- IV. *On the Extinct Land-Tortoises of Mauritius and Rodriguez.* By ALFRED C. HADDON, B.A., Scholar of Christ's College, and Curator in the Museum of Zoology and Comparative Anatomy of the University of Cambridge. (Communicated by Prof. NEWTON, M.A., F.R.S.)

(Plate XIII.)

Read November 20th, 1879.

HAVING been recently engaged in determining and cataloguing the large series of bones of the extinct Land-Tortoises of the Mascarene Islands contained in the Museum of the University, it has appeared to me that some notes made during that undertaking might, if published, be of interest to zoologists in general and herpetologists in particular; for though a portion of the series was submitted to Dr. Günther when preparing his admirable monograph*, yet a very considerable portion, in some instances containing more perfect specimens, has been received since the publication of that work, and has therefore never been described, while the whole forms the largest assemblage of these rare remains that has yet been collected.

All the specimens in this series were presented to the University by Mr. Edward Newton, M.A., C.M.G., formerly Colonial Secretary of Mauritius, and now Lieutenant-Governor of Jamaica. Those from Mauritius were obtained, with one or two exceptions, from the mud and peat of the Mare aux Songes, where they were found, together with numerous remains of the Dodo and other extinct members of the fauna of that island, under circumstances which have been described by the late Mr. George Clark †. The portion of the series received in 1867 was examined by Dr. Günther, and several of its specimens have been described and figured by him in his work above mentioned; but the larger portion did not reach the Museum till the summer of the present year, 1879. The bones from Rodriguez were received in like manner at two different times; but they were all obtained from the caves of that island, the first portion having been collected by Sergeant Morris, who was working under the direction of Mr. George Jenner, during the excavations and explorations made at the expense of the British Association for the Advancement of Science between 1866 and 1871, inclusive ‡, and the second portion having been obtained similarly by Mr. James Caldwell on his visit to the island in 1875 §. This last collection was received at our Museum during the past summer and, like the Mauritian series, which arrived at the same time, has not had the advantage of Dr. Günther's inspection.

* 'The Gigantic Land-Tortoises (Living and Extinct) in the Collection of the British Museum.' By Albert C. L. G. Günther, M.A., M.D., Ph.D., F.R.S. London, 1877.

† "Account of the late Discovery of Dodos' Remains in the Island of Mauritius." By George Clark. *The Ibis*, 1866, pp. 141-146.

‡ Report of the British Association, 1865, p. xli; 1866, pp. 401, 402; 1867, pp. 287, 288; 1872, pp. 23, 24.

§ "Notes on the Zoology of Rodriguez." By J. Caldwell, C.M.Z.S. *Proc. Zool. Soc.* 1875, pp. 644-647.

In writing the following remarks, it is needless for me to mention the inestimable assistance that I have derived from Dr. Günther's elaborate monograph, as well as from a comparison of the specimens in our Museum which have been named by him. Indeed without these latter I could hardly have determined and catalogued our more recent acquisitions; but since they are so extensive, it seems to me desirable that some detailed account of them should be given, not with the view of superseding, but of supplementing, the excellent descriptions which he has already given. I think it cannot but be gratifying to him to find that the larger amount of materials at my disposal enables me to confirm in almost every respect the conclusions at which he had arrived.

In all cases I have closely followed his treatment of the subject, in order to facilitate comparison.

I. TORTOISES OF MAURITIUS. *Testudo triserrata* and *T. inepta*.

The remains of these, the two common Mauritian species, when sufficiently perfect, can, with the exception of the femur and the smaller leg-bones, be easily distinguished, the other forms indicated by Dr. Günther, *Testudo indica* and *T. leptocnemis*, being of doubtful value. *T. indica* is known from the shell only, "the upper profile of which is straight, and not declivous in front;" while *T. leptocnemis* rests alone on the scapula, pelvis, and femur; but its scapula does not differ from that of *T. triserrata*, though its pelvis and femur are "more slender than in either *T. triserrata* or *T. inepta*."

Skull.—The additions are:—(1) a portion of the occipital and tympanic regions of a moderately sized skull; but not having the maxilla it is impossible to refer it to either species.

(2) A slightly imperfect lower jaw of a very large specimen of *T. inepta*, from the deposits of Flacq.

Mandible, extreme length and breadth 78 millim.

Carapace.—Only a small fragment of a plastron.

