MESOZOIC MAMMALIA. II: TINODON AND ITS ALLIES.

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CONTENTS.

SUMMARY.

The present paper is concerned with the morphology and classification of a group of Jurassic mammals which seem to be related more or less closely to the English genus *Spalacotherium* Owen. The distinctive feature of the so-called spalacotheres is that the lower molars consist of three cusps arranged in a symmetrical triangle. Only about seven specimens referable to this group are at present known from the Morrison formation. As, however, these few specimens represent no less than four species and two genera, referable to two families, it becomes apparent that the group may have been fairly diverse. The following classification is proposed:

Family Spalacotheriidae Marsh.
Tinodon bellus Marsh.
Tinodon lepidus Marsh.

Family Amphidontidae, nov.
Amphidon superstes, gen. et sp. nov.
Amphidon aequicrurius, sp. nov.

Menacodon rarus Marsh is shown to be a synonym of *Tinodon lepidus* Marsh.

MORPHOLOGY AND SPECIFIC TAXONOMY.

Family Spalacotheriidae
Genus *Tinodon* Marsh
Tinodon bellus Marsh

(See Figs. 1-3.)

Fig. 1.—*Tinodon bellus* Marsh. Holotype, Cat. No. 11843 Y. P. M. Internal view. x7.

Tinodon bellus Marsh 1879, A, p. 216; Hay 1901, p. 567. Morrison Formation, Quarry 9, Como Bluff, Wyoming.

Holotype Cat. No. 11843, Yale Peabody Museum.

The type consists of a right mandibular ramus, nearly complete posteriorly, with crowns of four molars and alveoli for three more anterior teeth. In matrix, internal aspect exposed.

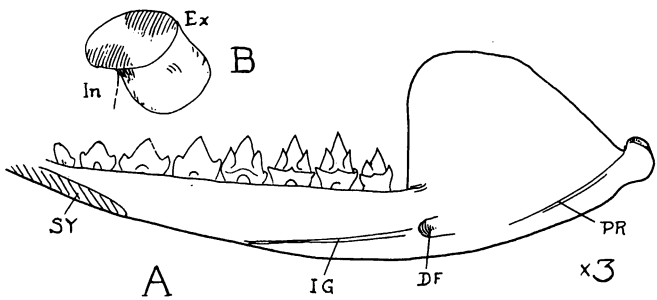

Fig. 2.—*Tinodon bellus* Marsh. A, outline restoration of mandible, internal aspect, x3. DF: dental foramen. IG: internal groove. PR: pterygoid ridge. SY: symphysis. B, posterior view of condyle, much enlarged. Ex: external side. In: Internal side.

Dentition.[1]—The first tooth preserved is the first of the four molars characteristic of this genus. It consists of three blunt cones, somewhat compressed laterally, with their tips truncated horizontally (by abrasion). Cones *a* and *c* are lower than *b* and internal to it. Their tips, in the worn tooth, scarcely rise free from the internal slopes of the main cusp. They are separated from the latter internally by shallow vertical grooves. In horizontal section all three cusps are somewhat convex internally, and in vertical section each is nearly straight. The cingulum is very poorly developed and rounded, rising slightly in the middle and scarcely at all at the ends, where it forms small horizontal heels, but no true cusps.

M_2 is much less compressed laterally, a section of the base being more nearly equilaterally triangular, instead of nearly elliptical as in M_1. The disparity in height between the cen-

[1] The Osbornian nomenclature, so convenient in describing pantotherian and Tertiary lower molars, is not applicable to this group. The antero-internal cusp is designated *a*, the centro-external *b*, and the postero-internal *c*.

tral and accessory cusps is greater. *B* is higher and nearly triangular in section, with the outer angle rounded and the other two quite sharp. The tips of *a* and *c* (here broken) rose free. These two cusps are more internal to *b* than in M_1. The cingulum is much more prominent and somewhat sharper, rising to a point in the middle and also anteriorly

Fig. 3.—*Tinodon bellus* Marsh. Cat. No. 13644 Y. P. M. Internal view, x7. The original specimen is bent sharply just back of M_1 and this has been corrected in the figure.

and posteriorly. The small rounded anterior and posterior cingulum cusps are internal to the accessory cusps, each lying in a straight line through the adjacent accessory cusp and the main cusp.

M_3 is still more nearly equilaterally triangular. *A* and *c* are somewhat more prominent and more internal to *b*. The cingulum is prominent, rising in a point in the center, broad anteriorly and posteriorly, with antero-internal and postero-internal cingulum cusps. The cingulum undulates slightly on *a* and on *c*.

