

ART. XVII.—On a foetal Manatee and Cetacean, with remarks upon the affinities and ancestry of the *Sirenia* ;\* by Prof. BURT G. WILDER, of Cornell University.

*A foetal Manatee.*—The foetal Manatee here described was obtained by Professor James Orton† at Pebos,‡ Peru, upon the Marañon, a tributary of the Amazonas.

Detailed measurements are reserved for a more extended article, but the following will be found useful.

|                                                                                                                | Grams. |
|----------------------------------------------------------------------------------------------------------------|--------|
| Present weight,.....                                                                                           | 11.    |
| Original weight (estimated by comparison with a foetal pig of nearly the same size, preserved in spirit),..... | 22.    |
|                                                                                                                | Meter. |
| Present apparent length, vertex to root of tail, (2·3 inches)                                                  | ·055   |
| Original apparent length (estimated as above), (2·6 inches)                                                    | ·059   |
| Tip of muzzle to ear.....                                                                                      | ·020   |
| Ear to point opposite anus.....                                                                                | ·037   |
| Point opposite anus to tip of tail.....                                                                        | ·028   |
| Real length, as if extended, (3·7 inches).....                                                                 | ·085   |
| Tip of muzzle to depression between eyes.....                                                                  | ·011   |
| Between eyes to vertex.....                                                                                    | ·015   |
| Total length of head.....                                                                                      | ·026   |
| Greatest width of tail.....                                                                                    | ·011   |

It is not very easy to state the dimensions of this foetal manatee so as to permit accurate comparison with other foetal or adult individuals. This is owing less to the distortion of the trunk by lateral pressure in packing for transportation, than to the non-conformity of the axes of head, trunk and tail, which, in the adult, nearly coincide.¶

With adult animals a common measurement is from "tip-to-tip;" from the muzzle to the end of the tail. It is evidently inappropriate to measure directly between these points in this or any other young foetus; and almost equally so to follow the

\* Abstract of portions of a communication to the Boston Society of Natural History, April 7th, 1875.

† Knowing me to be engaged in the dissection of a foetal dugong (2½ feet long, obtained through Prof. H. A. Ward of Rochester), Prof. Orton very generously transferred the little manatee to the Cornell University.

‡ Murray (3, 302) states that this species "ascends the rivers Orinoko and Amazon for great distances." Upon Map LI the coloring indicates a westward limit in Brazil at about 65° west longitude. The locality above named is about 72° west longitude and 3° south latitude.

The first number of references indicates the number of the work in the list at the end of this paper; the last the number of the page; the middle one, when it occurs, the volume.

¶ More desirable than even the adoption of a simple (metric) system of weights and measures is the acceptance of a uniform method of weighing and measuring animals and their organs. The aphorism that "figures do not lie" is nowhere less true than in zoölogy.

outer curves of the head, trunk and tail. But while we may feel sure that the truth lies between these two extremes, it is not easy to decide upon the points which should be traversed by a straight line representing the total length. The measurements here given may therefore be regarded as only approximately true to nature.

The head is sharply bent upon the chest. The arms (anterior limbs) are likewise pressed flat upon the chest, the left manus overlapping the right. (In the photograph the manus is represented as projecting forward). The tail forms nearly a right angle with the trunk. Upon its ventral border near the tip is a minute median papilla, which does not appear to have been observed in larger specimens; but there is no trace of the notch or depression described by Dr. Murie in both of his specimens (1, 128); neither does there appear the raised border described by the same author (1, 133).

The abdomen is closed but the umbilicus is large, .004 in diameter. The umbilical cord is not present, but there projects a loop of intestine about .040 long, together with a delicate membranous tube which is apparently connected with the intestine and is probably the remains of the yolk sack. (This will be fully described when the dissection is made).

The clitoris is large, .003,2 in length. By its caudal deflection it covers the genital and anal orifices.

The brain was softened and its parts hardly distinguishable. It will be described hereafter. (The photograph was taken after its removal by a longitudinal incision). The extent of the cavity is approximately indicated by the dotted line.

