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Comparative Diagnostic Imaging of the Reproductive Tract in Monitors
Radiology – Ultrasonography – Coelioscopy

BERND SCHILDGER, HANNA TENHU, MARTIN KRAMER, MARTIN GERWING, GERALD KUCHLING, GRAHAM THOMPSON & RUDOLF WICKER

Abstract

121 monitors from 11 species were examined radiologically, ultrasonographically and coelioscopically; most specimen were *Varanus gouldii* (n=44) and *Varanus indicus* (n=32). The three diagnostic methods were compared concerning techniques, requirements and displayability of reproductive organs. In addition 19 free living *Varanus gouldii* from Western Australia were examined ultrasonographically and coelioscopically in the field to compare technique and results.

No severe side effects were evident resulting from the 401 examinations. Radiology permitted the representation of calcificated eggs and larger vittelogenic follicles. In only very few cases were testis (n=2) and calcificated hemipenal structures (n=5) verifiable (males n=60). The method was easily performed and didn't require anesthesia. Ultrasonography allowed the display of previtellogenic and vitellogenic follicles, and eggs of any stage of development; in some cases testis were verifiable (n=7). Juvenile gonadal structures were not displayable. Advantages were multiple reexaminations were possible (development control) and no chemical restraint was required. Coelioscopy permitted the display of ovaries and testis of any stage and size, even for juveniles. Main disadvantages were the invasivness and anesthesial requirements.

For sex determination coelioscopy was the only reliable method for all species irrespective of their age, size and sexual development. Ultrasonography permitted the determination of gender if follicles were displayable, it didn't work for juveniles and sexually inactive males. Radiology allowed sex determination if calcificated eggs or calcificated hemipenal structures were evident.

Key words: Varanidae, monitors, radiology, ultrasonography, coelioscopy, sex determination

Introduction

Radiology, ultrasonography and endoscopy are diagnostic methods used in reptile medicine and biological science. Radiology is used to diagnose calcificated eggs and egg binding in the reproductive tract of reptiles (JACOBSON 1988, RUBEL et al. 1991, SCHILDGER & GABRISCH 1991).

To examine the development of ovarian follicles in various species of tortoises and turtles ultrasonography has been used by KUCHLING (1989), ROSTAL et al. (1990), KUCHLING & BRADSHAW (1993), ROSTAL et al. (1994) and CASARES (1995). The application of ultrasonography in lizards and especially in monitors to examine the anatomy was descibed by SAINSBURY & GILL (1991), TENHU et al.(1995) and SCHILDGER et al. (1996). To control the stage of ovarian development and to determine the sex of monitors ultrasonography has been rarely used (SCHILDGER et al. 1993, MORRIS et al. 1996 a, b).

Coelioscopic techniques have been used in reptiles to determine the sex of monomorphic species like the Green Turtle (*Chelodina mydas*) (WOOD et al. 1983) or

HORN, H.-G. & W. BÖHME (eds.): Advances in monitor research II. – Mertensiella 11: 193-211.

the Shingle-Back (*Tiliqua rugosus*) (SCHILDGER & WICKER 1987). It was developed as a method of clinical diagnosis in reptile medicine, for ovarian development and sex determination in various species (CREE et al. 1991, SCHILDGER & WICKER 1992, SCHILDGER 1995).

Each of these methods has its advantages and disadvantages. Coelioscopy is invasive and requires anesthesia. Ultrasonography is impeded by gas filled structures (lungs, ecdysis, bowls) and requires different scanning probes depending on the size of the species examined. Radiology is only useful in cases of calcificated egg structures. The objective of this investigation was to compare the requirements, the advantages and disadvantages of the three methods in monitors based on 121 individuals, derived from private owners and Zoological Gardens. In addition ultasonographic and endoscopic methods have been compared in 19 free living *Varanus gouldii* in Western Australia.

Materials and Methods

One hundred and twentyone Monitors out of 11 species were examined using all three methods (radiology, ultrasonography, coelioscopy). The species and numbers are listed in table 1. They were derived from private owners and Zoological Gardens. In addition, 19 free living *Varanus gouldii* were captured in Western Australia and

Species	Number
Varanus s. cumingi	2
Varanus dumerilii	4
Varanus exanthematicus	2
Varanus gouldii	44
Varanus griseus	7
Varanus indicus	32
Varanus mertensi	5
Varanus niloticus	3
Varanus rudicollis	3
Varanus salvadorii	3
Varanus timorensis	8
Varanus varius	8
Total	121

Tab. 1. Monitors examined using radiology, ultrasonography and coelioscopy

	Body mass in grams							
	10-20	21-50	51-100	101-200	201-500	501-1000	1001-2000	2001-5000
Monitors (n=140)	1.4	11.4	17.9	13.6	22.9	20,7	7.9	4.3

Tab. 2. Bodymass (grams) of the examined monitors, counted in percentage of 140 individuals (n = 140).

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examined endoscopically and ultrasonographically in the field. The bodyweight of the examined monitors (Tab. 2) varied from 15 to 4000 g.

19 monitors which died for other reasons were examined to determine and measure anatomical structures (Fig. 1). Two dead and frozen animals were cut into transverse slices to assess the anatomical situation in the intersections which were later displayed in the sonographic pictures (Fig. 2).

Due to various changes in nomenclature of the *Varanus gouldii complex* (BÖHME 1991) this study refers to the reduced nomenclature of *Varanus gouldii*-as per STORR 1980.