M_4 is much smaller. *A* and *b* are similar to those of the preceding tooth, but *c* is very much reduced relative to the others, its tip does not rise free, and it is less internal in position than is *a*. The cingulum is little prominent, rounded, forming a small antero-internal cusp, much as in M_2 and M_3, but not rising in the center of *b*, and disappearing altogether on *c*, forming no posterior cusp.

Mandibular characters.—Horizontal ramus very slim. The alveolar border is almost perfectly straight, while the lower border forms an even gentle curve from condyle to symphysis, the lowest point being beneath the penultimate molar. The dental foramen is far forward, just posterior to a point

beneath the anterior border of the coronoid. It is somewhat anterior to the shallow pterygoid fossa and communicates with it by a definite but shallow and short groove.

Back of the last molar is a toothless continuation of the alveolar border about equal in length to this molar. In view of the simplicity of M_4, this part of the border must have been toothless throughout life. The anterior edge of the coronoid rises at almost exactly 90° to the alveolar border. The coronoid is moderately high and very broad, and is not at all recurved, with no notch between it and the condyle. The coronoid border is thickened slightly internally all round.

The internal groove runs from the lower part of the rim of the dental foramen in a gentle curve, slightly concave upward, to a point on the lower border beneath the middle of M_1.

The condyle is subpedunculate, a little above the level of the alveolar border, and its articular surface is oval, looking rather back than upward, the maximum convexity along a line from above and a little out to below and a little in, a line at right angles to this being a little longer and nearly straight (see Fig. 2, B). The angle is confluent with the condyle. Running forward from the condyle is a very low and rounded ridge below the pterygoid fossa. The masseteric fossa is bounded below by a strong ridge, which extends somewhat below the level of the condyle posteriorly.

Cat. No. 13644, Yale Peabody Museum.

This fine specimen, only recently uncovered in the matrix which entirely concealed the teeth, is much better preserved as regards the teeth than is the holotype and presents no apparent specific differences. It includes a left ramus with three premolars and four molars, perfect save for part of the last cusp of M_4.

Dentition.—The premolars are alike save in size and proportions. They consist of a compressed trenchant central cusp with very small and rounded anterior and posterior accessory cusps of about equal size. The latter, which are not at all internal to the central cusp, increase slightly in prominence from P_1 to P_3. The length and height increase somewhat in the same order, as does also the acuteness of the main cusp.

M_{1-3} differ in no comparable characters from those of the holotype, save that they are little worn and entirely unbroken.

The molars become progressively shorter, wider, and higher from one to three. (An apparent diastema back of M_1 is due to a slight bend in the specimen at this point.)

M_4 differs from the holotype in that the cingulum is more sloping and its anterior cusp lower—differences due in part to different preservation and in part to slight individual variation.

Tinodon lepidus Marsh

(See Figs. 4-5.)

Tinodon lepidus Marsh 1879B, p. 398.
Menacodon rarus Marsh 1887, p. 340.
Morrison Formation, Quarry 9, Como Bluff, Wyoming.

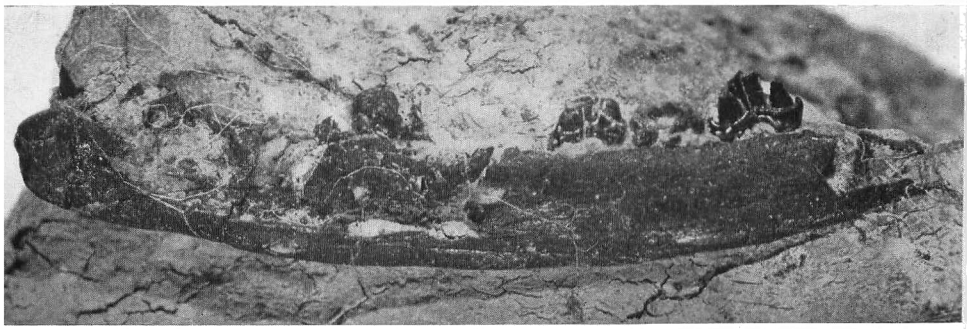

Fig. 4.—*Tinodon lepidus* Marsh. Holotype, Cat. No. 11845 Y. P. M. Internal view, x7.

Holotype Cat. No. 11845, Yale Peabody Museum.

The type consists of part of a left mandibular ramus in the matrix with the inner aspect visible.

