

Survey for hydatidosis in cattle bred in the northern region of the Northern Territory of Australia

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Objective To determine whether hydatidosis occurs in cattle bred in the northern region of the Northern Territory.

Design A survey utilising two stage sampling was designed to provide 95% confidence of detecting hydatids in cattle with a herd prevalence of 10% and animal prevalence of 10%.

Procedure For a 1 year abattoir killing season, lesions from the liver and/or lung were collected from 4348 cattle being slaughtered at a Northern Territory abattoir and examined for hydatid cysts. The origin of cattle was established through identification of the brand.

Results Sample sizes of 41 or more Northern Territory bred cattle were achieved for each of 29 properties. No hydatid cysts were found in cattle bred in the northern region of the Northern Territory.

Conclusion This study provides evidence that a cycle of hydatid transmission does not occur in the northern region of the Northern Territory.

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Hydatisidosis has implications for trade such as the importation of infected cattle into countries free of this disease,¹ for some economic losses through offal condemnation² and human health awareness campaigns for its zoonotic potential.³ Hydatidosis in Australia is caused by the larval stage of the taeniid cestode, *Echinococcus granulosus*. World-wide there are a number of strains of *E granulosus*. With *E granulosus* in Australia, it was initially thought that different strains occurred in wildlife and domestic animals but molecular studies now indicate that there are no differences.⁴⁻⁶ The parasite uses two major transmission cycles, a sheep/dog domestic cycle and a dingo/macropod sylvatic cycle, with overlap between the two cycles.

Cattle can be infected with the larval cestode, but cysts are usually sterile and degenerate and thus propagation of the life cycle through these animals would not be expected.⁷ In a survey of hydatid cysts from cattle in tropical Queensland less than 1% of cysts were fertile, most cysts were less than 20 mm in diameter and 43% showed obvious necrosis.⁸

A high prevalence of hydatid cysts in cattle has been reported over a number of years from Queensland cattle, with the highest prevalence of 55% being in aged cattle from the south eastern corner.^{2,9} Since these areas have relatively few sheep, it is thought that the transmission cycle predominantly occurs through dingoes and macropods, with cattle becoming accidentally infected by ingesting eggs from contaminated pastures.

Cattle in the Kimberley region of Western Australia were once considered almost free of hydatid disease.⁹ A recent finding in abattoirs killing cattle from throughout Western

Australia indicated 78% of lesions (236/304 hydatid cysts) were from cattle culled from the Kimberley region.¹ These findings suggested that a sylvatic cycle, similar to that in northern Queensland, was present in the Kimberley region and this could raise public health and trade concerns.

The prevalence of hydatids in cattle in the Northern Territory has been reported as low. Surveys conducted over 30 years ago in abattoirs reported no evidence in cattle or pigs slaughtered in Darwin and a prevalence of 2% in Alice Springs.⁹ No surveys have been conducted since then in the Northern Territory. Verbal reports from abattoir inspectors have indicated that hydatid-type cysts were being found with increased frequency.

In 1999, the Veterinary Committee, an advisory body to the Standing Committee on Agriculture and Resource Management, recommended that data be collected to document where the prevalence of hydatid disease may be increasing. This and concerns about the possible occurrence of a hydatid cycle in the Kimberley region prompted this survey for hydatidosis in cattle in the Northern Territory to be conducted in 2000. Cattle from southern regions of the Northern Territory were not sampled because they are not processed through abattoirs in the Northern Territory. The presence of cysts in cattle bred in the Northern Territory can indicate a local hydatid transmission cycle. The possible establishment of a sylvatic hydatid cycle in the Northern Territory cannot be dismissed as potential definitive hosts in the form of dingoes and intermediate hosts in the form of macropods are abundantly available. In the Northern Territory there are few sheep and no commercial sheep operations and therefore no opportunity for a sheep to dog or dingo cycle.

Materials and methods

Survey design

If hydatidosis were present in the Northern Territory, it could well cluster within properties indicating pockets of infection, rather than be evenly distributed throughout a region. For a hydatid cycle to occur on a particular property, risk factors would include introduction of infected hosts such as cattle or dogs and the existence of suitable intermediate and definitive hosts. The number of Northern Territory bred cattle to sample was calculated using a two-stage sampling regimen,¹⁰ albeit the sampling was not random. The abattoir sampling was carried out by convenience sampling, because collections could only be undertaken when stock inspectors were available to record the brands. The number to sample was calculated in order to provide 95% confidence of detecting at least one infected Northern Territory bred cattle herd, assuming the following parameters: 95% herd level sensitivity and 100% herd level specificity, population of 250 herds, 10% minimum herd level prevalence, 70% test level sensitivity, 100% test level specificity, average herd size of 2000 cattle, and 10% minimum expected

within herd prevalence. The test level specificity figure was chosen based on the lesion examination procedures described below and the test level sensitivity figure was chosen based on a maximal sensitivity of meat inspection for tuberculosis lesions.¹¹ The number of herds to sample was calculated as 29, and the number of cattle to sample from each herd was calculated as 41.¹²