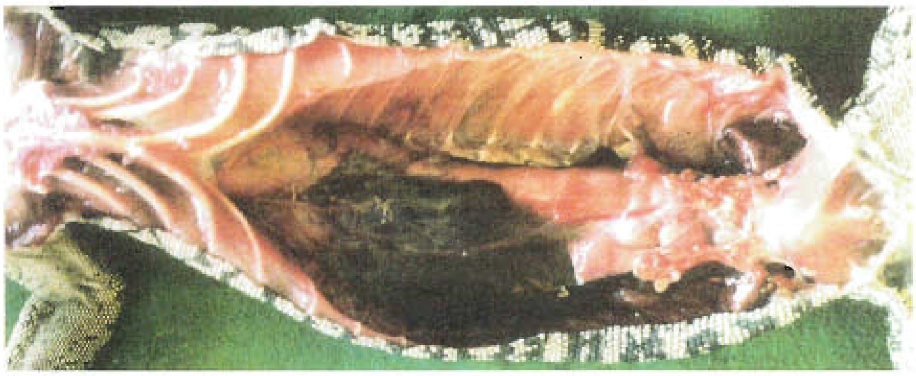

Fig. 1. Post mortem examination and measurements in *Varanus gouldii*, view from ventral, left and right ovaries.

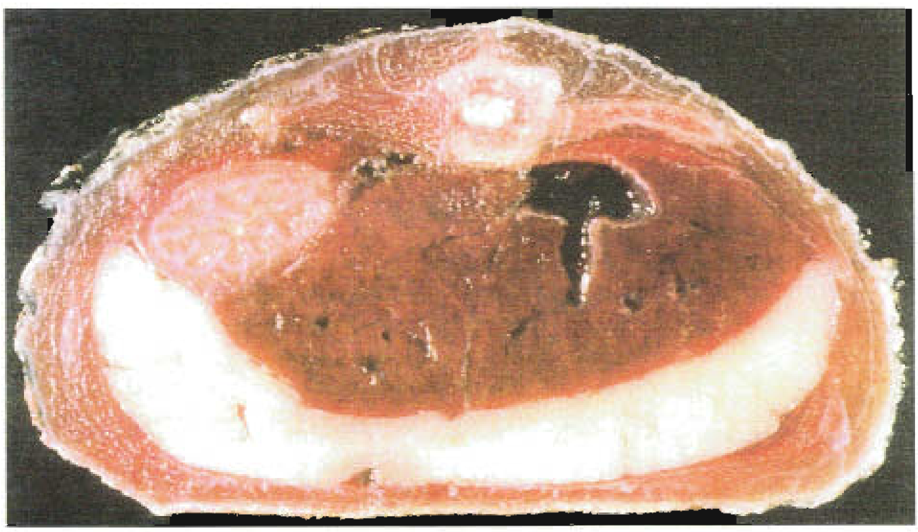

Fig. 2. Transvers slice of a frozen *Varanus gouldii*, center of the body cavity, brown liver with black gallbladder, light yellow fat bodies (ventral) and light red stomach (top left).

Radiology

For radiological examinations the animals were placed directly on the cassette and restrained manually. Dorsoventral and laterolateral x-rays were taken using Kodak NMB® film, Kodak Lanex Single Fine® screen and X-O-Matic® cassettes.

Ultrasonography

The specimens were placed in dorsal recumbancy on a vacuum pillow and manually restrained, without sedation or anesthesia. A coupling gel (Sonogel®) was applied and the coelom scanned in longitudinal and transverse sections from cranial to caudal aspects. A Linear Transducer of 7.5 MHz and a Convex Transducer of 5 MHz were connected to a Kranzbühler Petscope 30®. For documentation, direct video prints, S-VHS videorecords and direct digitalisation (PIA-Professional Imaging Archiving®) were used.

Coelioscopy

For endoscopic examination of the coelom, food was withheld for 2 to 4 days prior to examination. General anesthesia was applied using isofluran (Forene®). Isofluran was administered through a face mask and where necessary endotracheal intubation with silicon tubes was performed. The patients were restrained in lateral recumbancy and a 3-5 mm incision made in the lateral skin fold. Muscles and coelomic wall were perforated with a blunt probe and the endoscope inserted. The coelomic organs were examined from the cranial (heart, lungs) to the caudal (kidneys, bladder) aspect. After removal of the endoscope, antibiotics were instilled (Doxicyclin), and the skin sutured.

Two endoscopes were used in this investigation, a 4 mm rigid scope with 25° ankle (Storz 64200) and sheath with blunt obturator and a 3 mm rigid scope with 30° ankle and integrated working channel (Storz 27030 B). Insufflation of CO_2 or filtrated air was always necessary. The light source and flash generator was a Storz 600. For documentation, a endovideocamera (Storz endovision 539) was attached to the endoscope. The examination was recorded using a portable U-matic recorder (Sony, VR 6800 PS). For slides, a specially adapted camera was used (Ricoh 135-36 KR, Storz 576 A objective).

Results

No deaths or severe side effects occured in any monitors examined. Isofluran anesthesia produced a state of surgical tolerance in 140 cases without any side effects. Ultrasonograhic and endoscopic methods were easily performed in the field.

1. Females, juvenile

Anatomical situation

The ovaries were placed laterally on the both sides of and very close to the *aorta dorsalis* between liver and kidneys (last third of the body cavity). The size of the ovarial structures varied depending on age, size and sexual activity. The ovaries of juvenile monitors up to 100 g body mass were very small (0.7-3 mm total length). Follicle structures were not recognizable macroscopically. The very thin blue-white oviducts run laterally, very close to the ovaries leading caudally to the cloaca.

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Imaging methods

Juvenile ovaries were not displayed radiologically and ultrasonographically in the 29 juvenile monitors examined.

Coelioscopic methods permitted the display of juvenile ovaries even in very small specimens. The smallest individual examined was a *Varanus acanthurus* (10.5 g body mass and 2 months of age). *Varanus gouldii* of 50 g body mass and 3 months of age and *V. cumminghi* of 250 g body mass and 5 months of age displayed similar stage of juvenile ovaries.