Dentition.—Only M_1 and the base of M_3 are preserved. The dentition is described below in connection with the referred specimen No. 2131 U. S. N. M.

Mandibular characters.—The horizontal ramus is as in *T. bellus.* The coronoid process is broken off, but from the base it is seen to have arisen as in *bellus,* at an angle of about 90° to the alveolar border a short distance back of M_4. The internal groove is broader than in the genotype and ends under the middle of M_2. The posterior portion of the mandible is

crushed and the roof broken off part of the dental canal. The condyle is similar to that of *T. bellus* but is a trifle narrower and more oblique, results which may well be due to the crushing suffered by this part of the specimen. The ridge which bounds the pterygoid fossa below is little if any sharper than in the type of the genus, although it is accentuated by crushing.

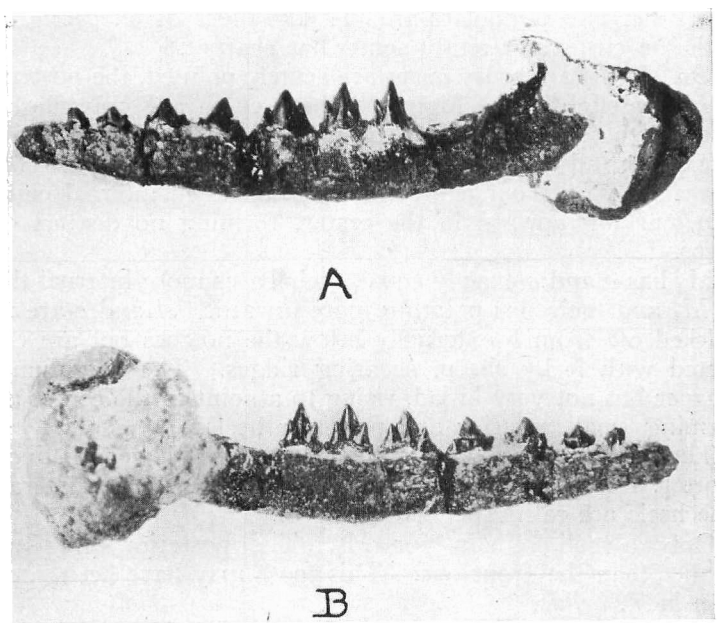

Fig. 5.—*Tinodon lepidus* Marsh. Cat. No. 2131 U. S. N. M. A, external view. B, internal view. x3½. (Photographs from the United States National Museum.)

Cat. No. 2131, United States National Museum.

Left mandibular ramus with canine and all but the last of the post-canine series, free of the matrix. This specimen is the holotype of *Menacodon rarus* Marsh. It agrees perfectly in every comparable detail with *Tinodon lepidus,* hence, the latter having been proposed first and being an adequate type, the present specimen must be referred to that species and *Menacodon rarus* becomes a synonym.

Dentition.—This specimen permits the establishment of the dental formula of *Tinodon* as I ?, C_1 P_3 M_4.

The first tooth preserved is small, simple, compressed, pointing somewhat forward, with a very small posterior cusp. The root is furrowed longitudinally. There is no cingulum. It can only be designated as the canine, as Marsh believed.

The first premolar appears to lack a true anterior accessory cusp, but this is probably due to wear or post-mortem causes. The other two premolars are just like those of *T. bellus*, but with the cusps apparently somewhat sharper.

On M_1 the accessory cusps are acutely pointed, the posterior one very slightly the higher. These cusps are only slightly internal to *b*, and separated from the latter by slight grooves internally and by still more shallow ones externally. There is a faint, very rounded, somewhat nodulated internal cingulum, curving upward in the center, forming no distinct end cusps.

M_2 has *a* and *c* exactly equal, their bases more internal than in M_1 and their tips pointing more inward. *A* and *c* are not marked off from *b* externally below the notches but are connected with it by sharp, shearing ridges. The cingulum is sharper but not very broad, rising to a point in the center and forming small anterior and posterior heels.

The third molar is very similar but a little lower, distinctly shorter, but as broad (hence base more nearly equilateral). The heels are rather better developed.

Only alveoli remain for M_4. The posterior fang was smaller than the front one. This tooth may have been larger than in *T. bellus*.

Mandibular characters.—The absence of an internal groove, noted by Marsh, may well be artificial. There is a trace of one still visible, and the internal surface of the mandible is somewhat pitted and worn. Otherwise the parts preserved are as in the holotype.

Tinodon ferox Marsh

This species was in 1887 removed by its author to the new genus *Priacodon* Marsh, which has been discussed by the present writer in an earlier paper (Simpson, 1925).

