Ultrasound, a useful tool for health assessment in crocodilians

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Health assessment

- For clinical purpose or for research, the health of individuals, or populations of, crocodiles needs to be assessed
- That is difficult because of : species-specific characteristics, lack of data and lack of experience

General examination

Body score, external appearance, behavior, integrity of limbs, dental hygiene, palpation, auscultation,

Special examination

- Parasites, CBC and chemistry, imaging, others

General examination, Body score



General examination, Body score

- Chronic disease vs. recent disease?
  - Overall size, neck and tail girth



This fat looking Nile crocodile was one of the Kruger crocs affected by pansteatistis. Its GIT was empty and it is very unlikely that it had been feeding over the past several months(?)





General examination

Auscultation, percussion and palpation are of more limited value than in (most) mammals.

Difficult to interpret how existing lesions actually impact a crocodile's survival







Septic status?

- No lymph nodes to assess
- Poorly accessible mucosae
- Superior resistance to infection and tendency to seal off infections
- Pathogenic parasites?







Teeth are used as indicator of stress, not scientifically verified



does dental/oral integrity affect survival?







Blood values?

- Lack of specific studies linking disease with blood picture
- Lack of specific studies linking blood picture to systems insult/integrity
- Poor reflection of sepsis on hematology and chemistry
- No automated hematology
- Lack of commercial serology/diagnostic kits

2012 Effect of venipuncture site on hematology and serum biochemical parameters in Chinese alligator (Alligator sinensis),

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Aim

The aim of this study was to measure CBC and serum chemistry of blood collected from 3 different venipuncture sites and to calculate bias between these sites.

Introduction

Complete blood count and serum biochemistry are commonly used to assess health status and response to treatment. References values, validity, sensitivity or specificity of the various blood parameters are incompletely understood in crocodilians.

Blood values are affected by extrinsic factors such as season, temperature, husbandry and, directly related to this study, venipuncture site[4]. Understanding the effect of venipuncture site allows better interpretations and comparisons of blood results.

In crocodilians, blood is typically obtained from the tail vein (ventral coccygeal) or the neck (supra-vertebral vein). We included a third site, discovered by the author and as yet unpublished, the mandibular shelf sinus.

Potential dilution of the blood by lymph or CSF is an ever present possibility, complicating interpretation.

Manual counts for the CBC carries a degree of variability (of the order of 10% for competent technicians), bigger than what one would encounter with automated cell counters (less than 5%).

Method

4 healthy Chinese alligators (*A. sinensis*) were restrained manually and bled from the tail vein, supra-vertebral sinus and mandibular shelf within 5 minutes. There were 24 sampling events.

Lithium heparinized blood samples were used for hematological and biochemical examinations. The evaluation of samples involved determination of the packed cell volume (PCV) by microchematocrit centrifugation. Total erythrocyte count and total leukocyte count were based on manual hemacytometer-counting system using Natt-Herrick solution[1]. The leukocyte differential count and cells morphology[2&3] was done manually from blood smears stained with Romanowsky-Wright's stain.
Haemoglobin (Hb) was determined by cyanmethemoglobin method[3].
Heparin plasma samples for chemistry profile were processed in-house using standard methods and reagents (Dimension Xpand Plus™ analyzer, Siemen Healthcare Diagnostics Inc., Glasgow, USA).

Mean, Standard Deviation and Coefficient of variation were calculated where CV= Mean/SD

Biais of site a over site b

∎

Results

Differences exist between sites, although the statistical analysis is in progress and not reported here. Differences could not be explained by lymph or CSF dilution alone as the bias is not unidirectional

WBC are more abundant in the peripheral vessels than in the large supra-vertebral vein (bias 14%)

Continual high bias for the differential count may be the result of changes in cell appearance at different sites increasing variability in identification, adding variability to the count

The bias for LDH , ALP, CK and GGT may be the result of differences in vascular flow rate and RBC permeability or perivascular trauma when locating the vessels.

Important diagnostic parameters such as uric acid, TP, electrolytes, etc vary little between sites

	Sex	Length	Mass
Alligator 1	F	1.25	8.706
Alligator 3	M	1.525	12.69
Alligator 4	F	1.13	5.43
Alligator 5	F	1.25	7.732





hematologic parameters of *Alligator sinensis* from 3 venipuncture sites

	ventral coccygeal			supravertebral vein			oral venous sinus					
parameters (units)	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	relative bias tail / mouth	relative bias tail / neck	relative bias neck / mouth
RBC (x10^6/ µl)	0.45	0.09	20%	0.45	0.08	18%	0.42	0.09	21%	8%	0%	8%
Hemoglobin (g/dl)	9.32	1.26	14%	9.43	1.06	11%	9.66	1.42	15%	-4%	-1%	-2%
PCV (%)	24.14	3.16	13%	25.40	2.12	8%	24.35	2.31	9%	-1%	-5%	4%
MCV (fL)	550.49	106.82	19%	580.97	112.37	19%	598.92	87.45	15%	-8%	-5%	-3%
MCH (pg)	212.95	43.71	21%	215.00	39.18	18%	238.43	48.73	20%	-11%	-1%	-10%
MCHC (g/dl)	38.48	3.11	8%	37.04	2.72	7%	39.73	4.67	12%	-3%	4%	-7%
WBC (µl)	5163	2221	43%	4520	1018	23%	5278	3685	70%	**-2%**	**14%**	**-14%**
heterophils (%)	35.45	3.64	10%	45.30	13.09	29%	40.80	8.34	20%	**-13%**	**-22%**	**11%**
lymphocytes(%)	33.55	11.70	35%	19.60	11.36	58%	27.70	13.66	49%	**21%**	**71%**	**-29%**
monocytes (%)	7.09	4.55	64%	8.89	4.86	55%	7.00	4.81	69%	**1%**	**-20%**	**27%**
Eosinophils(%)	1.27	1.79	141%	0.60	1.26	211%	1.00	2.21	221%	**27%**	**112%**	**-40%**
Basophils(%)	11.82	6.27	53%	16.90	7.00	41%	16.80	10.78	64%	**-30%**	**-30%**	**1%**
Azurophils(%)	7.10	3.93	55%	6.67	4.30	65%	7.44	3.43	46%	-5%	6%	-10%





serum chemistry parameters of *Alligator sinensis* from 3 venipuncture sites

	ventral coccygeal			supravertebral vein			oral venous sinus					
parameters (units)	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	relative bias tail / mouth	relative bias tail / neck	relative bias neck / mouth
sodium (mmol/L)	149.5	4.9	3%	149.0	7.4	5%	146.5	3.1	2%	2%	0%	2%
potassium (mmol/L)	3.7	0.6	17%	3.9	0.6	15%	3.7	0.2	5%	-2%	-5%	4%
chloride (mmol/L)	110.8	4.0	4%	109.2	5.3	5%	108.0	2.2	2%	3%	1%	1%
Calcium (mmol/L)	4.8	2.3	47%	4.6	2.1	46%	4.7	2.2	46%	2%	4%	-2%
Phosphorus (mmol/L)	1.5	0.4	29%	1.5	0.4	26%	1.4	0.4	27%	5%	2%	3%
Total protein (g/l)	69.2	7.1	10%	69.2	6.0	9%	69.0	6.3	9%	0%	0%	0%
albumin (g/l)	22.5	1.3	6%	22.6	0.8	4%	23.0	1.8	8%	-2%	0%	-2%
globulin (g/l)	46.8	6.8	15%	47.1	7.1	15%	46.2	6.0	13%	1%	-1%	2%
A/G	0.5	0.1	13%	0.5	0.1	17%	0.5	0.1	14%	-3%	0%	-3%
Glucose (mmol/l)	5.1	1.1	21%	5.5	0.6	12%	4.9	0.5	11%	5%	-7%	12%
Urea (mmol/l)	0.6	0.2	35%	0.6	0.2	24%	0.6	0.2	30%	9%	-2%	11%
Creatinine (mmol/l)	29.8	12.7	43%	31.7	12.5	39%	29.1	9.7	33%	3%	-6%	9%
AST (U/L)	120.8	36.3	30%	112.6	25.4	23%	114.9	36.6	32%	5%	7%	-2%
ALT (U/L)	111.8	28.6	26%	109.7	23.1	21%	108.7	21.6	20%	3%	2%	1%
LDH (U/L)	132.8	119.7	90%	78.0	23.7	30%	148.2	71.6	48%	**-10%**	**70%**	**-47%**
ALP (U/L)	56.7	21.5	38%	44.2	10.1	23%	57.0	9.2	16%	**-1%**	**28%**	**-22%**
CK (U/L)	887.5	1435.0	162%	91.6	60.0	66%	81.2	50.3	62%	**993%**	**869%**	**13%**
Cholesterol (mmol/l)	3.4	1.4	42%	3.2	1.6	49%	3.1	1.5	46%	9%	8%	1%
GGT (U/l)	15.8	17.2	108%	8.4	4.3	52%	8.0	3.4	42%	**98%**	**88%**	**5%**
Uric acid (µmol/l)	90.2	41.0	45%	93.4	40.2	43%	94.4	33.6	36%	-4%	-3%	-1%
Bile Acid (µmol/l)	12.1	4.5	37%	8.0	4.1	51%	9.0	2.4	27%	**35%**	**52%**	**-11%**

Conclusion

Choice of venipuncture site in the Chinese alligator affects such parameters as WBC, LDH, ALP, CK, GGT and bile acids. Blood results should be interpreted accordingly when trying to establish health status and response to treatment.