The juvenile ovaries displayed as a cigar shaped long body of a similar size to the adherent adrenal gland. The colour was light grey-reddish with very thin vessels. There were no discernable follicles. The surface of the ovary looked more like a cauliflower. The adrenal gland was bright yellow coloured with distinct clear vessels evident on the surface. The differentiation between adrenal gland and ovaries could be determined based on colour, blood vessels and position. Lateral to the ovary the witish partly folded *oviduct* runs from the *septum postpulmonale* to the kidney and the *cloaca* (Fig. 3).

2. Females, sub-adult and adult

Anatomical situation

Size and shape of the ovaries in adult and sub-adult monitors depend on the reproductive stage. In sub-adult animals, the ovaries were 10 to 15 mm long and 3 to 5 mm in diameter. The more vitellogenic and larger the follicles, the more space in the coelomic cavity they occupied. Before ovulation the ovaries could be located from both sides of the heart to the kidneys. The oviduct runs lateral to the ovaries from cranial (close to the *septum postpulmonale*) to the caudal aspect and are fixed by a serosa close to the dorsal body wall. Caudally they run ventrally over the kidneys leading to the cloaca. The oviducts are white, band like, thin and partly folded.

Imaging methods

Radiological examination displayed larger vitellogenic ovarian follicles (VO, > 10 mm diameter) in monitors of various size and body mass (BM). The follicles showed a round shaped surface, overlaying each other. In some cases, radiology allowed the number of follicles to be counted (Fig. 4).

Ultrasonography permitted the representation of previtellogenic (PVO) and vitellogenic ovarian follicles of various size. PVOs displayed as roundshaped anechoic structures, often arranged in a grape-like line, one after the other in longitudinal sections (Fig. 5). The displayable minimum size of follicles depended on the size of the animal and the resolution of the transducer. In small monitors (up to 500 g BM) and using a 7.5 MHz transducer follicles of 1 mm diameter were recognizable. The more vitellogenic the follicles became, the more hypoechoic they displayed (Fig. 6). *Corpora lutea* were not displayable. Follicles in regression showed an inhomogenous reflex pattern. The surface was not as smooth as in growing follicles (Fig. 7).

Coelioscopy allowed the display of PVO and VO of any size and stage. PVO were amber coloured with waterlike contents, with only small vessels running between the follicles (Fig. 8). The diameter varied from 1 to 8 mm depending on the species and development. The more crowded the PVOs, the more vessels appeared on the surface. VO showed a bright yellow colour with broad vessels on the surface (Fig. 9). They

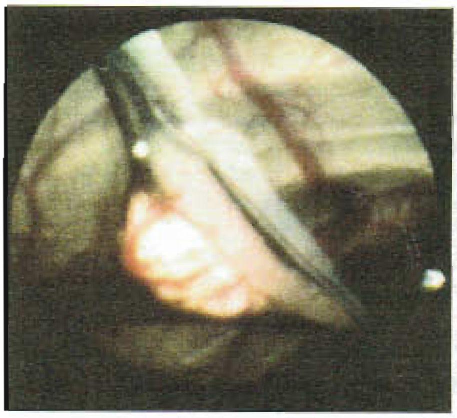

Fig. 3. Coelioscopic picture of a juvenile female *Varanus gouldii*. grey - bodywall, white - ribs, left - yellow adrenal gland with strong vessels, centre - white pink, cigar shaped ovary, right - blue white, flat and partly folded oviduct.

Fig. 4. Radiographic picture of a *Varanus acanthurus*, dorsoventral projection, round radio-dense follicles.

occupied large parts of the coelom. *Corpora lutea* displayed as small yellow buttons on the surface of the ovary (Fig. 10) and often possess a central dent. The size of the *copora lutea* was similar to the PVO.

Follicles in regression were characterised by a yellow colour with broad vessels covering large parts of the surface. The border of those vessels was irregular and vapid (Fig. 11). The size decreased from the size of VOs to PVOs and smaller.

The oviduct displayed as a flat and folded tube running from the *cloaca* cranially to the *septum postpulmonale* lateral to the ovary. In juvenile and sub-adult monitors the oviduct was flat and thin. In adult animals, it was thicker and turned redder closer to egg disposition.

3. Females, eggs within the oviduct

Anatomical situation

Egg development was symmetrical in both oviducts. In some species like *Varanus acanthurus* the eggs could occupy two thirds of the body cavity, placing some of the

Fig. 5. Ultrasonographic pic
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eggs to the left and right
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Imaging methods

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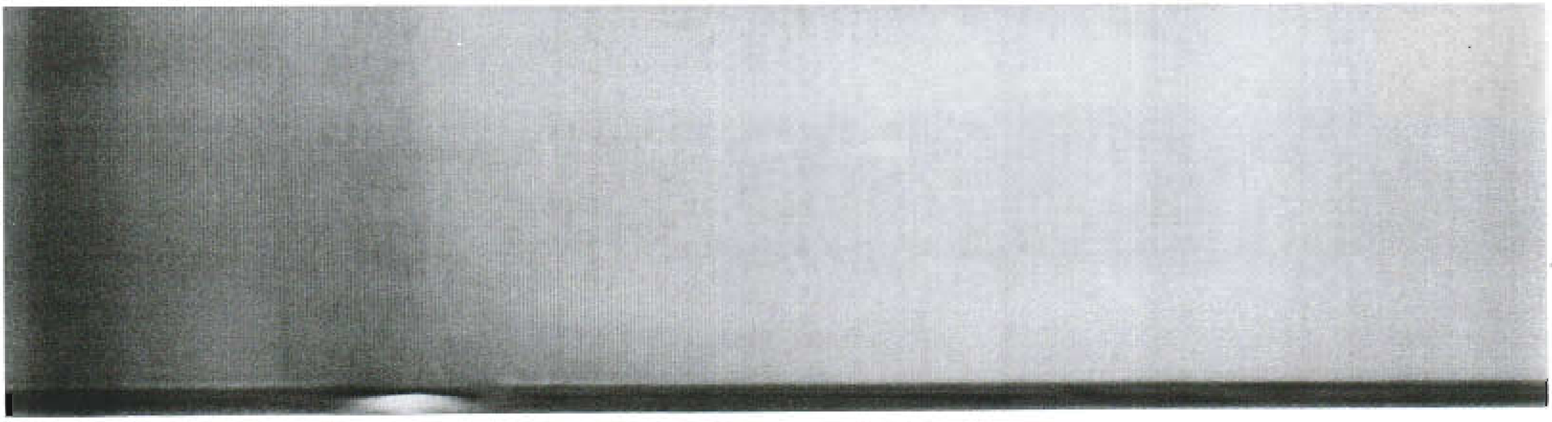