There is no external ear, and the orifice of the auditory meatus is a minute round hole\* with wrinkled borders as in the adult. A pigmentary deposit in the surrounding skin is all that can be seen by the unaided eye. The skull is prominent at this point, as shown in fig. 4.

The upper and lower eyelids are separated by an elliptical opening, the long axis of which is oblique to that of the head. Its length is .001,2. The third eyelid, if it exists, does not appear. By blowing between the lids there is revealed a space surrounding the orifice about .004 inch diameter; how far this represents the size of the globe can only be known by dissection.

The nostrils have the same form as in the adult, but owing to the squareness of the muzzle, they do not appear upon a front view.

\*At the time this communication was made the writer thought he had found an inverted triangular pinna. It proves to exist upon only one side, and has probably been produced artificially. Its position is just behind that of the meatus, and it closely resembles the early stage of the pinna in swine.

*A fetal Cetacean.*—Fig. 6 represents, of natural size, a foetal cetacean kindly loaned by Mr. Alex. Agassiz, Curator of the Museum of Comparative Zoölogy.

The specimen is labelled *Talcahuano, Chili*, and was given to the late Prof. Agassiz upon the Hassler expedition. The donor, an old whaler, said it was from the "Hump-back whale," (*Megaptera*). But, aside from its small size, the blow-hole is a single transverse aperture as in *Delphinidæ*; so that unless we assume that a transformation could occur so as to divide this into two holes, longitudinally or obliquely placed, we must regard it as the embryo of a porpoise or dolphin.

|                                                                |                        |
|----------------------------------------------------------------|------------------------|
| Length from vertex to root of tail opposite anus, (2·3 inches) | <sup>Meter.</sup> ·055 |
| Tip of muzzle to supposed location of auditory meatus          | ·015                   |
| Auditory meatus to opposite anus                               | ·042                   |
| Opposite anus to tip of tail                                   | ·018                   |
| Real length as if extended (2·9 inches)                        | ·075                   |

The smallest cetacean foetus of which I have found record (Gervais, 4, 323, pl. xvii) was ·102 (about four inches) long; it is assigned to the common dolphin, *Delphinus delphis*. The general aspect is similar in the two, but Gervais' figure has the upper and lower jaw of equal length, while in the specimen here figured the lower projects about ·001 beyond the upper.

The blow-hole is a transverse aperture ·004 long. Its lips are rounded and tumid, and the posterior has a distinct hinder border. The eyelids are closed.

The tail is narrow and lancet-shaped, with no trace of a terminal notch. No trace of dorsal fin is apparent, but as the cuticle of the back is somewhat abraded by friction during transportation, it is not impossible that a rudimentary fin existed as in Gervais' specimen. The vertical crest, mentioned by Wyman (6), exists above and below the tail.

*Existing views respecting the affinities of the Sirenia.*—At the present day no zoölogist follows Rondeletius (7) in enumerating the manatee and dugong with the fishes, and very few adopt Cuvier's arrangement of them as "Herbivorous Cetacea."

Yet the hiatus between the Ungulata and the adult manatee and dugong is so great as to lead to the general recognition of the latter as a distinct order, Sirenia (Brandt, 2 *ferè*; Murray, 3, 196; Owen, 12, ii, 281; Huxley, 13, 387); and three recent authors, by a kind of taxonomic reversion, seem to be again forcibly impressed with the striking outward resemblances of the adult Sirenia to the Cetacea. The late compiler of the Catalogue of Seals and Whales in the British Museum includes the manatee and dugong among the Cetacea; Gray, 15, 62. Hæckel (14, 545, 556) recognizes their affinities with the Ungulata, but makes the Cetacea the descendants of the Sirenia.

The most recent writer concludes an able anatomical description of the manatee with a diagram, in which equal weight seems given to the cetacean and ungulate relations of the *Sirenia* (Murie 1, 190).