Tinodon robustus Marsh

This species was removed by the present writer to the genus *Priacodon,* and has already been discussed (Simpson, 1925).

Comparison of Tinodon bellus and T. lepidus

The genus *Tinodon* thus includes at the present time only the two species: *T. bellus* and *T. lepidus.* Professor Marsh distinguished these two species by the following characters in his definition of *T. lepidus:*

1. Smaller teeth.
2. Inner margin somewhat inflected, angle extending down below condyle instead of being emarginate.
3. Condyle on a level with the base of teeth instead of being above their crowns.

The first character must have been included inadvertently, since Professor Marsh's own measurements show that the teeth are of exactly the same size in each type. The inflection noted is the pterygoid ridge, present and similar in both but accentuated in *T. lepidus* by crushing. The extension below the condyle is not a homologue of the angle in other mammals, but part of the external lower border of the masseteric fossa, as is also seen in certain triconodonts, and the conditions are again similar in both species save as altered by crushing. Moreover, if the type of *T. lepidus* be oriented so that the alveolar border is perfectly horizontal, the condyle is well above this level, just as in the other species. The species are thus synonymous unless other features can be found to sepaate them. There are certain differences, which may be listed as follows:

Tinodon bellus	*Tinodon lepidus*
M_1 with rounded relief. Cingulum faint and rounded. No trenchant edge on *b.*	M_1 with sharp relief. Cingulum sharper. *B* with trenchant edges.
M_{2-3} with cingula relatively broad.	M_{2-3} with cingula a little less broad. Somewhat smaller space back of M_4.

These differences are slight and it is hard to know whether they are not due in part to age and state of preservation, but they are real, at least in part, and are easily recognizable, so

that the retention of the two species is possible, even though it carry no great conviction. It is impossible, however, to consider *T. lepidus* as belonging to a different genus from *T. bellus*, and since *Menacodon rarus* is synonymous with the first species, the genus *Menacodon* must be dropped.

Measurements of Tinodon.

	C	P_1	P_2	P_3	M_1	M_2	M_3	M_4	Depth of Ramus Anterior to M_4
Tinodon bellus:									
11843 Y. P. M.					1.9	1.8	1.5	1.0	2.5
13644 Y. P. M.		1.2	1.5	1.6	1.9	1.8	1.6	1.0	2.5
Tinodon lepidus:									
11845 Y. P. M.					1.9		ca.1.6		2.4
2131 U. S. N. M. ...	0.8	1.2	1.6	1.7	2.0	1.8	1.6		2.5

Measurements of teeth are maximum lengths. All measurements are in millimeters and are accurate to about 0.1 mm.

Family Amphidontidae nov.

Genus *Amphidon*[2] gen. nov.

Amphidon superstes,[3] sp. nov.

(See Figs. 6-7.)

Holotype, Cat. No. 13638 Yale Peabody Museum.

Morrison Formation, Quarry 9, Como Bluff, Wyoming.

The type consists of a right mandibular ramus, imbedded in plaster with the internal aspect exposed. Alveoli for first three premolars, crowns of fourth premolar and of the four molars.

Dentition.—There were four premolars and four molars. The canine was followed by a marked diastema.

The premolars were of nearly equal length but increased slightly from one to four. The last premolar is a compressed cone with sharp anterior and posterior slopes, the contour of each of which is very slightly convex. Directly anterior and posterior to the main cusp are accessory cusps, quite small,

[2] Greek ἄμφω + ὀδούς, both + tooth, in allusion to the anomalous character of the dentition, superficially resembling in part that of the reptilian prototype, that of the triconodonts, and that of the pantotherians, in addition to its basic relationships to the *Spalacotherium-Tinodon* type.

[3] Latin *superstes*, surviving, in reference to the relatively primitive molar pattern.

their tips rising free, their bases not distinct from the general convexity of the lower part of the crown. The posterior is a little the higher. There is no cingulum but there are tiny shelves just below the anterior and posterior accessory cusps. The whole inner slope is gently convex. There are two equal fangs, as in all the teeth of this mandible.