References

[1]Sykes JM, Klaphake E (2008). Retile Hematology,

Distribution of seven tissue enzymes in *Crocodylus porosus* 2012

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Introduction

In domestic animals serum levels of tissue enzymes are used to diagnose a number of tissue insults, including liver, kidneys, muscle, and heart disease.

In crocodile medicine there are no studies correlating known diseases or lesions with changes in blood chemistry. For the most part, extrapolation and assumptions replace veracity and certainty.

There are no reports of the distribution of enzymes in the tissues of crocodilians.

Aim

The aim of this study was to determine the distribution of seven serum enzymes in the tissues of estuarine crocodiles.

Method

Samples of fat body, muscle, liver, lung, kidney and spleen, were collected from 10 apparently healthy slaughter-size estuarine crocodiles, *C prorosus*, at a facility in Papua New Guinea. Brain was also collected from 5 of these. All tissues were suspended in Phosphate buffer saline and homogenized using the technique described by Deborah ,to break cell walls and release cellular content.

Total Protein, AST, ALT, LDH, ALP, CK, GGT and SDH levels were measured using wet chemistry (Dimension Xpand Plus™, Siemen Healthcare Diagnostics Inc., Glasgow, USA)

The results are expressed in concentration of enzyme /g protein in the tissue.

ID	Gender	Age	Body weight, kg	Total length cm
F18	M	3.8 Y	24.1	192
AG44	M	3.9 Y	16	198
BY27	F	unk	8.5	163
S5	M	3.6 Y	22	196
T18	F	unk	24.1	192
U7	M	3.7 Y	14.7	172
U8	M	3.9 Y	17.6	186
AG41	F	3.6 Y	15.6	177
BP6	F	unk	9.7	155
B21	F	3.5 Y	11	163

Results

The technique was fit for the purpose of measuring enzyme levels in homogenized tissue

AST was prevalent in Kidney and Liver. ALT was much higher in liver than in all other tissues. LDH is highest in the skeletal muscle but is also high in the fat body and kidneys. ALP levels are by far highest in the spleen, followed by the kidney. CK is most abundant in both muscles and CNS. GGT was very low in the liver and is abundant in the kidneys, though it was also found in the fat body. SDH levels were comparable in kidneys, fat body and liver.

One animal (S5) had elevated levels of all the enzyme in its lung tissue, suggesting the processed sample may have been the siege of pulmonary pathology.

Another crocodile (BY27) had elevated levels of all the enzyme in its skeletal muscle, suggesting the processed sample may have been the siege of muscle pathology.

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	Protein	AST	ALT	LDH	ALP	CK	GGT	SDH
ID: BR6	mg/L	U/g prot	U/g prot	U/g prot	U/g prot	U/g prot	U/g prot	U/g prot
CNS								
Fat	161.8	0.754	0.2534	4.9876	0.1236	0.6304	0.0247	0.0661
Kidney	3930.5	1.3179	1.6235	1.4739	0.1504	2.7373	0.0252	0.0216
Liver	4249.9	1.2313	0.064	0.9661	0.1781	0.0798	0.0061	0.0217
Lung	2416.1	0.2376	0.0224	0.6742	0.0683	3.2197	0.0083	0.0039
muscle	2498.2	0.3851	0.0232	9.3003	0.0152	125.16	0.008	0.0017
Spleen	3310.7	0.3966	0.0251	1.0847	1.5534	0.457	0.0051	7E-05
ID: U7								
CNS								
Fat	167.5	0.5851	0.0836	2.8179	0.0358	1.0149	0.0179	0.0115
Kidney	4026.4	1.4395	3.1847	2.0674	0.2879	3.2888	0.0375	0.0188
Liver	3471.2	1.1878	0.0527	0.8732	0.0539	0.1023	0.004	0.019
Lung	2348.2	0.2572	0.017	0.6439	0.0673	3.4737	0.003	0.0016
muscle	2297	0.5481	0.0239	10.917	0.003	139.87	0.0009	0.001
Spleen	3190.3	0.4708	0.0288	0.9601	1.6077	0.1069	0	0.001
ID: AG41	Protein	AST	ALT	LDH	ALP	CK	GGT	SDH
CNS								
Fat	137.2	0.4665	0.102	1.9169	0.0219	0.6341	0.0146	0.0117
Kidney	1569.2	1.5345	4.8349	3.3208	0.2944	4.2353	0.0459	0.0227
Liver	1520.2	1.1709	0.0526	0.892	0.2079	0.1105	0.0046	0.0189
Lung	946.6	0.2821	0.0254	0.6793	0.0444	3.128	0.0042	0.003
muscle	1128.7	0.3951	0.0204	12.857	0.0062	117.98	0.0044	0.0014
Spleen	1289.7	0.3776	0.0194	0.9219	2.1261	0.1233	0.0008	0.0013
ID: B21								
CNS								
Fat	59.5	0.7227	0.1849	3.3109	0.1008	0.7395	0.084	0.0266
Kidney	1795	1.3994	2.6485	1.7203	0.2763	4.2284	0.0373	0.022
Liver	1253.1	1.1228	0.0463	1.3439	0.1468	0.1524	0.0016	0.0115
Lung	891.9	0.2915	0.0258	0.8196	0.0549	3.7953	0.0067	0.0019
muscle	1177.1	0.4044	0.0221	12.308	0.0051	116	0.0008	0.0005
Spleen	1572	0.3263	0.0165	1.035	1.7093	0.1349	0.0013	0.0007
ID: BY27	Protein	AST	ALT	LDH	ALP	CK	GGT	SDH
CNS								
Fat	148.5	0.4848	0.0875	2.2222	0.0404	0.2424	0.0269	0.0036
Kidney	1441	1.3116	0.0534	1.433	0.0743	0.1617	0.0056	0.0166
Liver	905.7	0.5443	0.0353	3.266	0.0077	0.2562	0.0022	0.0025
Lung	1060.1	0.2424	0.0217	0.6754	0.0594	1.8866	0.0047	0.002
muscle	1789.8	1.4432	1.8689	1.5734	0.19	56.134	0.0402	0.012
Spleen	1535	0.456	0.0228	1.1759	1.9831	0.1922	0.0033	nd
ID: T18								
CNS	1325.7	1.2114	0.0377	1.0726	0.0596	9.3822	0.0015	0.0021
Fat	74.7	0.5489	0.174	2.3025	0.0669	1.071	0.0268	0.0234
Kidney	2023	1.259	5.5764	2.911	0.439	3.739	0.0667	0.0211
Liver	1398.8	1.1782	0.0508	0.9723	0.0979	0.1108	0.0043	0.0167
Lung	1055.3	0.1744	0.0208	0.4567	0.0493	2.0203	0.0038	nd
muscle	1121.1	0.421	0.025	0.2399	0.0009	48.433	0.0027	0.0014
Spleen	nd	nd	nd	nd	nd	nd	nd	nd
ID: S5	Protein	AST	ALT	LDH	ALP	CK	GGT	SDH
CNS	1287.1	0.9976	0.0458	0.9494	0.0979	7.945	0.0016	0.0016
Fat	101.3	0.4541	0.1382	1.9645	0.0494	0.7305	0.0197	0.0218
Kidney	2155.2	1.4365	4.1073	3.0174	0.4844	2.758	0.0464	0.0276
Liver	1588.1	1.2241	0.0548	0.9785	0.0718	0.124	0.0038	0.0187
Lung	92.42	2.9972	0.3462	8.2991	0.5518	37.86	0.0541	0.0291
muscle	1225.2	0.0392	0.0294	13.141	0.0041	122.31	0.0016	0.0016
Spleen	1470.4	0.4421	0.0252	1.2616	2.1477	0.0952	0.0014	0.0011
ID: F18								
CNS	1337.2	1.462	0.0479	1.198	0.0867	9.2058	0.0015	0.0017
Fat	104.6	0.5641	0.2008	3.0688	0.0574	0.2868	0.0191	0.0176
Kidney	1703.3	0.3117	5.086	1.8458	0.3617	4.6827	0.0499	0.0158
Liver	1556.6	1.1885	0.0533	1.0009	0.0944	0.1221	0.0058	0.0201
Lung	945.9	0.2918	0.0391	0.7041	0.0571	3.2488	0.0053	0.0032
muscle	1072.3	0.5334	0.0336	12.22	0.0037	125.44	0.0019	0.0018
Spleen	1430.4	0.3635	0.0182	1.0906	1.3038	0.1237	0.0007	0.0016
ID: U8	Protein	AST	ALT	LDH	ALP	CK	GGT	SDH
CNS	580	0.1034	0.0207	0.0155	0.031	4.7483	0.0052	0.0014
Fat	37.2	nd	0.2957	0.0269	0.0806	nd	0.0538	nd
Kidney	724.1	0.0718	0.7982	0.0055	0.2652	0.3328	0.0525	0.0017
Liver	494.8	0.0687	0.0263	0.0061	0.093	0.002	0.0081	0.0028
Lung	295.9	0.0101	0.0338	0	0.1994	1.2335	0.0169	nd
muscle	385.8	0.0959	0.0259	0.4951	0.0207	381.78	0.0078	0.0005
Spleen	543.5	0.0129	0.0202	0.0018	1.827	0.333	0.0074	0.001
ID: AG44								
CNS	1331.2	1.3447	0.0406	1.0832	0.0601	9.6605	0.003	0.002
Fat	168.5	0.4629	0.0772	2.9139	0.0534	0.3858	0.0059	0.0062
Kidney	1444.3	0.8405	1.4173	1.4028	0.1856	3.0575	0.0789	0.0088
Liver	1992.8	1.3233	0.0687	1.1225	0.0216	0.1004	0.0065	0.0111
Lung	1282.1	0.2356	0.0211	0.6653	0.0663	2.0521	0.0047	0.0017
muscle	880.9	0.3247	0.0534	12.89	0.0068	110.36	0.0045	0.0032
Spleen	1439.4	0.4127	0.0257	0.9949	1.6229	0.1966	0.0035	0.0016