Recording of property of origin

Cattle in the Northern Territory and Queensland are identified by hide fire brands and properties may also register cattle ear marks. As each animal entered the killing area at the abattoir, the brand was recorded. Cattle being slaughtered as separate property groups facilitated recording. Each animal was given a body number that was correlated to the brand record. Data on the sex and age of these cattle were recorded when possible, with age determined by a year brand. The body number accompanied the body along the chain.

Collection of samples

The liver and lungs from every animal were palpated for cysts as part of Australian Quarantine and Inspection Service (AQIS) meat inspection procedures. Organs that contained cyst-like lesions were collected and the body number recorded. Lesions were removed from an organ and the samples were chilled and sent to Berrimah Veterinary Laboratories for examination.

Lesion examination

The lesions were measured and the number of cysts recorded. Membranes from fresh material and cyst fluid were examined for protoscolices with a dissecting microscope. Samples of cysts were fixed in 10% buffered formalin and processed using standard histological methods. Sections were cut and stained with haematoxylin and eosin and periodic acid-Schiff (PAS) stains. These were examined by light microscopy to determine the presence of PAS positive laminated membranes.¹³ When a membrane was not detected, the section was further examined to determine the appropriate morphological diagnosis.

Results

From June to September 2000, livers and lungs from 4348 animals from 62 Northern Territory properties were examined for hydatid cysts. Sample sizes of 41 or more Northern Territory bred cattle (range: 42 to 161) were achieved for 29 properties. The distribution of these properties is shown in figure 1. Locality of each property is represented by a dot. Consignments of cattle from most properties contained cattle from mixed origins and cattle that could not be identified from a clear brand were excluded from this survey. From these 29 properties, 3244 cattle were identified. There were 2921 Northern Territory bred cattle and 323 Queensland bred cattle.

Female cattle made up 65% of the cattle surveyed, with the remaining animals being steers, bulls or sex not identified. The age of animals from most properties was mixed and ranged from 2 to over 9 years. Most animals were over 4 years.

Lesions in the lung and/or liver were collected from 26 animals.

Hydatid cysts

Lesions confirmed histologically as being hydatid cysts were detected in 15 animals. All of these animals were confirmed as originating from Queensland, giving a prevalence of 4.6% (2.6%, 7.5%; 95% exact binomial confidence interval) in the cattle from Queensland.

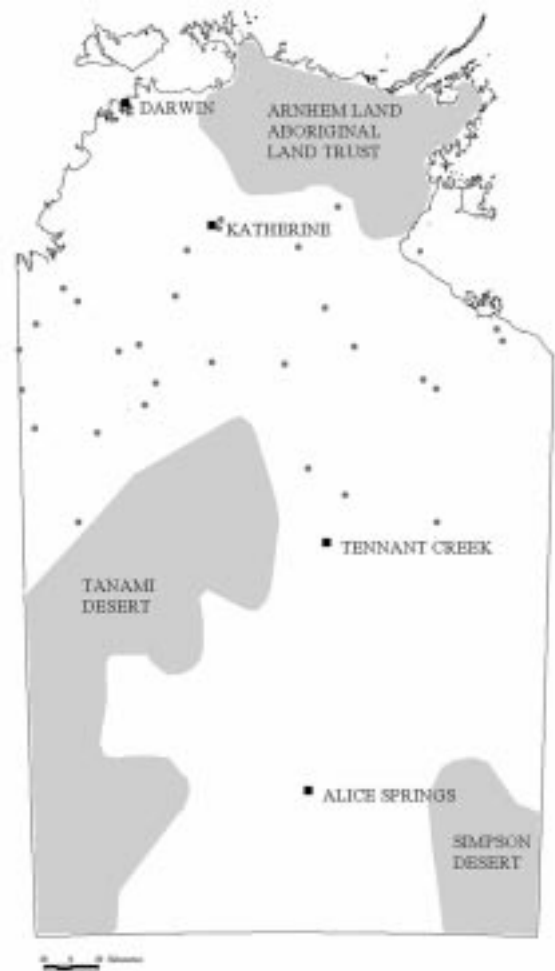


Figure 1. Distribution of properties sampled in the Northern Territory.