Vertebral column.—A single example of the seventh cervical, centrum only. It is biconcave, the hæmal spine as in *T. Vosmæri*. There is a groove between it and the tubercles of the anterior zygapophyses, and a deep fossa on the upper surface behind the anterior zygapophysis on each side, as in the sixth cervical of *T. Vosmæri*, and as is also occasionally found (see examples in the Museum) in the seventh vertebra of the same animal.

	millim.		millim.
Extreme length of centrum	38	Length in median line	34
" width "	27	" "	18
" depth "	10	" "	6

Shoulder-girdle.—Two right and five left can without difficulty be referred to *T. triserrata*. Of these there is nothing worthy of notice.

Of the three right and three left which are supposed to belong to *T. inepta*, two are of unusually large size. One right shoulder-girdle, marked $\frac{21.7.66}{92}$ (Pl. XIII. fig. 7), has the *coracoid ankylosed*: though this character is supposed to be peculiar to *T. triserrata*, yet it is found, probably as an individual variation, in this specimen, the compressed

curved precoracoid ("acromion") &c. proving it to be *T. inepta*. This peculiarity can be paralleled with the case of the corresponding bone of the Rodriguez tortoise.

There is no fresh example of *T. inepta*, var. *Boutoni*.

T. inepta.

	A. millim.	B. millim.	millim.	millim.
Length of scapula (measured from the suture with coracoid)	177	170	..	..
Circumference in its middle	72	72	..	..
Longitudinal diameter of glenoid cavity	40 (worn)	40	..	..
Length of precoracoid (acromion)	95	92	..	..
Length of coracoid	..	..	102	91
Greatest width of coracoid	..	..	69	broken
Least circumference of shaft of coracoid	..	..	49	50

The great amount of variation in the shape of the coracoid in *T. triserrata* is worthy of special attention. Though all the well-marked specimens in our collection have passed through the hands of Dr. Günther, he only remarks (*l. c.* p. 46) that "the coracoid lamina [is] sometimes deeply grooved." The amount of the variations can be well understood by reference to Plate XIII. figs. 1-5.

The anterior side is sometimes produced into a long spur. The posterior may become straight rather than bowed for the greater portion of its length, as may also the internal edge ('epicoracoid' region). The shaft may be narrow, or broad and flattened; but it is in the blade that we see the greatest variations. This may be almost smooth, concave above, and gently convex on its inferior surface, as in the typical example (Günther, pl. xxiv. fig. B), or flat superiorly, with the concave inferior surface traversed by prominent longitudinal ridges, or convex on the upper surface, with the concave lower surface strongly marked by prominent palmated ridges. The interspaces may become so thin as to be more or less perforated.

The relative measurements of these bones also vary very considerably, as the following table shows:—

	A (type). millim.	B. millim.	C. millim.	D. millim.	E. millim.
Length of coracoid	74	75	66	76	76
Greatest width of coracoid	61	71	63	58	67
Least circumference of coracoid ..	54	66	47	62	63

It will thus be seen that while the length averages about the same, the width and circumference of the shaft vary greatly, the normal proportions being, length of coracoid *n*, breadth *n*—9, circumference *n*—15.

The study of all these variations irresistibly calls to mind the remarks of Messrs. A. and E. Newton*, the truth of which has been subsequently confirmed by the latter gentleman and Mr. J. W. Clark†, in their respective memoirs on the osteology of the extinct Didine bird of Rodriguez, as to the wonderful variability of that species. To quote the former:—"There does not seem to be a single bone in the skeleton of *Pezophaps solitaria* which is not liable to greater or less individual variation of some kind or other, . . . but

* "On the Osteology of the Solitaire or Didine Bird of the Island of Rodriguez, *Pezophaps solitaria* (Gmel.)." By Alfred Newton, M.A., and Edward Newton, M.A. Phil. Trans. 1869, p. 330.

† "On the Osteology of the Solitaire (*Pezophaps solitaria*, Gmel.)." By Edward Newton, C.M.G., and John Willis Clark, M.A., Superintendent of the Museum of Zoology and Comparative Anatomy in the University of Cambridge. Phil. Trans. vol. 168, p. 451.

the individual variation is not at all confined to absolute size; it extends to the relative proportion of divers parts of the bones, to processes or depressions upon them, such as are commonly held to be specifically characteristic, so that it is often utterly impossible to predicate any definite limits of individual modification. . . . Nor is the variability of which we speak wholly dependent on age or sex."