Dr. Murie continues as follows: "Is it (the manatee) a retrograde, dwarfed or undeveloped Elephant? a 'true embryonic type of Pachyderms,' as the elder Agassiz puts it (9). Is it a partially converted Cetos? Is it the reflex of unknown and antedated swarms of mammals of intermediate organization which would fill up the chasms of structural differentiation, yielding lines of demarcation to modern systematists? Such interrogations, to be answered satisfactorily, require a more comprehensive knowledge of the embryology of Pachyderms and Cetacea, a far greater acquaintance with allied fossil forms, a better appreciation of what constitute transitional links, and a further profound investigation into the principles of the doctrine of evolution."

It will be noted that, although Dr. Murie uses the word *retrograde* in his general query respecting the affinities, the idea is not distinctly enunciated. For while embryo Pachyderms and Cetacea are mentioned as likely to throw light upon the problem, those of *Sirenia* are not alluded to. This is not so strange in view of the fact that the smallest foetus then known (Daubenton, 22) was about ten inches long (.254) and already unmistakably a manatee.

*Affinities of the Sirenia.*—The likeness of the foetal manatee's head to that of some ungulate quadruped is as obvious as is its unlikeness to the head of the foetal cetacean. The following considerations seem to warrant our attaching more importance to these resemblances than to those features of the trunk and limbs which, in the adult forms, seem to separate the *Sirenia* from the Ungulata and to unite them with the Cetacea. "In the eyes of most naturalists, the structure of the embryo is even more important for classification than that of the adult. In two or more groups of animals, however much they differ from each other in structure and habits, if they pass through closely similar embryonic stages, we may feel assured that they are all descended from one parent-form and are therefore closely related." (Darwin, 24, 403).

It is to be borne in mind that resemblances may be of two kinds.

1. Those features which are common to the earlier stages of development with all members of larger groups. 2. Those which are peculiar to smaller groups. The former are relatively *negative*; the latter, relatively *positive*.

In the case of the manatee the large tail, the absence of hinder limbs, the pinniform manus, the flexion of the head upon the chest, and the absence of external ear; these charac-

terize a certain stage with all mammalian embryos, and have merely a general significance as indicating a remote common or similar origin within the mammalian class. Nor does the resemblance they may involve with the Cetacea require us to regard the latter as nearly related to the Sirenia.

But all mammalian embryos have, in the earlier stages, a high and rounded head with a short facial region. With an "embryonic type" like the Sirenia we should expect to find in the embryo an especially high and rounded head and a short face. Whereas the height of the head is by no means excessive, and the facial region is greatly prolonged. Now this is what exists in the adult pig, horse, and hippopotamus.

Among human beings, likeness to relatives and to ancestors, more or less remote, is usually recognized in the form of the head, the shape or expression of the features. The same value can be attached to resemblances among animals only in so far as there is community of structure underlying the external resemblance.

It is admitted by nearly all that the anatomical resemblances upon which affinities are recognized are much greater between the Sirenia and certain Ungulata than between either of these groups and the Cetacea.

There would seem to be reason, therefore, for attaching very considerable taxonomic value to the fact that the head and face of this foetal manatee resemble not those of cetaceans, but those of certain Ungulata; notably hippopotamus, pig and horse.

*Probable ancestors of the Sirenia.*—In the discussion of this question several matters must be considered.

1. Few now dissent from the doctrine of Darwin, that "descent is the hidden bond of connection which naturalists have been seeking under the term of the natural systems." (24, 403.)

By all zoologists the Sirenia are regarded as an inferior type, whether as an order among Mammals, or a sub-order or family of the Ungulata in general, or of the more restricted groups Pachyderms or Perissodactyla.\*

The group is well named by Dana "*Urothenic aquatic Herbivores*;" (21, 160); and it is a source of gratification to all that that eminent naturalist now admits that the terms above used, with others introduced in his works, may have an actual in place of a purely ideal signification.