Hydatid cysts were mostly found only in the liver (11/15 animals). All liver cysts were degenerate. Cysts were locular and could be easily peeled out of the liver tissue. Histological examination indicated cysts had a layer of granulomatous inflammation, including giant cells, around mineralised, caseous contents. This layer varied in its thickness and degree of mineralisation. The presence of PAS positive lamellated membranes confirmed the identification as a hydatid cyst. These membranes were present in varying amounts; sometimes attached to the lining or else found folded within the cyst contents. The number of cysts in the liver varied from 1 to 8 and ranged in size from <0.5 cm to 4 cm in diameter.

A few animals had cysts only in the lungs (2/15 animals) or cysts in both lungs and liver (2/15 animals). Cysts from the lung were fluid filled, with a layer of granulomatous inflammation, and with abundant giant cells. Within lung cysts there were often separate, loose, thin, PAS positive lamellated membranes. In a few cysts these membranes were still adhered to the lining. Protoscolices were found in two lung cysts from the same animal. The number of cysts found in the lung were fewer in number, usually only one or two cysts, and larger, up to 10 cm, than those in the liver. Of the 15 animals with hydatid cysts, protoscolices only occurred in one animal.

Non hydatid cysts

A number of submitted lesions did not have the PAS positive lamellated membranes. These cyst-like lesions which were confirmed as not being hydatid cysts were submitted from 13 animals. These lesions were all in the liver. They came from ten Northern Territory and three Queensland cattle, with two of these Queensland cattle also carrying hydatid cysts. In 11 of the 13 cases these were single cysts. Cysts ranged in size from <0.5 cm to 10 cm.

Histological examination of these gave the following diagnoses: bacterial pyogranulomas (hepatic abscess), club forming pyogranulomas, developmental or congenital causes, chronic active cholangiohepatitis and possible liver fluke.

Discussion

On a total herd perspective, 29 properties provided sufficient numbers of Northern Territory bred cattle to give 95% confidence that herd level prevalence of hydatid infection is less than 10% and the within-herd prevalence is less than 10%. No hydatid cysts were found in Northern Territory bred cattle from these 29 properties. In the hydatid endemic areas in southern Queensland, the percentage of farms infected was 29.7% and the average number of cattle infected 14.6%.²

Detection of no hydatid cysts in Northern Territory bred cattle indicates that it is highly unlikely that an active hydatid transmission cycle occurs in the northern region of the Northern Territory. The prevalence of hydatid cysts in cattle increases with the age of the animal, but does not vary with sex.^{2,8} Most cattle surveyed from the abattoir in the Northern Territory were culled cattle in the age range of >4 years and thus good indicators of hydatid infection. An abattoir survey to detect hydatidosis was determined to be appropriate, since hydatidosis in cattle has a negligible mortality rate and the age of the animals sampled gave a positive bias to detecting hydatid cysts.

Cysts were classified as being those of *Echinococcus granulosus* by the presence of lamellar membranes. The hydatid cyst outer wall is thick with a concentrically laminated membrane. The acellular lamellar hyaline outer layer is the distinguishing characteristic for *Echinococcus* species and is retained even in heavily granulated cysts. This layer consisting of polysaccharide-protein complexes is PAS positive on histological sections of cysts.¹³ Lesions from 15 animals were identified as being hydatid cysts based on this characteristic.

Sampling theory is based on the assumption of random sampling. For many surveys, this is not possible for financial or practical reasons and therefore statistical conclusions may be flawed. Ideally, information from this survey could be used to draw rigorous conclusions about the whole Northern Territory bred cattle population. However, limitations to this aim arise because it is a single abattoir survey, and sampling was carried out on 'convenient' days and not on all of the cattle killed from a consignment.

Further support that hydatids do not occur in cattle bred in the northern region of the Northern Territory can be gained by looking at data collected from all animals examined. In the overall sampling program, cattle were sampled from more than these 29 properties. In the Northern Territory, most young marketable animals are sent for live export and are not routinely sent to an abattoir. Animals at the abattoir tend to be culled stock. Therefore the number of animals from any particular property could not be predicted and had to be sampled when they became available at the abattoir. In total, 4348 animals

from 62 Northern Territory properties were examined for hydatid cysts and, of these, 3530 were bred in the Northern Territory, 436 in Queensland and 382 could not be identified. Lesions were submitted from 36 animals, from which 23 animals had confirmed hydatid cysts. Twenty-one of the animals with hydatid cysts were confirmed as originating from Queensland. Brands on the remaining two animals, which came from different properties, could not be read. If these were Northern Territory bred cattle, then this is only two cattle with hydatid cysts out of 3530 animals (0.01%, 0.20%; 95% exact binomial confidence interval).

