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POSTER PRESENTATIONS

Animal Behavior & Well-Being - Livestock and Poultry

T1 Impact of elevated embryonic corticosterone on development, stress, and fear in broilers. S. M. Brougher and S. J. Snow*, *Delaware State University, Dover.*

Corticosterone (B), an adrenal steroid, is known to elevate in response to stressful poultry housing conditions (e.g. temperature extremes, density, negative behavioral interactions, and feed restriction). Negative consequences associated with elevated stress in poultry include reduced growth, increased fear, developmental instability, and compromised welfare overall. One concern is the deposition of B from stressed female broiler breeders into the yolks of their developing offspring. We hypothesized that an exogenous increase in embryonic B could disrupt development of the hypothalamic-pituitary-adrenal system, potentially manifesting through long term alterations in endpoints such as growth, fear, developmental stability, and plasma B. Broiler eggs were incubated at 37°C and 65% relative humidity, and randomly assigned to four treatment groups: control (C), sham control (S), low dose (L: 10 ng/mL) and high dose (H: 20 ng/mL) of B. Exogenous B was delivered via corn oil vehicle into the air cell of fertile eggs at d4 of incubation. Hatchlings were placed in 8 pens with 4 birds/treatment/pen (n=16 birds/pen) for 5 wks. Body weight was recorded weekly, and the following measurements were taken at 5 wks of age: (1) tonic immobility to determine the fear response; (2) the degree of asymmetry in tarsometatarsal length and width to evaluate developmental stability; and (3) plasma B by ELISA to determine overall levels of stress. Data were analyzed using a one-way ANOVA. Results showed no significant differences in growth rate degree of fluctuating asymmetry or the length of tonic immobility. Although there were no significant impacts of treatment on B levels, there was a trend ($P = 0.08$) for control and sham control females to have lower plasma B than males. In conclusion, the results of our study indicate that elevating B exposure during embryonic development does not seem to have any lasting residual effects on growth, fear response, or plasma B, therefore is unlikely to have any long term impact on broilers during the growout phase.

Key Words: Broiler, Stress, Fear

T2 The effects of rearing broiler chickens under different light intensities on fear responses. G. Fagerberg, J. A. Mench* and G. S. Archer, *University of California, Davis.*

It has been suggested that welfare of commercial broilers could be improved by increasing the ambient light intensity during growout.

However, there is also concern that broilers reared under high light intensities may be more fearful and difficult to catch at market age. Straight-run Cobb broiler chickens (N=240) were housed in environmental chambers providing either 5 (LOW), 50 (MED) or 200 (HIGH) lux illumination during the 16-hour photophase. There were 4 chambers of chickens/treatment. Beginning at week 4 of age, four tests were used to evaluate fearfulness: 1) induction of tonic immobility; 2) response to novel object placed in the home pen; 3) response to novel human entering the home pen; 4) response to inverted handling after catching. Data were analyzed using the GLM. There was a trend ($F=3.69$; $p=0.068$) for a difference in the novel human test, with the latency for the last, but not the first, bird in the pen to approach the novel human being greater in HIGH (120.07 ± 41.63) than in either MED (17.40 ± 3.40) or LOW (54.40 ± 21.37), with the difference between HIGH and MED being statistically significant. However, there were no significant treatment differences for the three other tests, with the number of attempts to induce tonic immobility and tonic immobility duration; number of vocalizations and number, intensity and duration of wingflaps during inverted handling; and latencies to approach the novel object; being similar among the treatment groups. These results suggest that rearing broilers at higher light intensities has little effect on fearfulness or on responses to catching and handling at market age.