It is an almost universally accepted rule that the earlier stages of animals resemble the permanent conditions of *lower* forms. This is stated by Dana as follows: "As a species in development passes through successive stages of progress, relative grade in inferior species may often be determined by com-

\* I use these terms for convenience and not because I regard them as expressing natural relations.

paring their structure with these embryonic stages. \* \* \* As the young of the frog (tadpole) has the tail and form of a salamandrian, therefore the salamanders are higher than the frogs." (20, 592.)

In accordance with the above rule, and upon the hypothesis of evolution, we should expect the embryo hippopotamus to resemble a manatee, and the embryo manatee to look "very like a whale." But since the young manatee has a head like an adult hippopotamus, we must either reverse the usual opinion as to the relative rank of the aquatic and terrestrial Ungulates, or qualify the rule above stated so as to meet the present case.

This apparent discrepancy between generally accepted views as to the coincidence between rank and stages of development seems to be accounted for by the doctrine of Retrograde metamorphosis, alluded to by Darwin (24) and Hyatt (26) and perhaps by other authors.

The following passages from the "Origin of Species" are especially applicable.

"The embryo in the course of its development generally rises in organization; I use this expression, though I am aware that it is hardly possible to define clearly what is meant by the organization being higher or lower. But no one probably will dispute that the butterfly is higher than the caterpillar. In some cases, however, the maturer animal must be considered as lower in the scale than the larva, as with certain parasitic crustaceans." (24, 396.)

"Recent forms are generally looked upon as being on the whole higher in the scale of organization than ancient forms; \* \* \* this fact is compatible with some forms having retrograded in organization, by having become at the last stage of descent better fitted for changed and degraded habits of life." (24, 426, also 402 and 397.)

"Slight variations generally appear at a not very early period of life and are inherited at a corresponding not early period." (24, 399 and 316.)

"Whatever influence long-continued use or disuse may have had in modifying the parts of animals will chiefly or solely have affected them when mature \* \* \* and the effect thus produced will be transmitted to the offspring at a corresponding mature age." (24, 401.)

"This process, while it leaves the embryo almost unaltered, continually adds, in the course of successive generations, more and more difference to the adult. Thus the embryo comes to be left as a sort of picture, preserved by nature, of the ancient and less modified condition of the animals." (24, 316 and 403.)

In other words, the idea of evolution, whether of individuals

or groups, *primarily* involves an increase in complexity and an advance in rank; but it is perfectly compatible with a subsequent retrograde metamorphosis, more or less extensive according to the rank already attained. Using the terms in their literal rather than their usually accepted sense, evolution *primarily* involves *ascent*, but it is perfectly compatible with *descent*.

Upon the derivative hypothesis all evidences of a parallelism or concomitancy between individual metamorphosis and the evolution of types toward a more perfect condition are equally cogent in favor of the conclusion that the retrograde metamorphosis of an individual indicates that the group to which it belongs is upon the downward rather than the upward path.

Upon the hypothesis of evolution we may regard exceptions to the rule quoted from Dana as to the resemblance between the earlier stages of higher forms and the permanent condition of lower, as strictly in accordance with the more universal law that *the earlier stages of animals resemble their more or less remote ancestors*; if these are lower in rank, as is usually the case, then the commonly accepted rule will hold good; but if higher, as is here suggested of the Sirenia, then that rule would fail, while the more universal one would still be kept.

The idea that existing Sirenia are the result of a retrograde evolution is supported by the very arguments which Brandt urges against the ordinary view of progressive development. He says: "To the supposition that *Halitherium* has given rise to the other and later genera are opposed many considerations. For the *Halitheria*, in addition to the well-developed pelvis provided with acetabula, had rudiments of hinder limbs (femorum), in which respect they approximated the more perfect animals more nearly than do the existing genera; while on the contrary, according to the theory, we should look for a perfection of body gradually evolved and a more complex structure, in *Halicore*, *Manotus* and *Rhytina*, rather than in the *Halitheria*." (Brandt, 2370.)