Although not strictly part of this survey, lesions from animals bred in Queensland were also submitted during our survey, since most cattle consignments at the abattoir contained some animals bred outside of the Northern Territory. Many properties in the Northern Territory were destocked and subsequently restocked with cattle sourced from Queensland with the advent of the Brucellosis and Tuberculosis Eradication Campaign programs that operated from the 1980s. Cattle bred in coastal Queensland have a high prevalence of hydatid cysts. In central Queensland prevalence in slaughtered cattle of 51% has been reported.⁸ In our survey of the 29 properties, 5.6% of imported cattle bred in Queensland had cyst-like lesions and 15 of these 18 animals had hydatid cysts. Most cysts were in the liver and all of these liver cysts were necrotic. Surveys in Queensland indicate that cysts in cattle were found predominantly in the liver and 60% were necrotic.⁸

Most hydatid cysts detected in this survey were greater than 5 mm in size. Occasional small cysts were detected. The detection of these lesions demonstrated the ability of meat inspectors to find small lesions. In an abattoir survey for hydatidosis in cattle in Queensland, 46% of liver cysts were less than 5 mm.⁸ Work on the growth rate of hydatid cysts in the liver of bovines indicates that 5 mm cysts were between 1 and 2 years old.⁸ Since most animals slaughtered in the Queensland survey were over 2 years, these small cysts were thought to be indications of recent infection. Few hydatid cysts of this size were detected in our survey, and those that were detected, were generally mineralised. Only 60% of the small cysts in Queensland cattle were necrotic.

The necrotic state of lesions in cattle introduced into the Northern Territory from hydatid endemic areas and a low prevalence of 4.6% further supports the theory that these animals acquired their infections in Queensland as young animals and did not acquire more cysts in the Northern Territory.

Reports from Western Australia indicated that hydatidosis occurred in the northern parts of that state.¹ The Kimberley area in Western Australia is similar in environmental conditions to the northern region of the Northern Territory. However, based on ongoing surveys of property of origin of Kimberley region cattle killed in northern abattoirs, Tully (personal communication) believes there is a sufficient body of evidence to say that a hydatid cycle in the region is most unlikely. The view currently held is that hydatids are not naturally endemic to the northern region of Western Australia but occur only in introduced cattle bred in Queensland.

If there was a local hydatid cycle in the Northern Territory, evidence of this cycle could be seen in feral pigs. Although not the major hosts in hydatid cycles, feral pigs are intermediate hosts of significance in native fauna in Queensland.⁸ In southern Western Australia a cycle involving western grey kangaroos, feral pigs and domestic dogs has been reported.¹⁴

Feral pigs are present in large numbers in the Northern Territory. A total of 790 pigs were extensively examined for lesions resembling tuberculosis by opening the thorax and abdomen.¹⁵ All macroscopic lesions were examined histologically and no lesions indicative of hydatidosis were detected (K. Small personal communication).

If an hydatid cycle does not occur in the northern region of the Northern Territory it poses the question of why such a cycle has not established when cycles are in areas of Queensland with a similar climate. Dingoes cohabit pastures with cattle and wallabies, so a ready source of final and intermediate hosts is available. Environmental factors such as high temperature, low humidity and rainfall will affect the survival of *Echinococcus granulosus* eggs.¹⁶ However these climatic variables could not be used to predict the distribution of *E granulosus* in tropical Queensland.⁸ It has been suggested that in areas where the climate is suitable, the establishment of a cycle depends on the presence of suitable species of wallaby.⁸ Three species of wallaby were found as suitable intermediate hosts for *E granulosus* in Queensland: scrub or black tailed wallaby (*Macropus dorsalis*), whip-tail wallaby (*M parreyi*) and red-necked wallaby (*M rufogriseus*).⁸ These do not occur in the Northern Territory and this may be the limiting factor for the establishment of a cycle. Wallabies present in the Northern Territory include *M agilis*, *M antilopinus*, *M rufus*, *M robustus*, *Lagochestes conspicillatus*, *Onychogalea ungifera*, *Petrogales* species and *M bernardos*. *M robustus* is the only species that occurs in the Northern Territory and which has been recorded elsewhere as having hydatid cysts.³ Macropods in which hydatid cysts have been demonstrated in other parts of Australia are: tammar wallaby (*M eugenii*), Eastern grey kangaroo (*M giganteus*), wallaroo/euro (*M robustus*), red-necked wallaby (*M rufogriseus*), red-legged pademelon (*Thylogale stigmatica*), red-necked pademelon (*T thetis*) and black-tailed or swamp wallaby (*Wallabia bicolor*).³

The lack of hydatid cysts in cattle bred in the Northern Territory and the state of necrosis of cysts found in cattle bred in Queensland suggests that an active cycle of hydatid transmission has not established in the northern region of the Northern Territory.

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