Discussion

Results invite us to hypothesize that renal disease may cause a concurrent increase of all enzymes, with ALT being the indicative enzyme.

Increases in AST and CK may be indicative of CNS lesions rather than muscle as AST is very low in muscle. However that may be countered by the potentially large volume of injured muscles)

The high concentration of CK in the Central Nervous system may prove relevant to studies showing a marked increase in serum CK after stunning (Martelli, unpublished data).

GGT was very low in the liver and could be indicative of renal and fat tissue lesions

Two animals in this study (BY27 and S5) were found to have unusual distribution of enzyme activity, suggesting morbid process of the lung and liver respectively. Unfortunately we did not have serum or biopsies from these animals to be able to relate serum biochemistry to eventual organ lesions. Such studies ultimately are needed to verify what serum enzymes changes indicate what organ lesions.

	AST	ALT	LDH	ALP	CK	GGT	SDH
CNS	5/5				**5/5**		
Fat		6/10	8/10			7/10	7/10
Kidney	8/10	**9/10**	5/10	9/10	7/10	9/10	8/10
Liver	8/10		1/10	2/10			9/10
Lung*	1/10	1/10	1/10	2/10	10/10	1/10	1/10
Muscle^	1/10	1/10	**8/10**	1/10	**10/10**	1/10	1/10
Spleen				**9/9**			

References

Deborah AF, Mazet JAK, Gulland FMD, Spraker TR, Christopher MM (2008) Distribution of tissue enzymes in three species of pinnipeds. Journal of Zoo and Wildlife Medicine 39(1):1-5.

Acknowledgements

We wish to thank David Wilken and Eric Langelet from Mainland Holdings for providing access to tissue samples





Can ultrasonography overcome some/many of the species-specific limitation ?

- **Aim of our study:**
  - **describe access windows**
  - **Ultrasonography Topography**
  - **Ultrasonography Appearance**
  - **Can we correlate ultrasound findings with organ appearance, size and health**







Material and method

- Bulk of study on 3.12 *C siamensis* from Chimelong Crocodile farm (Guandong, China), TL 136 to 260, av: 202
- Aditional data from C siamensis, C porosus hatchlings, A sinensis, T schlegelli





Material and method



- Easote MyLab30cv, 3.5 MHz to 6 MHz probe for transcutaneous ultrasound on live subjects
- Focused on viscerae excluding lungs
- Right and left flanks and ventral approach
- Slaughtered humanely and immediately necropsied.
- Finer organ ultrasound examination with 10-18 MHz
- Compare to CT and frozen sections