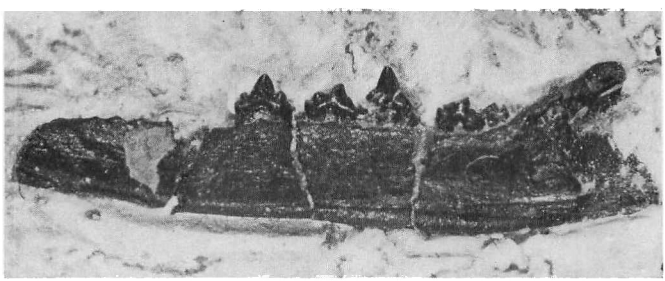

Fig. 6.—*Amphidon superstes*, gen. et sp. nov. Holotype, Cat. No. 13638 Y. P. M. Internal view, x6.

The first molar consists essentially of a single high pointed compressed cone with sharp anterior and posterior slopes. Near the tip these sharp edges run straight backward and downward, and forward and downward, respectively, but about half way down the crown they turn slightly inward, so that a section of the base is an obtuse isosceles triangle with the apex external and rounded, the base internal with two rather acute and sharp basal angles. The lower part of the anterior ridge undulates slightly as it runs downward and inward so as to produce at one point a slight external concavity and a more marked internal convexity. This slight break in the contour of the slope is hardly worthy of being called a cusp, but apparently might define the locus at which a cusp would arise. The same is seen on the postero-internal edge, but a trifle less marked and lower on the crown. There is no cingulum, although there are marked antero- and postero-internal shelves or heels, the anterior one higher and a little more developed. The base of the crown is much more convex than the upper part.

The second molar is very closely similar to the first.

The third molar is smaller; the inward running part of the sharp anterior and posterior crests is very much less developed,

especially the posterior one. The heels are, on the other hand, better developed than in either preceding molar and form distinct but small antero- and postero-internal cusps, the anterior one higher.

M_4 is a rather shapeless small tooth, consisting of a compressed crown with a higher central cusp, an ill defined lower

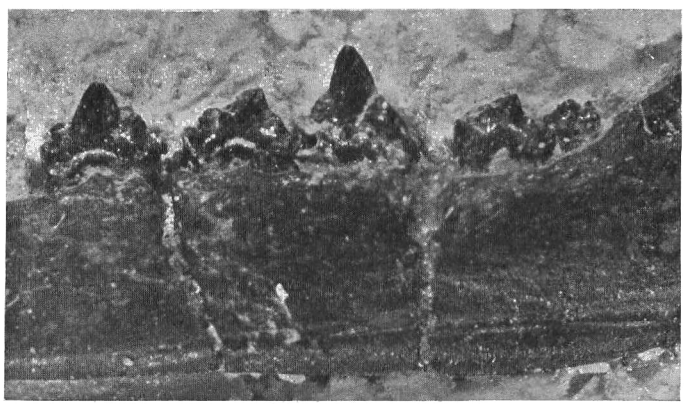

Fig. 7.—*Amphidon superstes*, gen. et sp. nov. Holotype, Cat. No. 13638 Y. P. M. Detail of dentition, internal view, x12.

one antero-internal to it, and a still lower, but better defined posterior one.

Mandibular characters.—The horizontal ramus is long and slender, with a nearly straight alveolar border and a rather unevenly convex lower border, lowest beneath the posterior end of M_3. The anterior part of the coronoid rises directly back of M_3, M_4 being crowded and at an angle to the other teeth. The pterygoid fossa is well developed, and at its anterior end is the dental foramen.

The internal groove begins near the lower border at a point beneath the dental foramen and runs forward parallel to the alveolar border to a point beneath M_1.

The pterygoid ridge is moderately sharp and prominent. There is no indication of the existence of a true angle below the condyle, although it could probably be detected on this specimen had it existed. The angle seems to have been of the type of *Triconodon* and *Tinodon*.

This specimen differs so widely in the structure of the

molars from any other Mesozoic mammal hitherto described that it obviously cannot be referred to any established genus.

Amphidon aequicrurius,[4] sp. nov.

(See Figs. 8-9.)

Holotype, Cat. No. 13639 Yale Peabody Museum.

Morrison Formation, Quarry 9, Como Bluff, Wyoming.

The holotype consists of part of a right maxilla with a single molar.

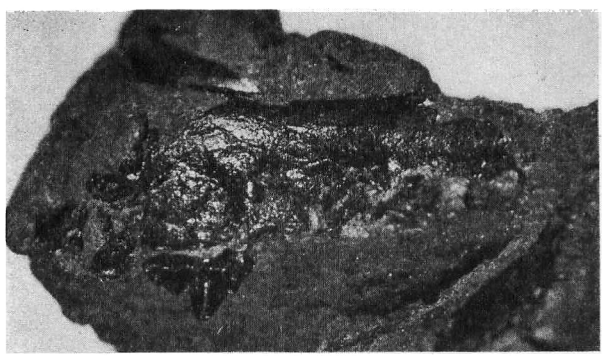

Fig. 8.—*Amphidon aequicrurius,* sp. nov. Holotype, Cat. No. 13639 Y. P. M. External view of maxilla, x7.