To find that the same results attend the examination of these Tortoise-remains cannot fail to suggest the possibility that when a sufficient series of specimens of *any animal* is compared a similar amount of variability may be observed; and if this consideration should lead to nothing else, it should at least make us, in many cases, hesitate about describing a new species of vertebrate from a single bone, or even from several fragments.

A second variety of coracoid has been added, which, since it is free, may be safely referred to *T. inepta*; of this we have three examples, one, however, being fragmentary. They differ from the former type in both form and size (Pl. XIII. fig. 6). The absolute length is much greater than in *T. triserrata*; the neck is more slender, and the posterior edge straighter, as is also the internal margin. Even in these few examples we see ample evidence of tendency to variation. The great difference of the length of this bone in the two species is well seen by averaging the relative proportions; for taking the length of the coracoid to be n , the average breadth would be about $n-30$, and the least circumference $n-47$.

Humerus.—Six right and eight left belong to Dr. Günther's group *a* (*T. triserrata*).

Two right and four left of *T. inepta* (group *c*); one of the latter is of enormous size. In one or two examples the hollow behind the head is extremely shallow, as in Dr. Günther's group *b*, thus showing that the latter is merely a variation; indeed it is often rather difficult to distinguish between humeri supposed to belong to the two kinds of tortoises.

	<i>T. triserrata</i> . millim.	<i>T. inepta</i> . millim.
Length of humerus from summit of head to middle of trochlea	175	250
Narrowest circumference	70	112
Longest diameter of head	43	50
Shortest diameter of head	34	35
Extreme breadth between condyles	71	83

Ulna.—Three right examples apparently belonging to the same species.

	millim.
Extreme length	114
Narrowest circumference	44

Radius.—Three specimens, only one of which is perfect. Dr. Günther's types *a* and *c* may be easily recognized. The one right, *a*, has a rather slender shaft.

One well-marked right example of *c*; the other, left, is only a distal fragment; it would, however, be somewhat larger.

	<i>c</i> . millim.
Length of radius	175
Circumference in narrowest part	38
Longitudinal diameter of semilunar facet	30
Transverse diameter of semilunar facet	20

Pelvis.—*T. triserrata*. We have two pelves nearly perfect, three fragments, and one right pubis. Two are of great size; although one of these is of such large size, yet the os ilium is very narrow and thin. This is probably due to bone-absorption owing to age. The terminal portion of the pubic process is flattened horizontally, and is surrounded laterally by a deep groove.

The distinctive characters of *T. leptocnemis* appear of too slight a character to be of great certainty, especially as no perfect pelvis is known.

T. inepta. Our previous collection of portions of a male and female pelvis has been greatly enriched by the addition of four perfect pelves and of three halves. There is one immense os ilium, which is very broad but much compressed, and evidently belonged to a very old male. There is a femur probably belonging to this pelvis.

	<i>T. triserrata</i> .		<i>T. inepta</i> .	
	millim.	millim.	millim.	millim.
Longest inner vertical diameter of pelvis from summit of ilium to symphysis	156	..	138	..
Longest inner horizontal diameter of pelvis	..	..	120	..
Shortest inner horizontal diameter of pelvis between ilio-pubic prominences	..	..	80	..
Longest diameter of foramen obturatorium	..	..	36	..
Width of symphysial bridge	..	..	25	..
Breadth of posterior portion of ossa ischii	..	..	55	..
Length of os ilii	140	..	108	147
Least width of os ilii	29	..	25	40
Proximal width of os ilii	..	..	54	85+

Femur.—The sixteen new examples have so much the same facies that it is impossible to distinguish between the two species. There does not seem to be a specimen of *T. leptocnemis*.

	millim.
Length of femur	194
Least circumference	90
Width of condyle	73

This femur probably belongs to *T. inepta*.

Tibia.—Two right and two left. These show no peculiarity, except that one is stouter than the others.

	millim.
Length of tibia	144
Circumference, least	55
Breadth at upper end	46

II. TESTUDO VOSMÆRI. Rodriguez.

All the remains from this island are referable to one species only, notwithstanding the large series of bones examined. The experience of Dr. Günther points to the same conclusion.

Skull.—The additions to our previous fragment consist of one imperfect specimen of large size, two occipital crests, and one very perfect example of a young individual, the lower jaw being also present.

The largest probably measured $11\frac{1}{2}$ millim. long.

Carapace.—There are two small carapaces, with their plastra, one being very perfect, and the posterior marginal plates of a third and large example; also two

plastra of small size, and a portion of a much larger one. In all the thinness of the bones is very remarkable.