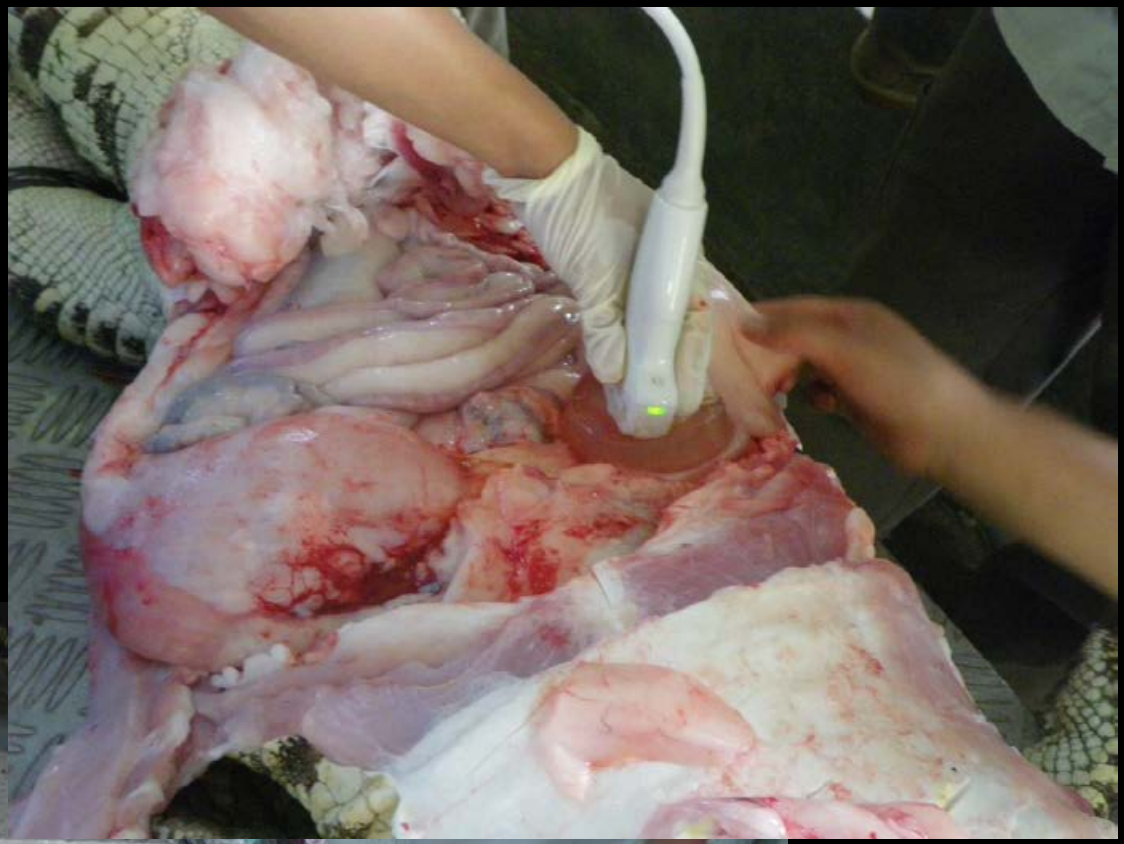








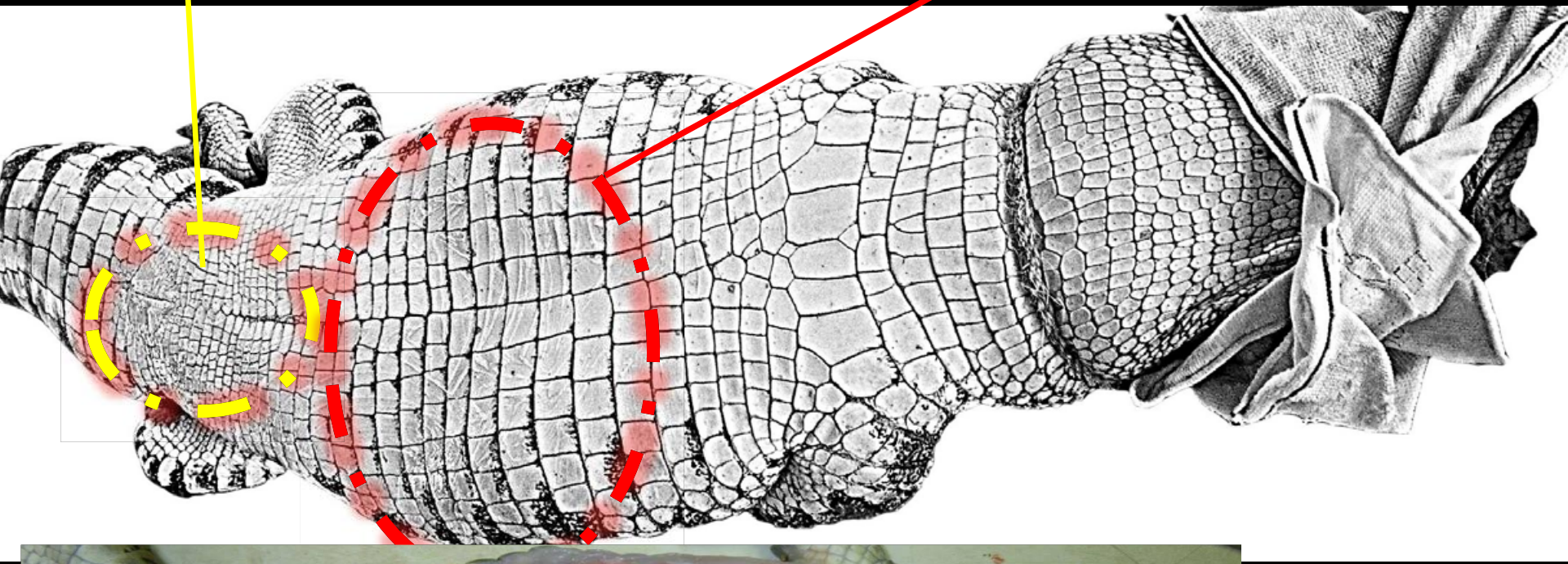
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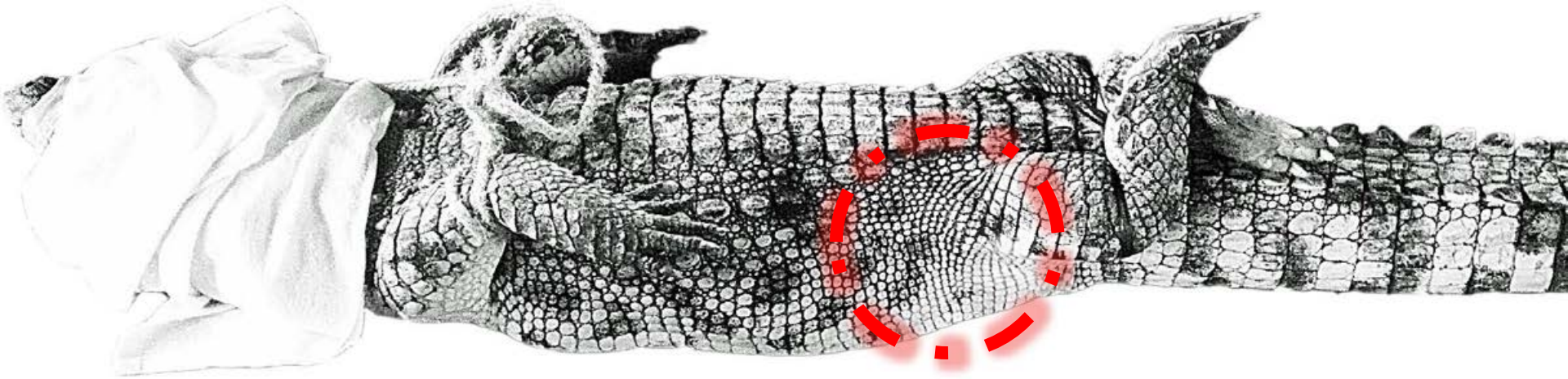


Kidneys, bladder, rectum,

Heart, Liver, spleen, Gall bladder, gonads, eggs, duodenal loop, guts, pancreas, fat body, ..

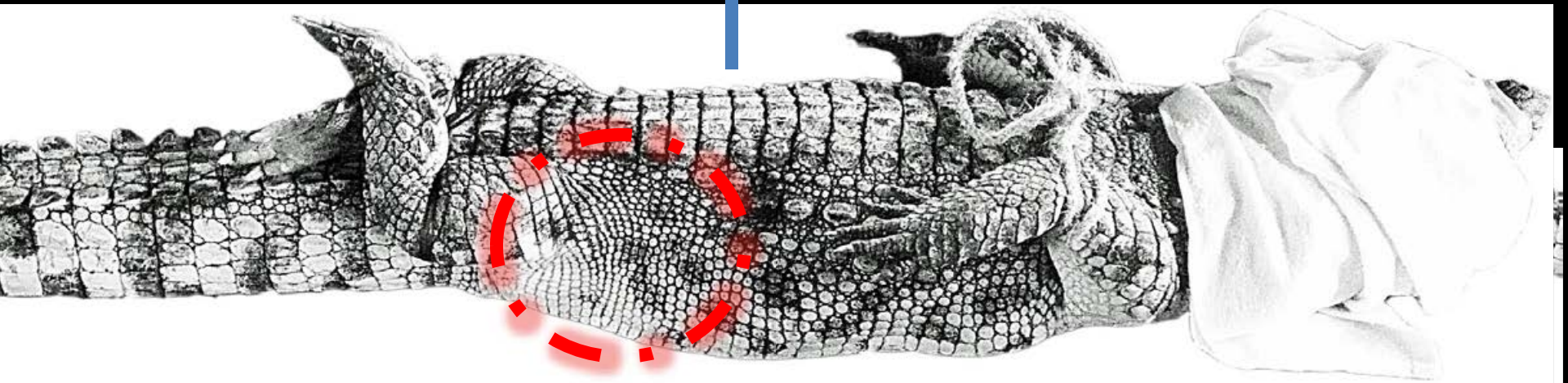






Right Flank: Right liver +, ovaries+, eggs +, spleen +/-, fat body, duodenal loop +, guts, kidneys and testis +/-,

Left Flank: Stomach+, ovaries+, eggs+, L. liver +/-, Kidney and testis +/-, guts, duodenal loop +/-