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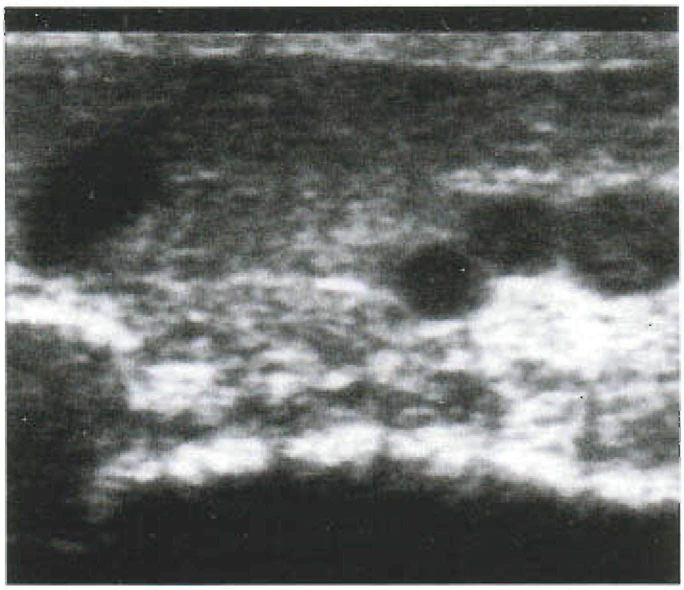

Fig. 5. Ultrasonographic picture of the ovary in a *Varanus gouldii*, the three anechoic (black) round shaped previtellogenic follicles are set in a row.

eggs to the left and right of the heart. The number and size of the eggs was species specific and varied from 2 to 3 cm in length and up to 20 eggs in *Varanus acanthurus* to 6 to 7 cm in length and 3 to 6 eggs in *Varanus gouldii*.

Imaging methods

Calcificated eggs were easily demonstrated using radiology. Number, size, surface and homogenousity of the calcification could be diagnosed (Fig. 12). Egg binding was diagnosed in 9 cases with the radiological symptoms being irregular calcificated egg shells. In 3 cases, doublelines were characteristic for 2 eggs being glued together in combination with clinical symptoms like dehydration, nervousity, digging trials and apathia were further indications of egg binding.

Ultrasonography allowed the display of hyperechoic, calcificated egg shell and the different layers within the shell (Fig. 13). In most cases, the shell consisted of a hyperechoic superficial, a hypoechoic midline and a hyperechoic inner layer. After ovulation, the contents of the egg within the oviduct is as hypoechoic as the vitellogenic follicles. Just prior to disposition of the eggs the contents is differentiated into two layers. One third to one half is anechcoic, two third to one half is hypoechoic (picture 13). In the 9 cases of egg binding, the contents of the eggs were irregular and the two layers were not clearly seperated from each other. The number of eggs in the oviduct was easily determined.

Coelioscopy required a minimum distance between the front lens and the examined structure. Therefore examinations were difficult to perform where a large number of eggs occupied the body cavity. No perforation of oviduct nor eggs occured during the 143 examinations. The eggs displayed as white round to ovoid shaped bodies within the oviduct. The oviductal wall was very thin, with a transparent light.

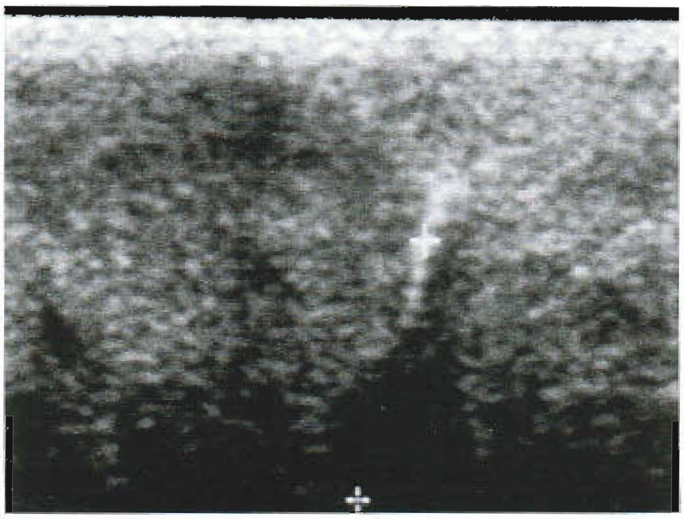

Fig. 6. Ultrasonographic picture of two large vitellogenic hypoechoic follicles (grey) in a *Varanus gouldii*.

reddish coloured. Large vessels cover the surface of the oviduct. Coelioscopy only permitted display of a few of the eggs, the total number could not be determined.

4. Males, juvenile

Anatomical situation

The testicles were placed lateral, on both sides of the *aorta dorsalis*, the right more to the cranium than the left. Both testicles are situated anterior to the kidneys, and mediodorsal to the light yellow testicles, the adrenal glands could be found which are of similar size and a bright yellow colour. The size of the cigar shaped testicles depend on age and size of the specimen. The testicles of juvenile monitors up to 100 g BM were very small (0.7-3 mm total length), similar to the juvenile ovaries. The white *Ductus deferens* is only a very thin string running from the testicle caudally on the ventral surface of the kidney to the *cloaca*.