If *Deinotherium* \* be regarded as a Sirenian with limbs yet more developed than in *Halitherium*, then the series is at least provisionally intelligible.

Of course the above considerations in no way account for the prior existence of the hypothetical stem-form of quadrupeds

\* By Owen (12, ii, 282); Huxley (13, 431); Haeckel (14, 560); Brandt (2, 190); Gill (23, 90), the *Deinotherium* is regarded as a Proboscidian; but it is included among the Sirenia by De Blainville and St. Hilaire (Murray, 3, 198), Dana, 20, Murray, 3, 190, and L. Agassiz. According to the placental classification of Huxley and Haeckel, the Proboscidea are in one great group Deciduata, while the Sirenia are in the other, but provisionally, since their placentation is not known. It would seem that osteological comparisons are not as yet conclusive in this case.

from which the Sirenia may be supposed to have retrograded. Neither do they preclude the idea that they and the other mammals may have been evolved from cetacean forms.

But it must be admitted even by those who may not recognize the ungulate affinities of the Sirenia, that the comparison of these two embryos does not materially lessen the gap between the Cetacea and the other Mammals, upon which Murray has so strongly insisted. 3, 55, 196 and 203.\*

As to the zoological status of the Sirenia, if the views above advanced are correct, there would seem to be no more ground for their removal from the Ungulata than for the separation of the Pinnipedia as an order apart from the Carnivora. Nor would the comparison be invalidated by the view that the seals may be upon the upward rather than the downward path.

The limits of this preliminary paper will not allow the discussion of the relations of the Sirenia with special ungulate families and genera, or of the relative position of the sirenian genera.†

But there is one point of resemblance between the Sirenia and the Proboscidea upon which, it seems to me, undue stress is liable to be placed, namely: that in both groups the mammary glands are pectoral or axillary, while in the hippopotamus they are inguinal.

The consideration of the variations as to number and position of these organs in other groups shows, however, that in recent times they have never been regarded as of sufficient taxonomic value for the determination of ordinal or even family affinities. (For instances, see Owen, 12, iii, 775-780.)

It may at first seem strange that there are no traces of hinder limbs in this fetus, and that the front limbs are not more like the legs of its supposed quadrupedal ancestors.

It is by no means *impossible* that an embryo just forming would present rudimentary hinder limbs in accordance with the usual vertebrate type.

As to the manus, it is to be borne in mind that the vast majority of existing vertebrates‡ have anterior limbs which vary but slightly from the pad-like form which they present in the embryos, and which may be supposed to have prevailed in past times. The quadrupedal pattern is comparatively recent, and has affected so few mammals, especially such as may be

\* With the Cetacea it is said that "the apex of the heart is sometimes indented," (Owen, 12, iii, 521). But we need further information upon this point and also respecting the statement of Gratiolet, (16,) that a like condition prevails in the new-born hippopotamus.

† I am inclined to think that a careful study of embryos and brains will be more satisfactory than even such exhaustive osteological comparisons as those of Brandt.

‡ Nearly all fishes, many batrachians, some reptiles, all birds, and a very large number of mammals.

regarded as in the line of sirenian descent, that we may regard its influence as almost inappreciable as compared with the other.

Further discussion of the subject is deferred until the foetal manatee has been dissected,\* and until the writer is able to prepare a longer paper in which the various questions involved may be more fully presented. It is to be hoped that no opportunity will be lost for securing still earlier sirenian embryos and for preserving the membranes.

#### SUMMARY.

1. The specimens here described are probably the smallest foetal sirenian and cetacean upon record; measuring, if extended, .085 (3·7 inches), and 0·75 (2·9 inches), respectively.

2. The head of the manatee is strongly flexed upon the chest, and the tail forms a right angle with the trunk.

3. The general aspect of the head and face of the manatee is ungulate rather than cetacean.

7. To this extent the embryo of a lower form resembles the adult of a higher.

5. This, while contrary to the usually accepted rule, may be really an exemplification of a more comprehensive law; namely, that the *young of animals resemble their ancestors*.