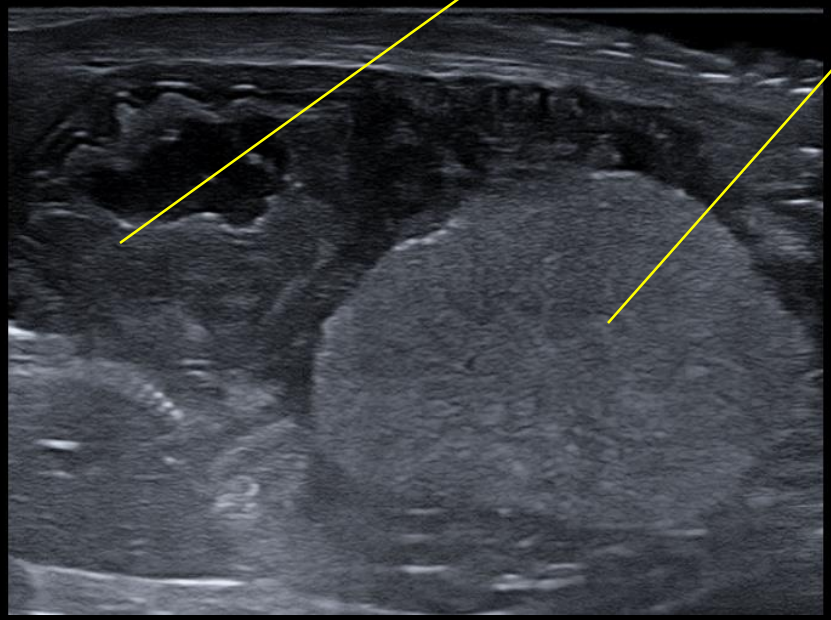



中央储备肉
西路488号
13973699356

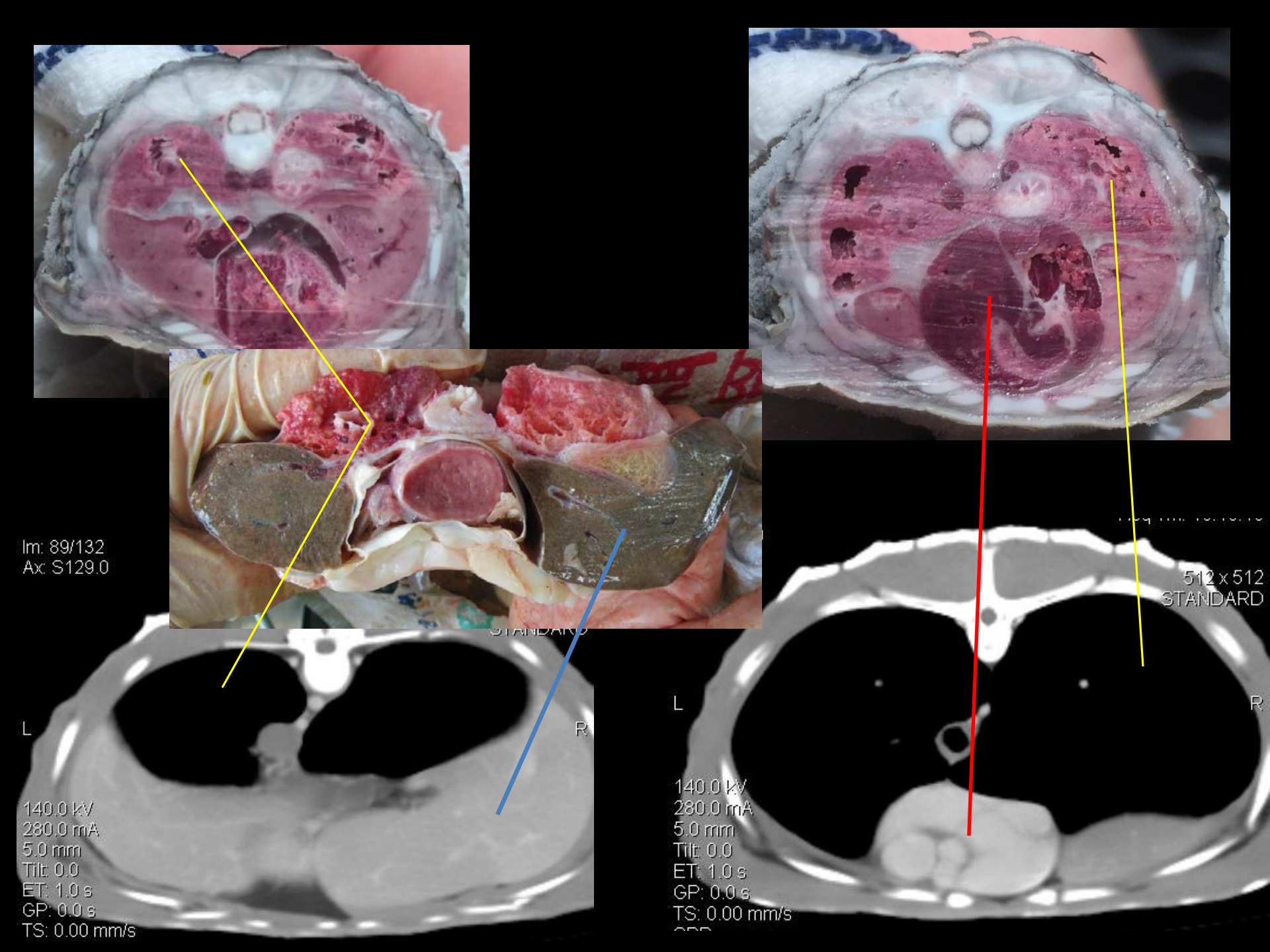






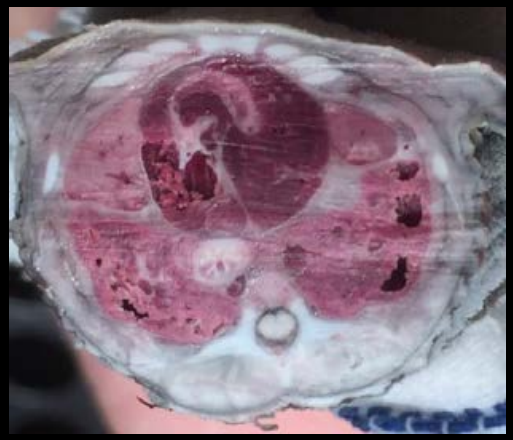




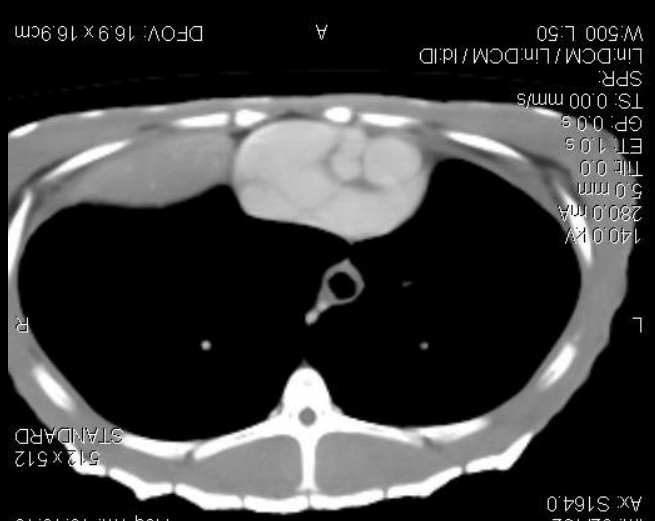

Im: 89/132
Ax: S129.0
L
R
140.0 kV
280.0 mA
5.0 mm
Tilt: 0.0
ET: 1.0 s
GP: 0.0 s
TS: 0.00 mm/s
512 x 512
STANDARD
L
R
140.0 kV
280.0 mA
5.0 mm
Tilt: 0.0
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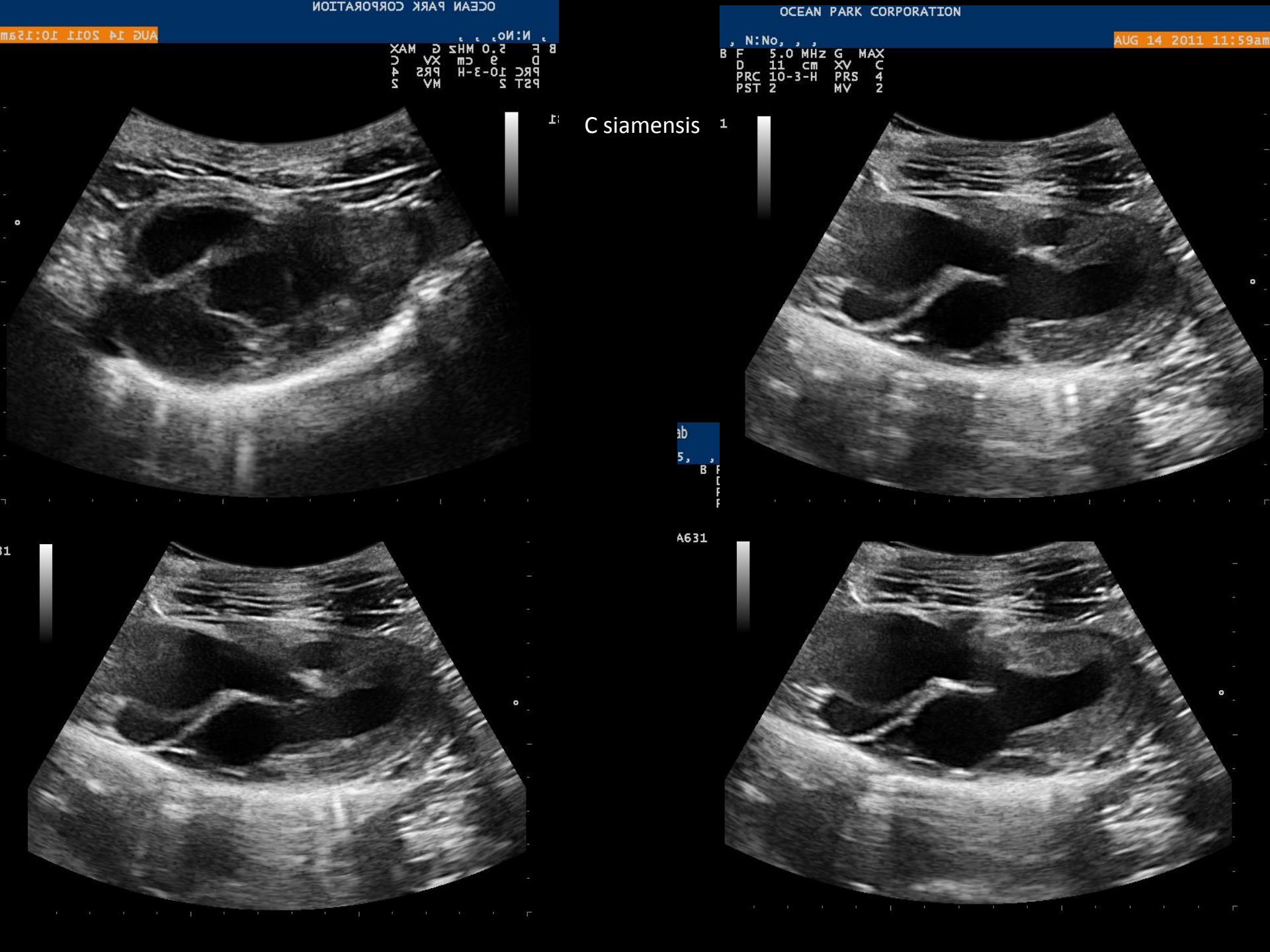
Heart