Dentition.—The dental formula, or information about any teeth other than the one preserved, cannot be obtained from this specimen.

The position of the molar in the series is uncertain, but it was about in the middle and may be supposed to be typical. In inner aspect it shows a high central cusp, compressed laterally, and with somewhat sharp anterior and posterior slopes. About half way to the alveolus, the anterior crest turns outward and runs antero-externally at a lower angle to the horizontal. It bears a distinct cusp, or cusp-like crenulation. The posterior slope is similar, but here there are two cuspules, a higher, more anterior, more internal, and a lower,

[4] Latin *aequicrurius,* isosceles, in reference to the distinctive contour of the crown.

more posterior, more external one just before the sharp edge reaches the cingulum. The whole inner surface of the crown is somewhat evenly convex horizontally, with short slight furrows just below the notches dividing the accessory cusps from the main one. In vertical section the internal surface is nearly straight, and it stood nearly vertical in the living animal. There is no internal cingulum.

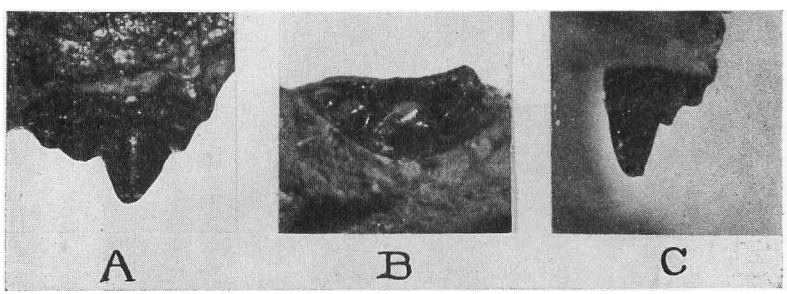

Fig. 9.—*Amphidon aequicrurius,* sp. nov. Holotype, Cat. No. 13639 Y. P. M. Views of molar. A, external aspect. B, crown aspect. C, posterior aspect. x12.

Externally the slopes of all the cusps are individually more or less convex, and the cusps are more distinctly separated. There is a very prominent and straight nodulated cingulum which becomes obsolete at the posterior end of the tooth but is very wide anteriorly and rises to form a prominent antero-external cingulum cusp.

This tooth would occlude only with a lower molar of one of the types represented by *Tinodon* and *Amphidon.* Of these it most resembles the latter, and is therefore provisionally referred to that genus. Apparently it would require a somewhat shorter occluding tooth than those of the only known species of *Amphidon* based on lower molars, hence it is referred to a new species—a step justified in any event by its importance and by the lack of definite assurance of the correctness of its reference to this genus.

Of upper molars hitherto described it most resembles *Peralestes,* as figured by Osborn (1907, p. 26), but even from this type the differences are marked, especially in the arrangement and development of the outer cusps; the whole crown, also, is more symmetrical.

Measurements of Amphidon.

	P_4	M_1	M_2	M_3	M_4	Depth of ramus bet. M_3 M_4
Amphidon superstes:						
13638 Y. P. M.	1.3 mm.	1.3	1.2	1.1	0.7	2.3
Amphidon aequicrurius:						
13639 Y. P. M. Length of tooth preserved: 2.0 mm.						

TAXONOMIC HISTORY OF SPALACOTHERIUM AND ITS ALLIES.

Owen did not attempt a formal zoological classification of the Mesozoic mammals, and he proposed no familial names. In his table of genera (1871, p. 115) he places *Spalacotherium,* along with all the genera then known save *Plagiaulax, Phascolotherium, Triconodon,* and *Triacanthodon,* in the group or marsupials with "more than two mandibular incisors" and with the "molary series more than the type number (multidentate)."

Marsh (1887, p. 340) proposed the family Spalacotheridae and said, "The type genus of this family is *Spalacotherium* of Owen, but it is probable that he included more than one generic form under this name, in the various specimens described. In this country, one well preserved jaw has been found, which appears to represent a distinct genus (*Menacodon*), and is described below." Under the succeeding family, Tinodontidae, he places *Tinodon,* a form which, as indicated by his manuscript notations, he was prone to link with the triconodonts, especially *Priacodon.* That he considered the family Tinodontidae closely related to the triconodonts is also shown by the fact that he apparently includes in it *Phascolotherium,* although this genus "may yet be found to represent a distinct family." No contrast between the families Spalacotheridae and Tinodontidae is given, nor do they seem to have been considered at all closely related.