Imaging methods

Neither radiological nor ultrasonographical methods displayed juvenile testicles.

Coelioscopic methods enabled the display of juvenile testis even in very small specimens; the smallest individual was a *Varanus acanthurus* (11 g BM). The juvenile testicles were light yellow, cigar to bean shaped and a similar size to the adjacent adrenal gland (Fig. 14).

5. Males, subadult and adult

Anatomical situation

The size of the bean shaped testicles in adult and subadult monitors depend on the size of the animal and the reproductive status. They vary from 3 mm to 4 cm in length

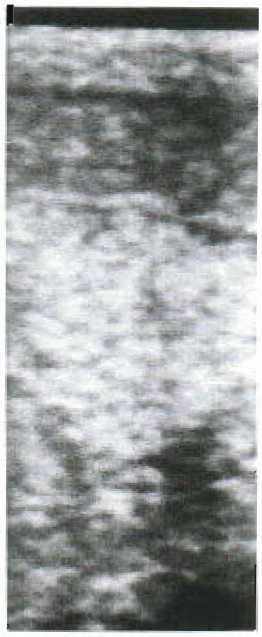

Fig. 7. Ultrasonographic
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Imaging methods

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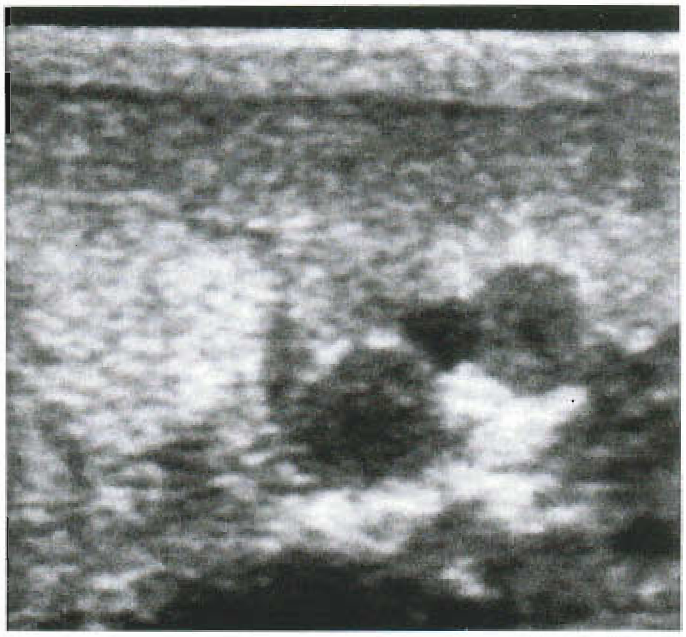

Fig. 7. Ultrasonographic picture of a female *Varanus indicus*, two round shaped follicles in regression (centre) are characterized by inhomogenous outer hypoechoic and inner anechoic layer.

to the size of the kidneys. In sexually active animals, the testicles were enlarged, although there is no enlarging of the epididymitis. The kidney enlarges and changes colour in sexually active males, it displays a red renal segment and white sexual segment alternating pattern.

Imaging methods

Only in two of the 60 male monitors radiologically examined were the testis visually evident. Both cases were highly sexually active *Varanus indicus* and had obstained from food for 5 and 6 days. The testis display as ovoid shadows anterior to the kidneys in dorsoventral and laterolateral projection. In five male monitors, calcificated hemipenal structures in the hemipenis cavities were evident.

Ultrasonography enabled the detection of testicles in 7 of the 60 cases. They displayed as ovoid bodies in longitudinal and round shaped bodies in transverse sections. They were hypoechoic structures partly surrounded by a fine hyperechoic line (Fig. 15). The medium length was 18 mm and the medium diameter was 8 mm.

Coelioscopy allowed display of testicles of any size in all of the 60 cases. The bean shaped testicles were white to light yellow in colour and between 3 mm and 4 cm total length (Fig. 16). The white curled *Ductus deferens* could be seen running from the testes caudally to the ventral surface of the kidneys. In sexually active monitors the kidneys displayed with white and red alternating structures (Fig. 17). The more sexually active the animal was the larger the white structures sexual segment.

Fig. 8. Coelioscopic picture of the ovary in a *Varanus mertensi*, the previtellogenic follicles are amber coloured, the white oviduct is partly folded.

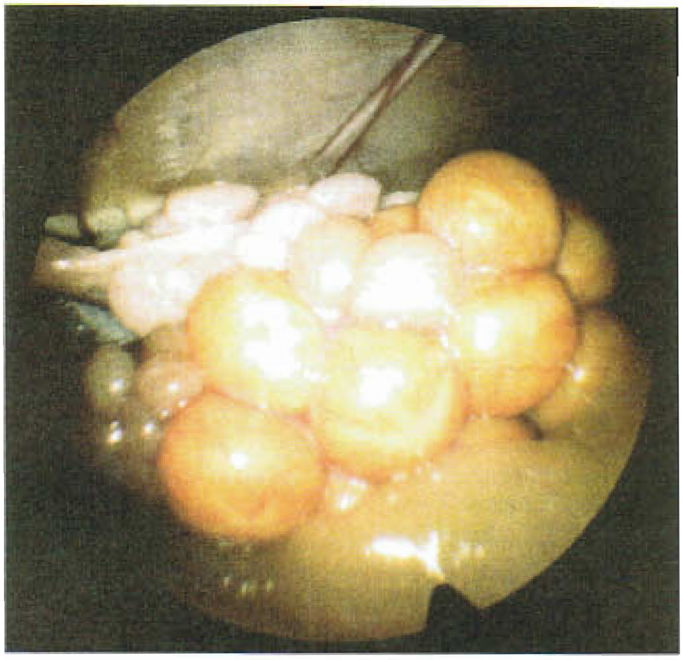

Fig. 9. Coelioscopic picture of a female *Varanus acanthurus*, multiple vitellogenic, large yellow follicles are visible.