- Texture of organ,
- Pericardial fluid: amount, clarity
- Gout crystals
- Dynamic studies possible





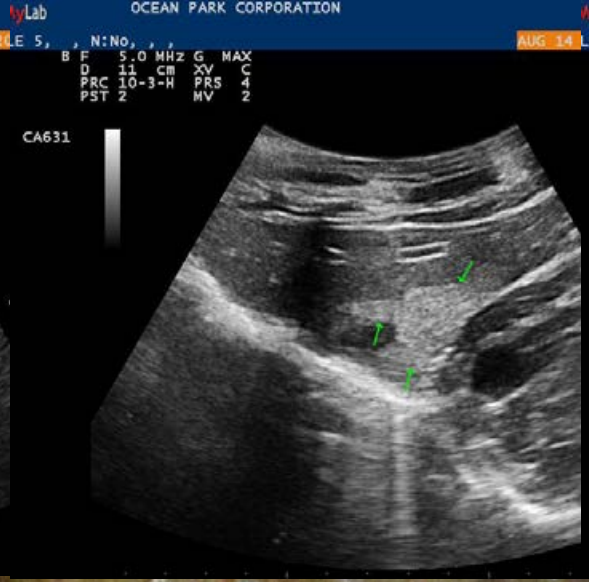



OCEAN PARK CORPORATION
AUG 14 2011 11:59am
B F 5.0 MHz G MAX
D 11 cm XV C
PRC 10-3-H PRS 4
PST 2 MV 2
C siamensis

Liver

- Liver can be assessed thoroughly, lesions can be seen and matched gross and microscopic findings in location and approximate size
- Hepatic lesions (fatty degeneration and necrotizing hepatitis). Common in septic states, nutritional disorders.
- Chlamydiosis, mycoplasmosis, sepsis by fecal bacteria,


OCEAN PARK CORPORATION
CA631
LT LOBE

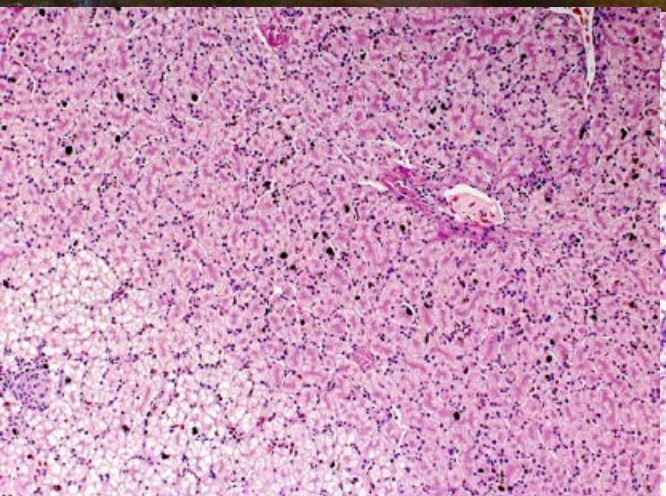

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CA631

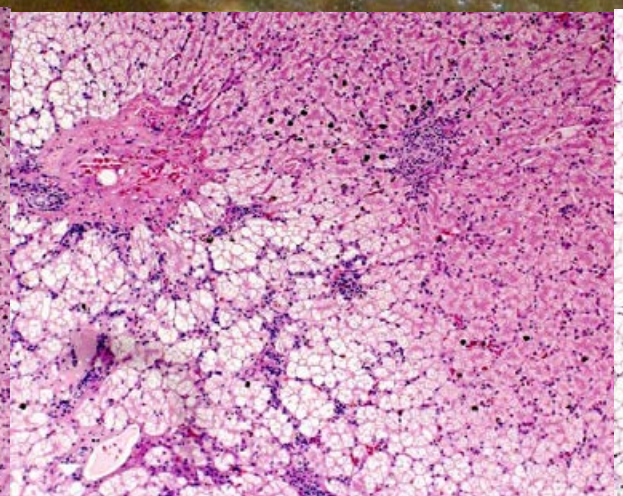

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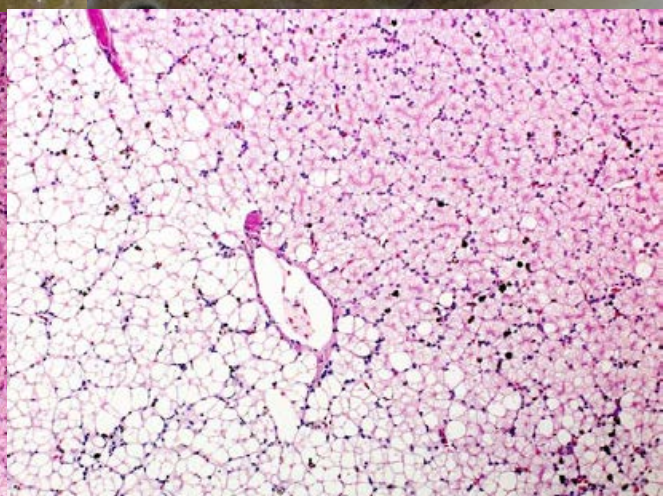










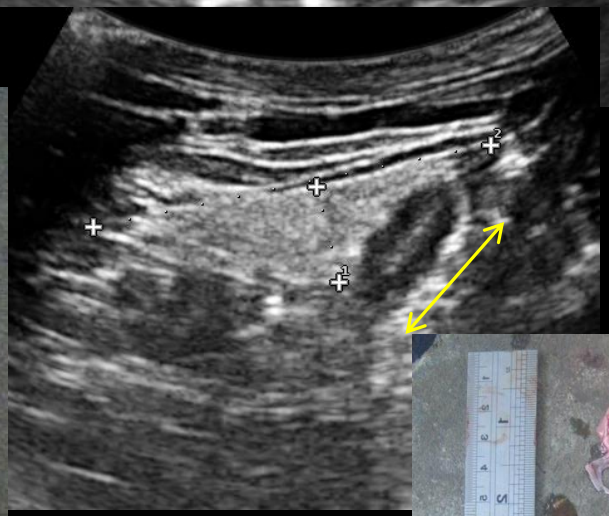


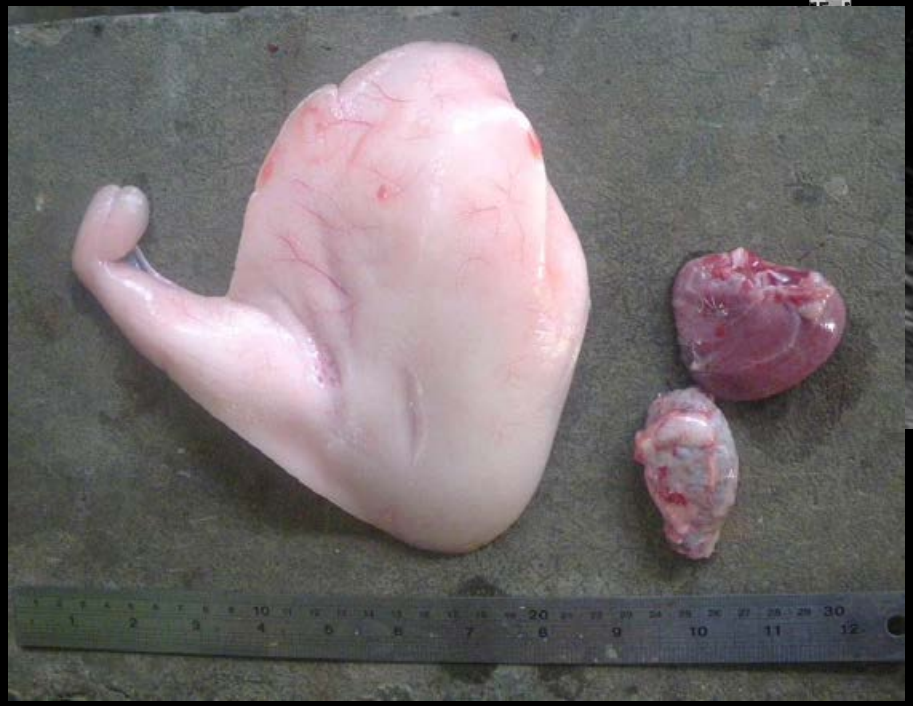
Fat body

- Size of the Fat Body is easily qualified (depleted, OK, Large) but organ measurements were not accurate. (better skills/method?)
- More data and more understanding of the fat body's physiology and function are needed for better interpretation