Length of Carapace.		Width of Carapace.		Sternum.		Caudal plate.	
In straight line.	Over curve.	In straight line.	Over curve.	Length.	Width.	Length.	Width.
millim.	millim.	millim.	millim.	millim.	millim.	millim.	millim.
13 $\frac{3}{4}$	16 $\frac{1}{2}$	9 $\frac{1}{2}$	17 $\frac{3}{4}$	9 $\frac{3}{4}$	7 $\frac{3}{4}$	1 $\frac{1}{4}$	3 $\frac{1}{4}$
..	..	9 $\frac{1}{2}$ +	..	..	9	1 $\frac{9}{16}$	3

Vertebral column.—We have 74 specimens of cervical vertebræ, all being well represented except the 1st, of which no example is known. The 6th does not present the foramen noticed by Günther (*loc. cit.* p. 57; also *Ann. & Mag. N. H.* 1873, xi. p. 397); for out of our 13 specimens of this bone only one has a perforation, which is very small, and might even be accidental. The foramen apparently only occasionally is present, and that only in old animals.

There are several examples of dorsal and caudal vertebræ.

In the majority of cases it has been impossible to distinguish between the slender and the stout varieties. There is a certain amount of variation in the size of the hæmal spine, in the thickness of the centrum, &c.

	2nd.	3rd.	4th.	5th.	6th.	B.		7th.	8th.
	millim.	millim.	millim.	millim.	millim.	millim.	millim.	millim.	millim.
Length of centrum.....	39	51	66	51	60	64	50	41	
Depth of centrum in the middle	10	9	9	10	14	13	18	10	
Horizontal width of middle of centrum	7	8	10	9	16	18	17	18	
Width of anterior condyle.....	12	broken	14	..	..	..	..	40	
Width of anterior glenoid cavity	..	..	..	20	15	..	26	..	
Width of posterior condyle	1	..	18	18	13	..	..	20	
Width of posterior glenoid	12	15	..	..	..	..	31	..	
Distance of outer margins of anterior zygapophyses.....	16	broken	25	20	29	..	25	30	
Distance of outer margins of posterior zygapophyses.....	20	23	23	19	broken	..	28	37	

Shoulder-girdle.—There is great uniformity about these bones, the chief degrees of variation being in the form of the transverse section of the scapula near the glenoid fossa. The general form of the precoracoid ("acromion") reminds one of the same bone in *T. triserrata*, in being laterally compressed proximally, and vertically compressed distally. In his monograph, Dr. Günther remarks (p. 59), "It must be mentioned that there are in the collection a right and a left scapula, evidently belonging to the same individual, which differ remarkably from all the others in not having the coracoid ankylosed, although the individual appears to have been fully adult, and in having the body of the scapula proper uniformly compressed. It is difficult to account for this apparently individual aberration." Now, out of the 85 scapulæ in our collection, there are 32 in which the coracoid is ankylosed to the remainder of the shoulder-girdle, leaving 53 in which that bone is distinct; of these, 23 are of larger size than the smallest of the ankylosed bones, several being considerably so. Thus it seems to be a characteristic of this species for the coracoid to be very irregular in its ankylosis with the coraco-scapula.

It is interesting to note that in one example there is a tendency towards the formation

of a coracoid foramen by ossification from the coracoid and precoracoid extending into the epicoracoid region.

	Coracoid ankylosed. millim.	Coracoid free. Total. (Large examples.) millim.	millim.	Total. millim.
Right	9	29	(11)	38
Left	23	24	(12)	47
Total.....	32	53	(23)	85

	Coracoid fused.			Coracoid free.	
	A. millim.	B. millim.	C (smallest). millim.	millim.	millim.
Length of scapula measured from the suture with the coracoid	105	..	75	132+	..
Circumference in its middle	35	40	8	50	..
Longitudinal diameter of glenoid cavity	24	30	19	30+	..
Length of coracoid.....	49	..	35	..	60
Greatest width of coracoid	38	..	27	..	48
Length of precoracoid (acromion).....	48	..	39	50+	..

Humerus.—There is nothing peculiar in our 54 specimens, the largest bone measuring :—

	millims.
Length (measured in a straight line from the summit of the head to the middle of the trochlea) ..	171
Circumference of the narrowest part of the shaft	62
Longest diameter of head	33
Shortest diameter of head	29
Extreme breadth between the condyles.....	50+

Pelvis.—Most of our examples are young, the symphysial bridge still being very narrow.