Discussion

Radiology

Radiology is a very useful tool in reptile medicine (JACOBSON 1988, RUBEL & KUONI 1991). It is a non-invasive diagnostic method that is easy to perform and therefore doesn't require anesthesia. Exeptions might be large, nervous and powerful reptiles like adult pythons or Komodo Dragons. Because it is an additive imaging method

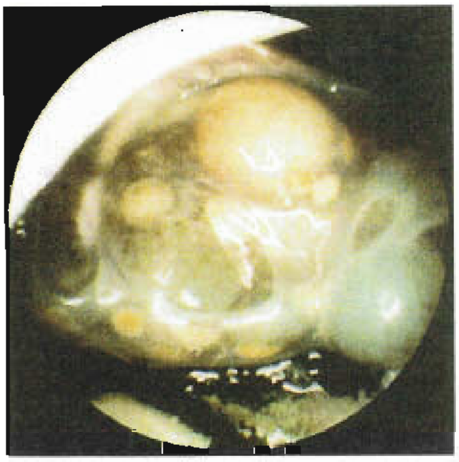

Fig. 10. Coelioscopic picture of a female *Varanus griseus*, ovary with previtellogenic follicles (grey) and multiple *corpora lutea* (small yellow buttons).

interpretation is not very difficult. Main disadvantage is the large and expensive equipment.

Radiology is the diagnostic method of choice for examining skeletons, lungs, bladders, large parenchymateous tumors and egg binding (SCHILDGER & GABRISCH 1991, SCHILDGER & TENHU 1993). In monitors, it is a valuable method to examine calcificated eggs and in small species large follicles and not yet calcificated eggs (SCHILDGER et al. 1992). The number of calcificated eggs, the size and shape, the surface, and the homogenity of the calcification could be demonstrated. For differentiation between normal gravidity and egg binding, egg shape surface and homogenity need to be judged. Bursting rounded shape, inhomogenousity of the calcification and irregular surface are indications of egg binding. In some cases, two or more eggs are glued together and fine parallel shell lines are radiologically evident. In the examined monitor species it is also possible to count and measure the size of larger vitelogenic follicles. The displayability of the follicles depends mainly on the size of fat bodies which can inhibit the view of the follicles. Thinner body wall and small

Fig. 11. Coelioscopic picture of a female *Varanus jobiensis*, ovary with large, yellow follicle in regression.

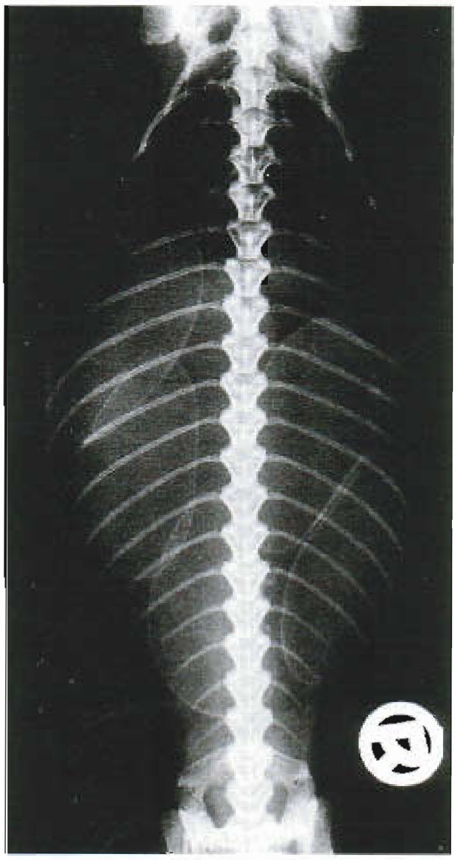

Fig. 12. Radiographic picture of a female *Varanus s. cumingi*, dorsoventral projection, five calcificated ovoid eggs are visible.

fat bodies make it easier to display the follicles. PVO could not be demonstrated because of their low radiological density. Even though radiology is described as a method of sex determination in reptiles (BAUMGARTNER et al. 1989, CARD & MEHAFFEY 1994) it didn't prove to be a reliable method in monitors. In the very few cases (five) calcificated hemipenal structures could be demonstrated is positive proof of male gender.

Ultrasonography

Ultasonography in reptiles was first developed to examine the ovarian cycle in endangered turtles and tortoises like the Oblong Turtle (*Chelodina oblonga*, KUCHLING 1989), the Kemp's Ridlea Sea Turtle (*Lepidochelys kempi*, ROSTAL et al. 1990), the Galapagos Tortoise (*Geochelone elephantopus*, ROBECK et al. 1990), the Western Swamp Tortoise (*Pseudemydura umbrina*, KUCHLING & BRADSHAW 1993), the Desert Tortoise (*Gopherus agassizzi*, ROSTAL et al. 1994), and Giant and European tortoises. (*Geochelone elephantopus*, *G. giganturus*, *Testudo graeca*, *T. hermanni*, CASARES 1995). Comparative ultrasonographic methodologies in reptiles were described by SCHILDGER et al. (1994).

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Fig. 13. Ultrasonographic picture of a female *Varanus s. cumingi*, two calcificated eggs, short from deposition, the contents is divided into a ventral hypoechcoic (grey) and a anechoic (black) dorsal part. Within the shell there are three layers (hyperechoic - anechoic - hyperechoic) differentiable.

