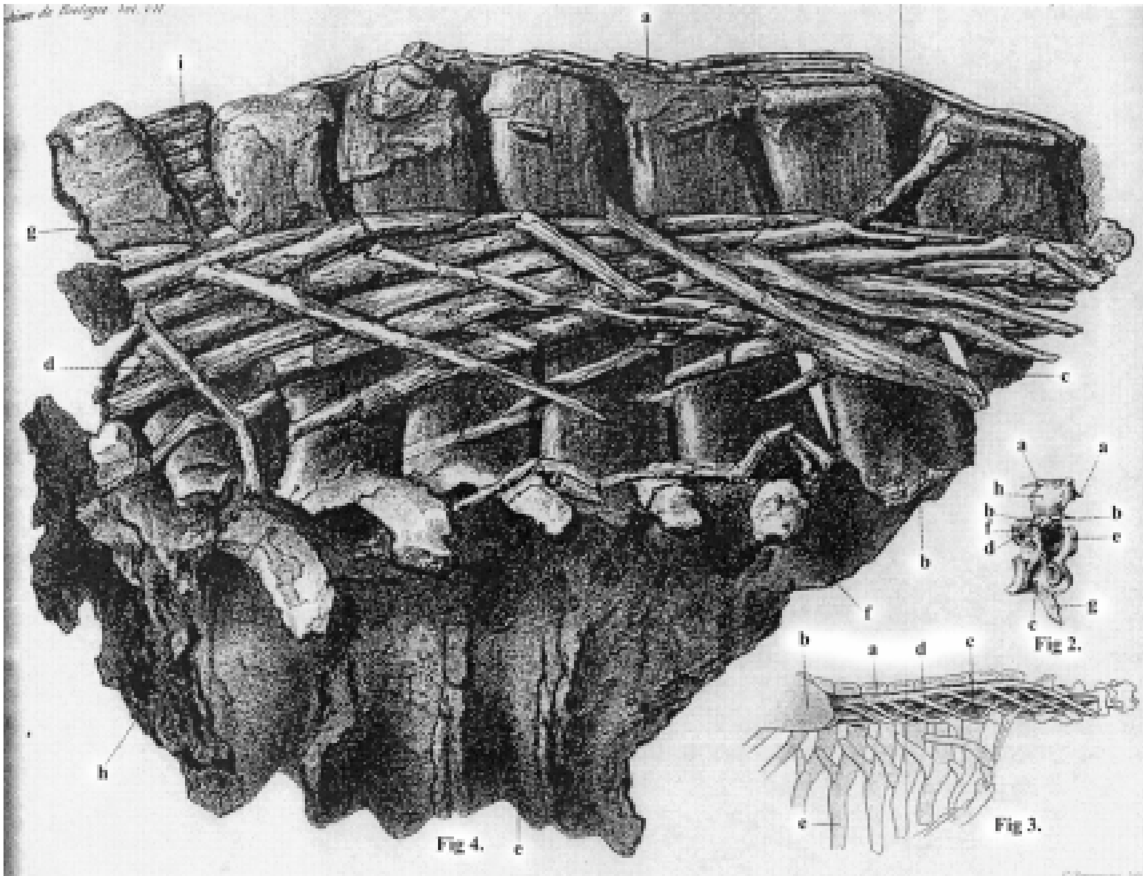


Planche VIII.
L. DOLLO. — LIGAMENTS OSSIFIÉS DES DINOSAURIENS DE BERNISSART.
IGUANODON MANTELLI, OWEN.



L. DOLLO – LIGAMENTS OSSIFIÉS DES DINOSAURIENS DE BERNISSART.