Osborn in his first classification (1888) disposed of these groups as follows:

Order Marsupialia
  Suborder Prodidelphia
    1. Carnivorous series
      1. Triconodontidae Marsh
        Phascolotheriinae
          Phascolotherium.
          Tinodon.
        Spalacotheriinae
          Spalacotherium.
          Menacodon.

The later classification in 1907 by the same high authority retains essentially the same disposition of these genera:

A. Infra-class Marsupialia
1. Order Triconodonta
1. Triconodontidae
Phascolotheriinae
Phascolotherium.
Tinodon.
Incertae sedis:
Spalacotheriinae
Spalacotherium.
Menacodon.
Peralestes.

Marsh seems to have associated *Tinodon* and the triconodonts because he assigned small value to the different placing of the cusps. Osborn, on the other hand, assigned great importance to this character, but thought that he saw in *Phascolotherium* and *Tinodon* stages intermediate between a true triconodont and a true spalacothere. By this series he traced the supposed origin of the trituberculate dentition through a spalacothere type derived by cusp rotation from a triconodont type.

Gregory (1910, p. 174) pointed out very important differences between spalacotheres and trituberculates and retains the former with the triconodonts. In 1922 the same author included the spalacotheres *questionably* in the Order Triconodonta, referring to them as "pseudo-trituberculates." A note by Dr. Matthew in the same work (p. xiii) states, "It appears to me more probable that *Spalacotherium* is related to the Trituberculata in spite of the difference in the angle. The teeth are quite close to *Stylodon* and its allies, and of a type that appears to me fundamentally distinct from *Triconodon* and equally distinct from *Phascolotherium.*"

GENERIC AND FAMILIAL RELATIONSHIPS.

Osborn's placing of all these forms in subfamilies of the family Triconodontidae does not now seem to be tenable. The triangular character of the molars is a very sharp difference of at least familial rank. Marsh's family Spalacotheriidae is therefore retained to include *Spalacotherium* and *Tinodon*

(the latter including the form previously known as *Menacodon*). The placing of *Tinodon* in a separate family (subfamily Osborn) is largely due to the fact that species of *Priacodon* were included in it, and that *Menacodon* was believed to be a distinct genus.

Position of Phascolotherium.

The linking of *Tinodon* and *Phascolotherium* adopted by Osborn has not been generally followed. *Phascolotherium* is now considered a true triconodont, the reported slight internal rotation of the first and third cusps apparently not being sufficiently pronounced for much significance. A condition which seems to be similar is seen in the American genus *Phascolodon,* which is a true triconodont with no indications of transition to the *Tinodon* type.

Spalacotherium and Tinodon.

These genera show many characters in common: same aspect of angular region, condyle above level of alveolar border, closely similar horizontal rami, toothless space between last molar and anterior border of coronoid, same type of premolar, closely similar molars, well defined internal cingulum of similar form, etc. Their association in one family is clearly indicated. The chief generic differences are as follows:

Spalacotherium	*Tinodon*
$I\ ?\ C_1\ P_4\ M_6$.	$I\ ?\ C_1\ P_3\ M_4$.
Canine moderate, erect.	Canine small, pointed forward.
Coronoid high, fairly narrow, recurved, at ca. 60° to alveolar border.	Coronoid very broad, not recurved, at 90° to alveolar border.
Ramus constricted back of last molar.	Ramus not constricted back of last molar.
Molars high. Length of molars along cingulum less than height above cingulum.	Molars long. Length greater than height.
Weak external cingulum.	No external cingulum.

Other differences no doubt occur. As has been noted by Professor Marsh and others, if all of Owen's figures of *Spalacotherium* are accurate they must pertain to more than

one genus. In any event, however, no described English form is congeneric with an American one.

Tinodon and *Menacodon* have been cited as transitional between a primitive triconodont and *Spalacotherium*, and hence as more primitive than the latter genus. *Tinodon* does not, however, seem actually to be more primitive. It has a lesser number of post-canine teeth, and the lateral cones are quite as high in proportion to the midcone as in *Spalacotherium*. The fact that all three cones are lower in proportion to the length of the crown is not primitive but correlated with reduction in the number of the molar series. This reduction is still progressing, as the last molar is small and practically functionless. Furthermore, granting for the moment that circumdiction of the accessory cusps took place, it is about as advanced in *Tinodon* as in the English genus. The penultimate molar of *Tinodon* is almost perfectly equilaterally triangular.