6. This retrograde metamorphosis of the manatee points to a like retrograde evolution of the Sirenia from prior ungulate forms.

7. This idea is confirmed by what is known of the geological succession of sirenian forms.

8. The determination of the affinities of the Sirenia, is likely to be accomplished by the study of brains and embryos rather than by minute osteological comparisons.

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\*This youngest specimen ought to throw light upon the development of the compound stomach and of the bifid heart; and may solve the question respecting the number of cervical vertebrae, upon which present opinions are wholly contradictory (Murie, 1, 137).

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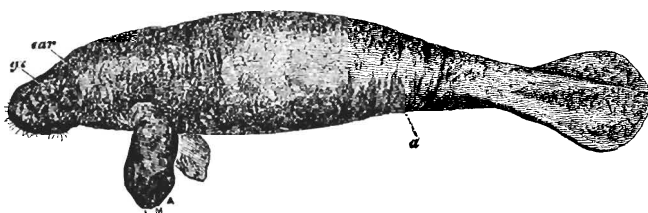
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## EXPLANATION OF FIGURES.\*

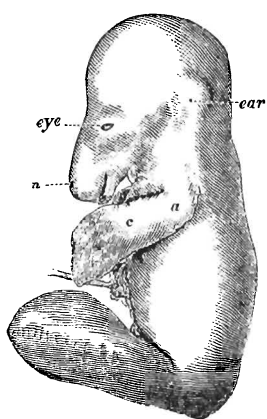
- Fig. 1.—Partly grown male Manatee,  $\frac{1}{5}$  of natural length. Reduced copy of Murie's figure. The eye and ear appear as black spots; *a*, anus; *i*, *m*, *a*, the nails of the index, medius, and annularis digits.
- Fig. 2.—Foetal Manatee, natural size. *n*, nostril; *a*, ancon (elbow); *c*, carpus.
- Fig. 3.—Head of foetal Manatee, enlarged two diameters; the muzzle being raised a little so as to expose the lower lip. The dotted line indicates the extent of the cranial cavity. The external meatus is represented by a black spot.
- Fig. 4.—Head of foetal manatee, seen from above and in front; natural size.
- Fig. 5.—Tail of foetal Manatee, seen from the ventral side; natural size. *cl*, clitoris turned toward the right; *v*, generative opening; *a*, anus; *cp*, caudal papilla.
- Fig. 6.—Foetal cetacean, natural size. *n*, nostril; *uc*, umbilicus; *cl*, clitoris; *a*, anus. The smaller figure represents the lance-shaped tail from the ventral surface.
- Fig. 7.—Head of foetal cetacean, natural size, from above; *n*, nostril.

\* The figures, excepting fig. 1, were drawn from nature and from photographs. and engraved by Mr. Philip Barnard.

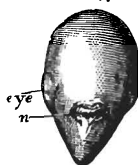
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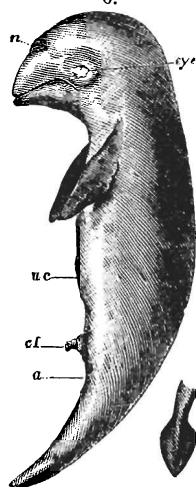
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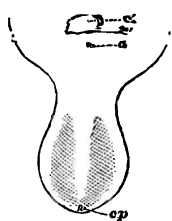
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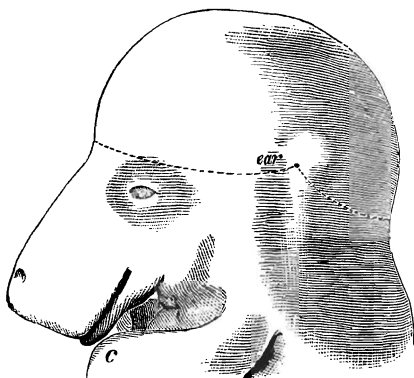
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