87%
RIGHT STE









Spleen

- Spleen shape and budding can be seen, size can be measured, also not accurate.
- Texture can be appreciated
- Budding sign of activation/stimulation of immune system
- Requires some patience to find and examine: find the GB, look below it






SPLEEN GB




GB
SPLEEN


SPLEEN

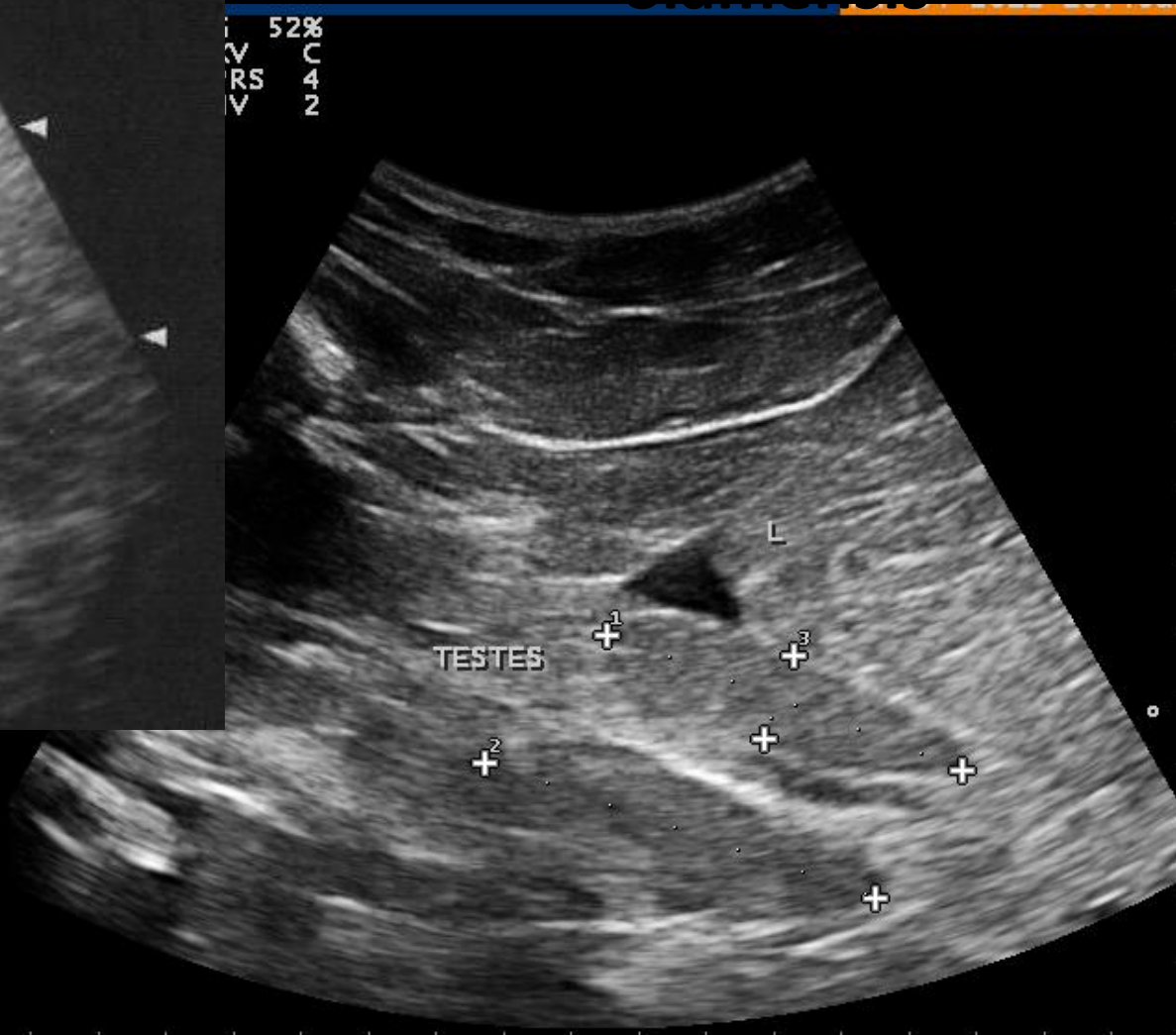


Findings, gonads

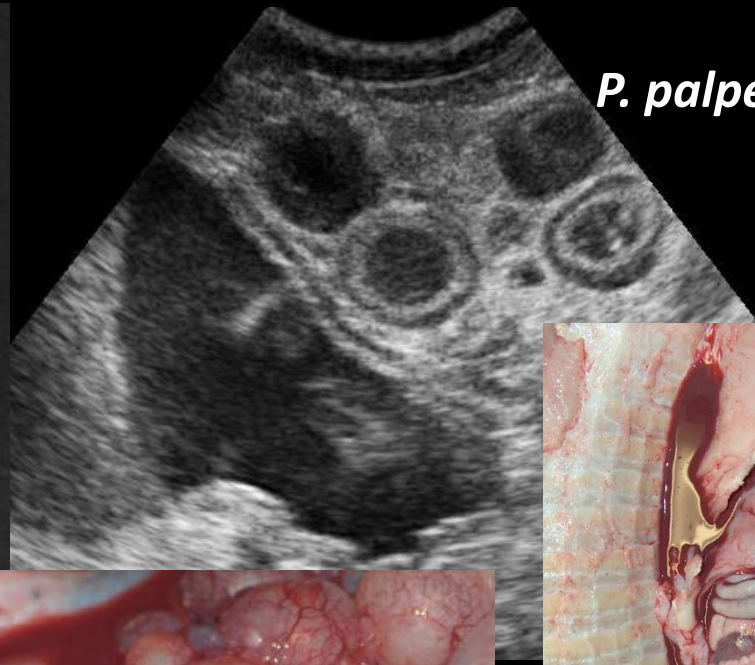
- Gonads can be visualized and measured
- Reproductive status of females is easily assessed
- Males reproductive status : data is lacking but testicles are observable, sometimes hard to find



A. sinensis

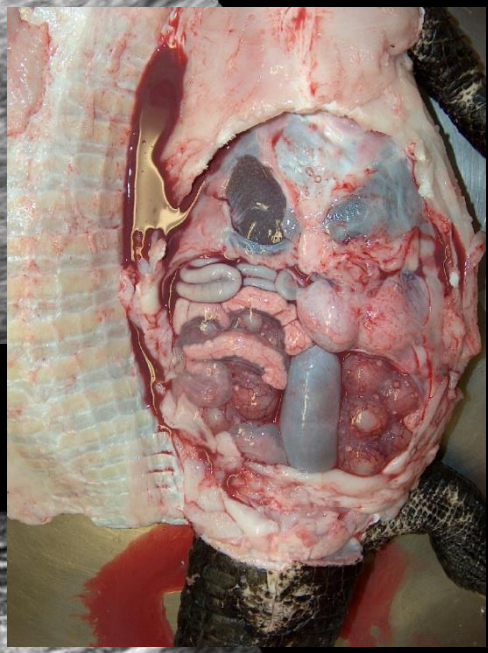


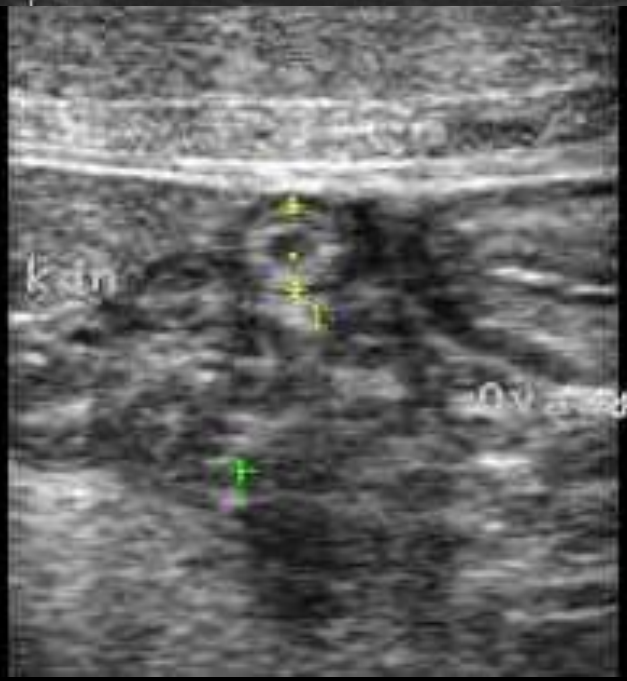




P. palpebrosus







siamensis



Other organs that can be found and assessed

- Gall bladder
- Pancreas : between duodenal loops
- Intestines and duodenal loop
- Stomach
- Kidneys: most difficult organ to recognise, species differences