Femur.—One of the 88 femurs is of gigantic size :—

	millim.
The extreme length being	166
The least circumference	68

In conclusion, I would draw the attention of herpetologists to these collections of Mascarene Tortoise-remains, now in the Zoological Museum at Cambridge, since they form by far the most complete series of specimens of these very interesting extinct reptiles. I also add my best thanks to Prof. Newton for his kind help whilst preparing these notes.

For the convenience of those who may wish to prosecute further the study of these animals, as well as to show the amount of materials on which the present remarks are based, I append a list of the specimens in the Museum of the University which I have consulted.

Testudo triserrata. Mauritius.

6 skulls and 2 lower jaws. (C.)	One figured, Günther, pl. xxiii. fig. A.
1 skull.	New Coll.
4 humeri, right. (C.)	
6 „ „	New Coll.
2 „ left (C.)	

- 8 humeri, left. New Coll.
 11 shoulder-girdles, right. (C.)
 2 " " New Coll.
 10 " left. (C.) One figured, Günther, pl. xxi. fig. b.
 5 " " New Coll.
 7 pelves (or portions). (C.) One figured, Günther, pl. xxviii. fig. c; 2 others mentioned.
 6 " " New Coll.
 2 portions of carapaces. (C.)
 5 plastrons, adult male. See Günther, p. 45. One figured, pl. xx. fig. e.
 1 carapace. Figured, Günther, pl. xx. fig. d.

Sp. incert. Mauritius.

- 1 femur, left. (C.)
 8 " " New Coll.
 6 " right. (C.)
 8 " " New Coll.
 3 tibiae. New Coll. (One C.)
 2 " "
 2 radii. "
 1 " "
 3 ulnae. "
 1 portion of plastron.
 1 " 7th cervical vertebra.

Testudo inepta. Mauritius.

- 5 skulls and 2 lower jaws. (C.) 1 skull and jaw, figured Günther, pl. xxiii. fig. b.
 1 lower jaw. New Coll.
 3 humeri, right. (C.)
 2 " " New Coll.
 3 " left. (C.)
 4 " " New Coll.
 1 coraco-scapula, right. (C.)
 2 " " New Coll.
 1 " left. (C.) *T. Boultoni*, var.
 4 " " New Coll.
 3 coracoids. New Coll. (2 right and 1 left.)
 2 pelves (or portions). (C.)
 8 " " New Coll.
 Portions of one carapace.

	<i>T. triserrata.</i>	<i>T. inepta.</i>	<i>Sp. incert.</i>	Total in each collection.
Old collection (C.)	48	15	10	73
New collection	28	24	26	78
Total of each species	76	39	36	151

Testudo Vosmæri. Rodriguez.

	Old Collection.	New Collection (1879).	Total.
2nd cervical vertebra	6	2	8
3rd " "	7	2	9
4th " "	9	1	10
5th " "	8	4	12
6th " "	11	2	13
7th " "	12	3	15
8th " "	5	2	7
1st dorsal "	2	1	3
Dorsal "	7	..	7
Sacral "	3	..	3
Caudal "	7	..	7
Right shoulder-girdle	13	3	16
Left " "	6	9	15
Right coraco-scapula <i>only</i>	14	19	33
Left " "	21	10	31
Right coracoid	3	1	4
Left " "	5	2	7
Right humerus	26	27	53
Left " "	20	27	47
Right radius	20	2	22
Left " "	17	7	24
Right ulna	20	5	25
Left " "	17	6	23
Pelvis	5	1	6
Portions of pelvis	33	33	66
Right femur	21	17	38
Left " "	18	32	50
Right tibia	19	2	21
Left " "	17	12	29
Right fibula	10	4	14
Left " "	7	3	10
Phalanx terminal	1	..	1
Skull	1 and lower jaw.	2 and fragments.	3
Carapace	..	2 and 1 fragment.	2
Plastron	..	2	2
Ribs	3	5	8
Total	394	250	644

DESCRIPTION OF PLATE XIII.

Figs. 1, 2, 3. Under surface of left coracoid of *Testudo triserrata* (fig. 1, type specimen).

Figs. 4, 5. Under surface of right " "

Fig. 6. Upper surface of right coracoid of *Testudo inepta*.

Fig. 7. Anterior view of right shoulder-girdle of variety of *T. inepta*.

(All of natural size.)

Fig. 2.

Fig. 3.

Fig. 1.

Fig. 4.

Fig. 6.

Fig. 7.

Fig. 5.