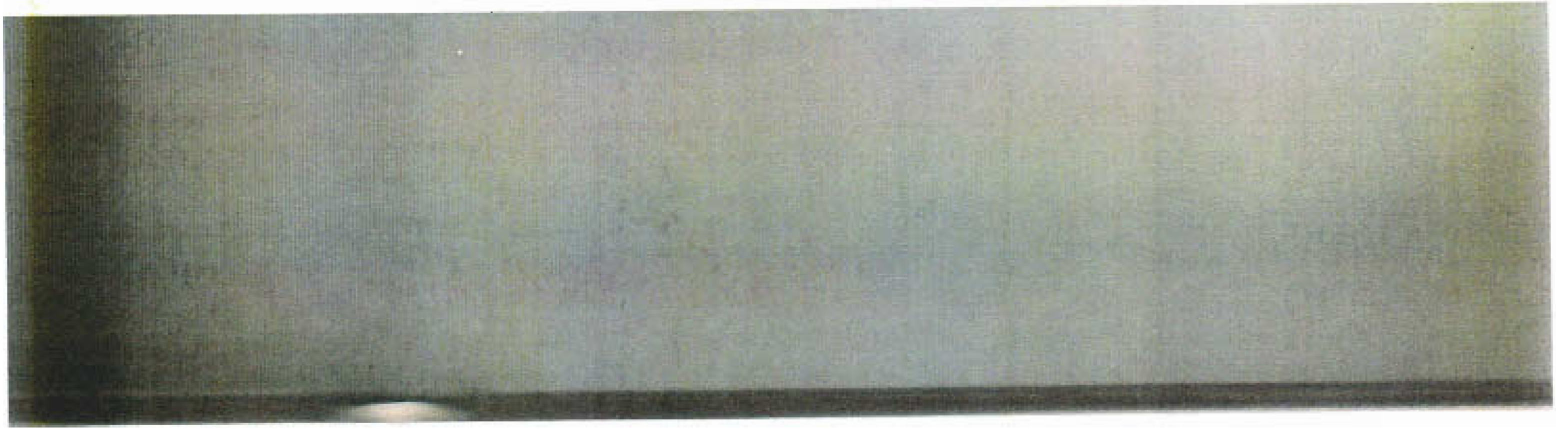
There are very few investigations of the anatomy of lizards using ultrasonographic procedures; SAINSBURY & GILI (1991) examined 3 Bosc Monitors (*Varanus exanthematicus*), TENHU et al. (1995) examined 82 Green Iguana (*Iguana iguana*). 22 species of lizards were examined by SCHILDGER et al. (1996). TENHU et al. (1995) investigated the sonographic anatomy of 38 *Varanus gouldii* and 28 *Varanus indicus*. Special emphasis on the reproductive tract in monitors were referred to by SCHILDGER et al. (1993, including 3 *Varanus panoptes*). MORRIS et al. (1996) used the sonography to predict the gender of 6 Komodo Dragons (*Varanus komodoensis*) and MORIS & ALBERTS (1996) determind the sex of 16 White Throated Monitors (*Varanus albigularis*).

Important advantages of transcutaneous ultrasonographic diagnostic methods in reptiles are non-invasiveness and the lack of relevant side effects. Therefore it doesn´t require anesthesia and could easily be used for reexaminations and control of development. In monitors, ultrasonography permits the determination of ovarian development from previtellogenic follicles (PVO. anechoic) to vitellogenic follicles (VO, hypoechcoic) and the inner structure of eggs. Whereas in terrapines only VOs

Fig. 14. Coelioscopic picture of a juvenile, male *Varanus gouldii*, on the left the bright yellow adrenal gland, on the right the light red, cigar shaped testis.

Fig. 15. Ultrasonographic picture of the testis in a *Varanus gouldii*, the homogenous hypoechoic testis is ovoid (encircled by white crosses).

and eggs could be predicted. In addition, there are some differences in the inner ultrasonographic structure of calcificated eggs between terrapines and monitors. In all the above mentioned investigations the eggs of turtles and tortoises are concentric; hyperechoic center-hypoechcoic mid layer- hyperechoic shell. In this investigation



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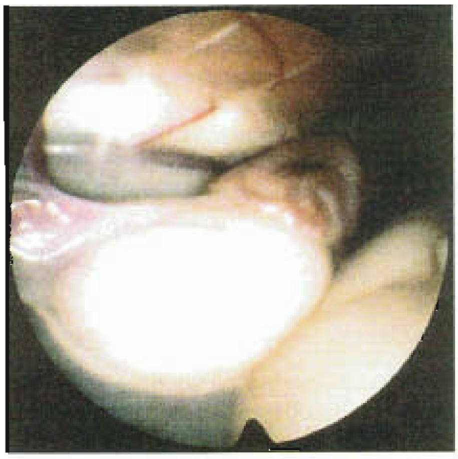

Fig. 16. Coelioscopic picture of a male, sexually active *Varanus jobiensis*, the bean shaped white testis is larger than the kidney and far larger than the small yellow-red adrenal gland at the left. The swollen, red-white banded kidney is placed caudally to the testis.

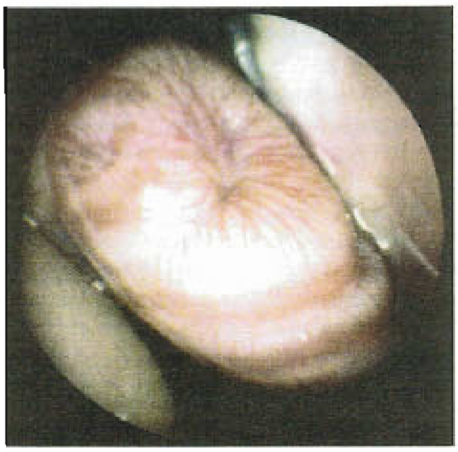

Fig. 17. Coelioscopic picture of the kidney of the sexually active male *Varanus jobiensis* (same patient as picture 15), the kidney is divided into red and white lobes with concentric strong vessels.