Amphidon and a New Familial Classification.

The position of *Amphidon* is a more difficult question. That it is related to the above genera seems indicated by the following characters which it possesses in common with them:

Size and proportions of horizontal ramus.
Probable condition of angle.
Dental formula $I\ {}_{?}C_1\ P_4\ M_4$, within the limits of the group.
Premolars compressed cones with smaller anterior and posterior accessory cusps.
Molars isosceles triangles, longer than broad, apex a high trenchant external cone with lesser antero- and postero-internal accessory cusps.

Despite these resemblances, which seem to indicate that it is of the same stock as *Spalacotherium* and *Tinodon*, *Amphidon* shows differences from these genera which are very significant. The more important of these differences are:

Accessory cusps mere crenulations in the sharp edge of main cusp, not rising free, very small, leaving the crown functionally monocuspid.
Section of molar distinctly triangular, but not so nearly equilateral as in the other genera.
No continuous internal cingulum, but distinct antero- and postero-internal heels.

These differences, of which the first is the most striking, are of more than generic significance. While showing a group relationship to the other two genera, *Amphidon* certainly differs a great deal more widely from *Spalacotherium* and *Tinodon* than either of these genera does from the other one. This fact is most simply expressed by placing *Amphidon* in a separate but related family, as defined below.

Family Spalacotheriidae Marsh 1887

Molars functionally tricuspid. Antero- and postero-internal cusps distinct and well developed, springing from base of crown. Internal cingulum marked, rising to point in center, and forming anterior and posterior cingulum cusps or heels.

Spalacotherium Owen.
Tinodon Marsh.

Family Amphidontidae, nov.

Molars functionally monocuspid. Accessory cuspules mere crenulations in sharp cutting edges of main cusp. No continuous cingulum, but anterior and posterior inner heels which may rise to form true but small cusps.

Amphidon, nov.

Significance of Amphidon.

The fairly close relationship between these two families has already been emphasized, but a word more concerning the meaning of the molar type of *Amphidon* is apropos. If we are correct in assuming a common source for these families, then there are two possible interpretations of the molars of *Amphidon:* either they have suffered reduction and degenerative simplification from a type more closely resembling that of the Spalacotheriidae, or else they represent a more or less modified primitive stage in the development of the *Spalacotherium* molar. There is, to be sure, some cause to think of reduction. Eight is a smaller number of post-canine teeth than occur in *Spalacotherium* and is relatively small for a Jurassic mammal. Furthermore the last of these eight is functionless, almost formless, in the last stages of reduction. It is, however, rather difficult to see how reduction or retrograde evolution of a well developed spalacotherid molar could produce the *Amphidon* type. On the other hand, *Amphidon* approaches in many respects the ancestral type which would be postulated

on the theory that the accessory cusps arose in place, instead of migrating or rotating. Conversely, the actual existence of such a type increases the probability that the cusps did so arise. No doubt the character of the cingulum heels in *Amphidon* is an independent specialization, but it is slight and does not alter the fact that here we have a triangular molar, essentially symmetrical with respect to a vertical transverse median plane, functionally composed of one high sharp cusp, but with a tendency to form antero- and postero-internal cusps. And just such a molar we would expect to be ancestral to the molar of the spalacotherids.[5]

The relations of the group including the Spalacotheriidae and the Amphidontidae to the Triconodonta and to the Pantotheria, to each of which the Spalacotheriidae have been referred, will be discussed in detail in the next of this series of studies.

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[5] *Amphidon* is absolutely contemporary with *Tinodon* and is somewhat specialized in its own way. Obviously it is not truly ancestral, but the survival of a relatively little modified ancestral type along with more highly modified derived types is a common occurrence.

In this discussion of generic relationships the upper molars have played no part. While *Amphidon aequicrurius* is referred to that genus with a certain confidence, or at least to the Amphidontidae, *Peralestes* is by no means so surely the upper dentition of a spalacotherid. Its resemblance to *Amphidon aequicrurius* may merely indicate the presence in the Purbeck of an amphidontid still unknown from the remains of lower jaws. In the present state of our knowledge it would be most unwise to base a discussion of the relationships of the Spalacotheriidae (or *Spalacotherium*) and the Amphidontidae (or *Amphidon*) on the assumption that *Peralestes* is the upper dentition of the one, *Amphidon aequicrurius* of the other.