Key Words: Broiler, Fear, Lighting

T3 Effect of feeding space availability on aggressive behavior of Holstein heifers on high-concentrate diets. L. A. González*¹, A. Ferret¹, X. Manteca¹, J. L. Ruiz-de-la-Torre¹, S. Calsamiglia¹, M. Devant², and A. Bach², ¹*Universitat Autònoma de Barcelona, Bellaterra, Spain*, ²*Unitat de Remugants-IRTA, Barcelona, Spain.*

Seventy two Holstein heifers (BW 138.0 ± 2.4 kg) were randomly assigned to a 3×3 complete block design, similar BW between treatment pens of each weight block, to study the effect of the feeding space availability on social behavior. Treatments consisted of 1 (T1), 2 (T2) or 4 (T4) concentrate feeding places/pen separated by vertical feed barriers (8 heifers/pen). The linear space available in the 2 straw feeders per pen was 0.35 m/animal in T1 and T2, and 0.25 m/animal in T4 pens with no feed barriers. Concentrate (3 Mcal of ME/kg, 16.4% CP, 20.3% NDF, DM basis) and straw were fed daily at 0830 ad libitum and in different feeders. Video recordings were analyzed by continuous sampling for the number and location of displacements over 2 d in wk 8, 16 and 28 of the fattening period. Data were analyzed as

a Poisson regression model considering the fixed effects of treatment, block and week (repeated measure), and pen as a random effect. The number of displacements (ND) per pen and day in the concentrate feeders was greatest in T1 (67.0 ± 2.6), intermediate in T2 (33.7 ± 1.8) and lowest in T4 (19.3 ± 1.4 ; $P < 0.05$). The ND in the straw containers was greater in T4 (54.8 ± 3.5) compared to T1 (36.2 ± 3.0 ; $P < 0.05$) and T2 (38.3 ± 3.2 ; $P < 0.10$). The ND in the water bowls (2 per pen) was greater in T2 (22.2 ± 1.4) compared to T1 (12.8 ± 1.1) but no different from T4 (17.2 ± 1.3 ; $P < 0.05$). These led to a treatment effect ($P < 0.05$) for the total ND per pen and day being greatest in T1 (122.4 ± 6.2), intermediate in T2 (100.6 ± 5.3) and lowest in T4 (81.9 ± 4.5). Although the ND from the concentrate feeders were highest with the lowest number of feeding places per pen (T1) and the ND from straw feeders were highest with the lowest linear space per animal (T4), it is possible that T2 groups re-directed part of the aggressive interactions, needed to establish or maintain the priority of access to resources, towards the water bowls.

Key Words: Heifers, Feeding Space, Aggressive Interactions

T4 Relationship between calves' social rank and performance after arrival at the feedlot with different feeding place availability.

L. A. González*¹, A. Ferret¹, X. Manteca¹, J. L. Ruiz-de-la-Torre¹, S. Calsamiglia¹, M. Devant², and A. Bach², ¹Universitat Autònoma de Barcelona, Bellaterra, Spain, ²Unitat de Remugants-IRTA, Barcelona, Spain.

Seventy two Holstein female calves (BW = 110.4 ± 2.5 kg) were randomly assigned to a 3×3 complete block design to study the effect of social dominance on ADG during wk 1 and 3 after arrival at the feedlot with different levels of social pressure at the concentrate feeders. Calves were blocked by BW and treatments consisted of 1 (T1), 2 (T2) or 4 (T4) feeding places/pen (8 calves/pen). Pelleted concentrate and straw were fed at 0830 ad libitum and in different feeders. Displacements between calves from the concentrate and straw feeders, and water bowls, were registered over 3 d at wk 1 and 3 after arrival at the feedlot, and DMI and ADG were determined weekly. Angular dominance value (ADV) was calculated as the arcsine square root of the average proportion of displacements won by an animal against each dyad member in the pen. Data were analyzed with a linear mixed regression model considering the fixed effects of treatment and block, and the linear and quadratic effect of ADV. Week as a repeated measure, animal within pen and pen were random effects. DMI and ADG increased linearly ($P < 0.05$) during wk 1 as the number of feeding places per pen increased. DMI increased quadratically at wk 3 ($P = 0.02$) with the lowest DMI for T1 calves. A significant ADV \times week \times treatment interaction was observed ($P < 0.001$). In T1 calves, increasing ADV resulted in a linear decrease in ADG at wk 1 ($\beta = -0.55$; $P = 0.03$) and a quadratic increase at wk 3 ($\beta = 5.49$; $\beta^2 = -3.45$; $P < 0.01$) showing a high positive slope. In T2 calves, increasing ADV resulted in a linear decrease of ADG at wk 1 ($\beta = -0.50$; $P = 0.04$) but a linear increase at wk 3 ($\beta = 0.56$; $P = 0.02$). No significant effect of social rank on ADG was observed in T4 calves. Increasing social pressure at the concentrate feeders reduced DMI and ADG because the repercussions of dominance values were greater.