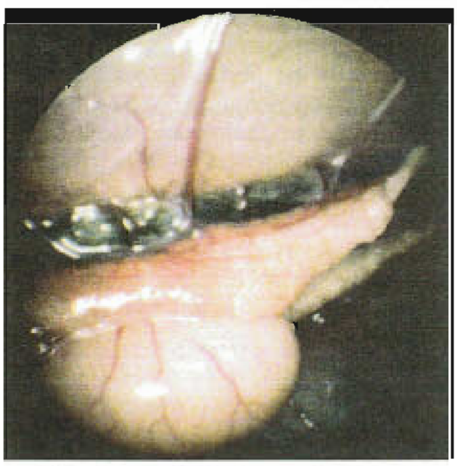

Fig. 18. Coelioscopic picture of a sexually active male *Iguana iguana*, in contrast to the monitor in picture 15 and 16, the epididymis is strongly enlarged, the folded *vas deferens* clearly distinguishable and the kidney (not visible in this picture) are normal.

the eggs of monitors are different. Prior to disposition of the eggs, the contents are divided into two parts, one dorsal hypo- and one ventral hyperechoic. In additon, the shell could be divided into three layers. The used 7.5 MHz scanner has a much better resolution than the 3.5 to 5.0 MHz scanner used for terrapines. The minimum size of predictible PVOs depend mainly on the frequency of the scanner. Using a 7.5 MHz scanner, follicles of 1 mm diameter are verifiable. The size and age of the specimen and ultrasonographic scanner resolution influences the capacity to determine juvenile ovaries or testis in monitors. The detection of follicles is also impeded by gas filled structures such as intestines, lungs or the air between the two layers of skin during ecdysis.

Coelioscopy

Because reptiles do not possess a diaphragm and therefore they do not have a seperate abdomen and thorax but one more or less undivided body cavity, the terminus for endoscopic examination of this body cavity should be coelioscopy and not laparoscopy (Cooper & Schildger 1991).

Coelioscopic techniques in reptiles were established to determine the sex of monomorphic species like the Green Turtle (*Chelodina mydas*) (Wood et al. 1983) and the Shingle-Back (*Tiliqua rugosus*) (Schildger & Wicker 1987). Other monomorphic genus like *Egernia, Corucia, Heloderma, Sphenodon* and *Varanus* have been examined more recently (Cree et al. 1991, Schildger & Wicker 1992). Coelioscopy not only permits the determination of gender but also the assessment of the reproductive status (Cree et al. 1991, Schildger 1995). Juvenile ovaries, previtellogenic and vitellogenic follicles, *corpora lutea* are also observable. Follicles in regression which are well known in vitellogenic and previtellogenic follicles in reptiles (Zwart et al. 1989) are characterized by their vessels. Juvenile testis, sexually inactive and active adult testis are able to be differentiated. The kidneys of sexually active male monitors is also altered and detectable by this technique. The enlargement of the kidneys due to swelling of the white parts, which are part of the sexual segment could, for example, not be found in Green Iguanas (*Iguana iguana*). There the epididymitis is enlarged in sexually active males (Fig. 18).

Interpretation of the results from this technique requires less experience than interpreting x-rays or ultrasonographic pictures because of natural shape, size, surface and colour of the examined organs. Endoscopes from 1.9 mm to 4 mm diameter permit examination of monitors from 10 g to 5 kg. The equipment is not as expensive as radiology or ultrasonography and it could easily be performed in the field, especially using battery driven light sources. Coelioscopy permit the clinical diagnosis of other inner organs and can be complemented by endoscopic biopsies for microbiological and histological examinations.

The invasiveness of coelioscopy requiring a general anesthesia is a disadvantage. For multiple reexaminations of developing organs like the follicles, ultrasonography is the method of choice.

Sex determination in monitors

Radiology only permitted reliable determination of gender if calcificated eggs or calcificated hemipenis were verifiable. Testis and hemipenis were only identifiable in a small percentage (3 % and 8 %) of examined male monitors. The risk of false interpretations is high.

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Ultrasonography permitted reliable sex determination only in sub-adult and adult monitors of the examined species if follicles or eggs were verifiable. These results are similar to the investigation of 6 juvenile - sub-adult *Varanus komodoensis* by MORRIS et al. (1996). In this investigation testis were only evident in a small percentage of the examined male monitors. WRIGHT and PUGH (1995) didn't find any testis in male *Heloderma horridum* and *suspectum*. MORRIS and ALBERTS (1996) displayed the testis of seven male *Varanus albigularis* and two male *Heloderma horridum*. If neither follicles, eggs nor testis are evident it is not possible to sex the specimen. Examination could be impeded by gas filled structures like intestines, skin (ecdysis) or just filled bowels. Ultrasonography did not permit sex determination in juvenile monitors.

Coelioscopy permitted reliable sex determination in monitors independent of species and age. Even juvenile individuals could be reliably sexed.

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Authors: Bernd Schildger,
Hanna Tenhu, Untersuchu
strasse 122, CH-3012 Ber
of Giessen, Department o
108, D-35392 Giessen, Ge
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Authors: BERND SCHILDGER, Tierpark Dählhölzli, Tierparkweg 1, CH-3005 Berne, Switzerland; HANNA TENHU, Untersuchungsstelle für Wildtierkrankheiten, University of Berne, Länggassstrasse 122, CH-3012 Berne, Switzerland; MARTIN KRAMER and MARTIN GERWING, University of Giessen, Department of Veterinary Surgery – Small Animal Surgery, Frankfurter Strasse 108, D-35392 Giessen, Germany; GERALD KUCHLING, Department of Zoology, The University of Western Australia, Nedlands, WA 6907, Australia; GRAHAM THOMPSON, Centre for Ecosystem Managment, Edith Cowan University, Perth, WA 6027, Australia; RUDOLF WICKER, Frankfurt Zoological Gardens, D-60312 Frankfurt, Germany.