Kidneys

C siamenis

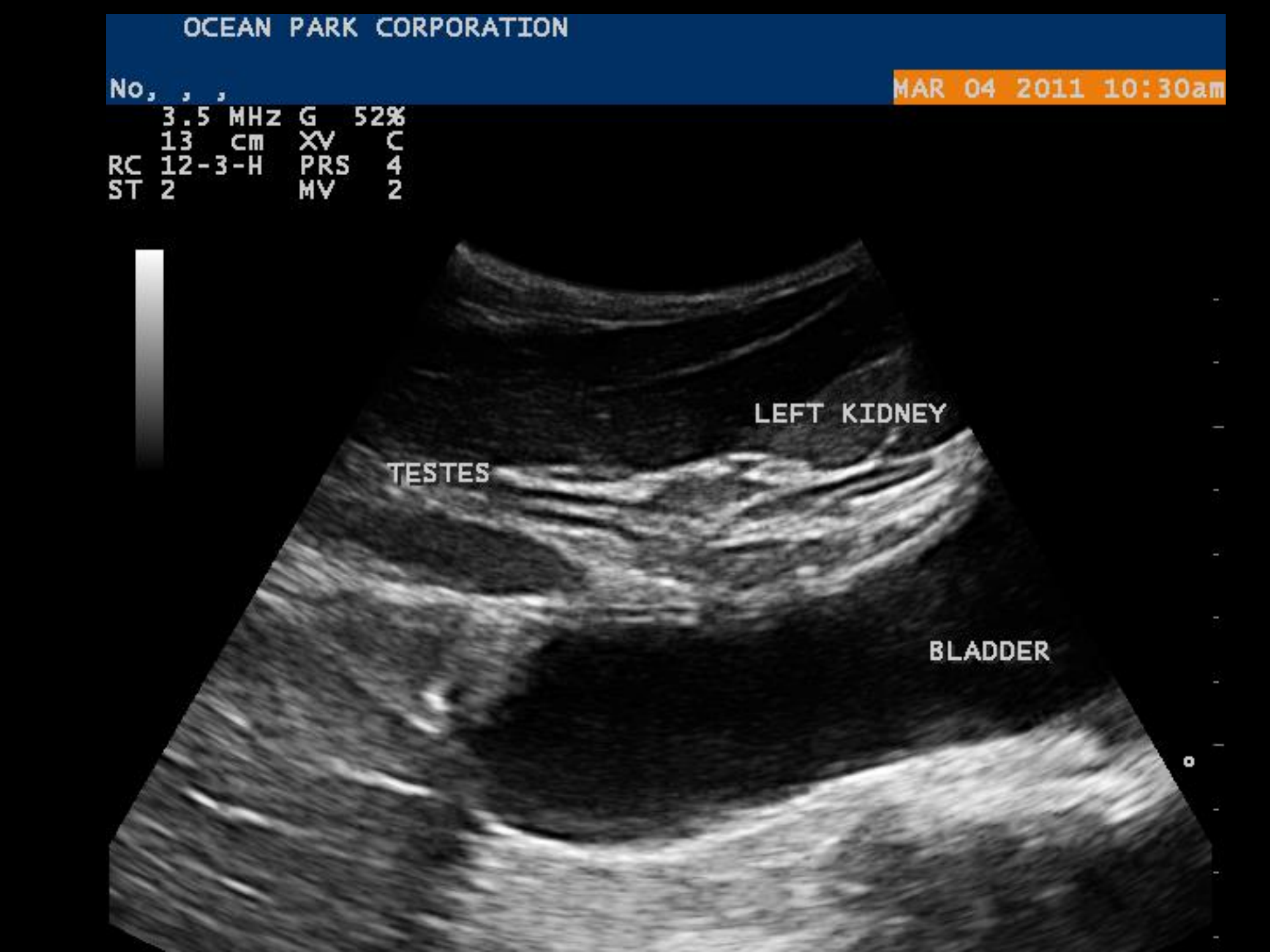


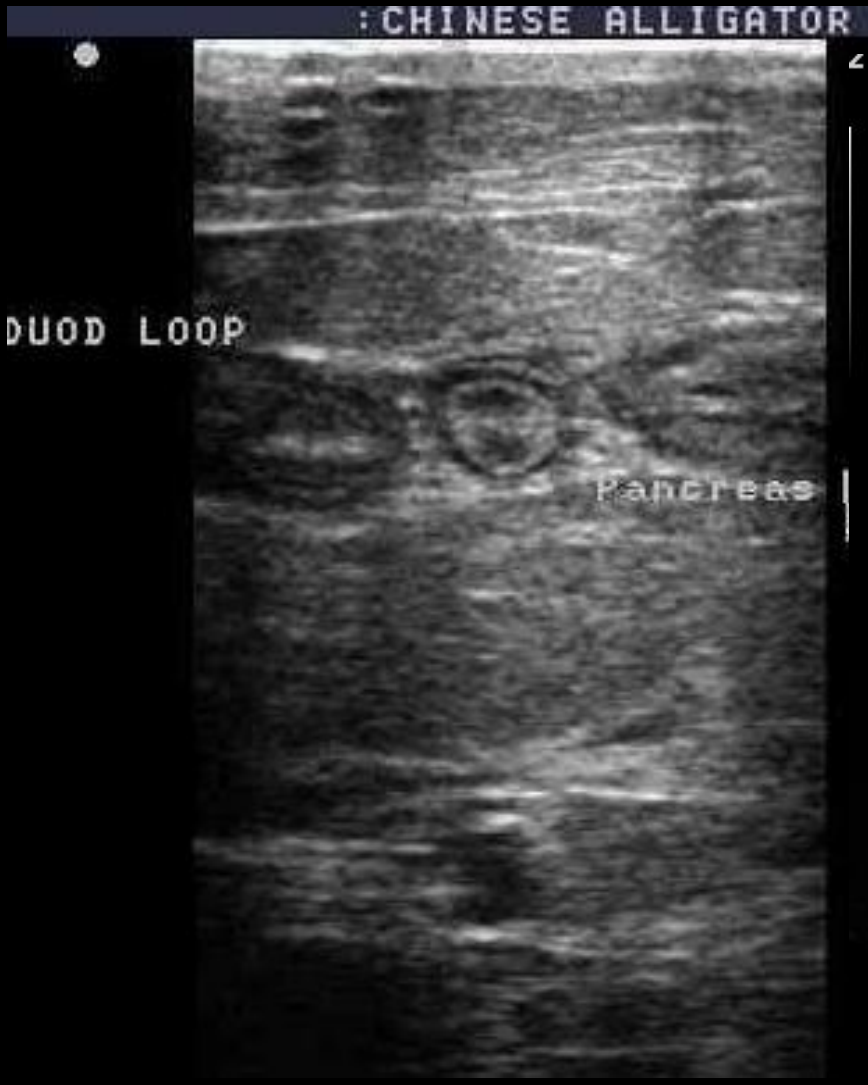


A sinensis

C niloticus




OCEAN PARK CORPORATION
No, , ,
MAR 04 2011 10:30am
3.5 MHz G 52%
13 cm XV C
RC 12-3-H PRS 4
ST 2 MV 2
LEFT KIDNEY
TESTES
BLADDER


:CHINESE ALLIGATOR
DUOD LOOP
Pancreas


LIVER
DL
PANCREAS

Acknowledgements

co-researcher Dr Brian Kot

Thank Dr Dong G.X. and the staff at the Chimelong Crocodile Farm
The crocodiles