Key Words: Calves, Feeding Place, Dominance

T5 Behavior and welfare of laying hens in single-tier aviaries with and without outdoor area. T. Tanaka*¹, T. Shinmura¹, T. Suzuki¹, S. Hirahara², Y. Eguchi¹, and K. Uetake¹, ¹Azabu University, Sagamihara, Japan, ²Kanagawa Prefectural Livestock Industry Technical Center, Ebina, Japan.

The objective of the present study was to examine the behavioral frequency and pattern of laying hens in single-tier aviaries with and without outdoor areas, and to compare the welfare level between the two systems in association with other important measurements. In total, 144 interbred cross layers (WL \times RIR) were used. At the age of 16 weeks, the hens were randomly divided into two groups consisting of four single-tier aviaries (SA) with 18 hens per pen and four free-range systems (FR) with 18 hens per pen. The free-range system was a single-tier aviary with an outdoor area (1.1 m²/hen) with planted clover. Behavioral observations were conducted before (0600-0800), during (1000-1200 and 1300-1500) and after (1700-1900) the pasturage. Eating, grazing, drinking, preening, aggressive pecking, feather pecking, litter pecking, object pecking and mate pecking were defined as pecking behavior. Feather condition, foot condition, TI test, H/L ratio were also measured. 18% of FR hens spent their time grazing. Conversely, eating ($P < 0.01$), preening ($P < 0.01$), litter pecking ($P < 0.05$), object pecking ($P < 0.05$), aggressive pecking ($P < 0.01$) and feather pecking ($P < 0.01$) were more frequently performed in SA than in FR. The total frequency of pecking behavior in SA was similar to that in FR ($61.7 \pm 2.0\%$ and $64.0 \pm 0.8\%$, respectively). While pre-laying behavior decreased from 0600-0800 to 1700-1900, pecking behavior increased. Aggressive pecking and feather pecking were observed frequently at 1000-1200 and 1300-1500 in SA, and at 1700-1900 in FR (system \times observation time, both $P < 0.01$). Feather condition on the part of vent as worse in SA than in FR ($P < 0.05$). Claw lengths of the center front and rear were shorter in FR than in SA ($P < 0.001$ and $P = 0.06$, respectively). TI duration was shorter in FR than in SA ($P < 0.05$). In conclusion, it was suggested that total frequency of pecking behavior was similar between these systems either with or without outdoor area. The risk for cannibalism is lower, and hens' fear reaction and claw length is also improved by the existence of an outdoor grazing area. It was indicated that welfare level is higher in FR compared with SA.

Key Words: Non-cage System, Welfare

T6 Relation between social order and use of resources in small and large furnished cages for laying hens. T. Shimmura*¹, T. Azuma¹, S. Hirahara², Y. Eguchi¹, K. Uetake¹, and T. Tanaka¹, ¹Azabu University, Sagamihara, Japan, ²Kanagawa Prefectural Livestock Industry Technical Center, Ebina, Japan.

The objective of the present study was to determine the relation between social rank and use of resources such as the nest box and dust bath by using a popular smaller furnished cage and an approved large one. In total, 92 interbred cross layers (WL \times RIR) were used. At the age of 16 weeks, the hens were randomly divided into two groups consisting of four small furnished cages (SF, 90 cm wide \times 46.5 cm deep) with five birds per cage, and four large furnished cages (LF, 240 cm wide \times 62.5 cm deep) with 18 birds per cage. The dominance hierarchy was determined; by which high, medium and low ranked hens in each cage were identified. The behavior, use of resources and physical condition of these hens were measured. Data were analyzed by using repeated measure ANOVA. The high ranked hens spent more

time in the dust bath than the medium and low ranked hens in LF (both $P < 0.05$), while no significant difference was found between them in SF. The high ranked hens performed dustbathing and litter scratching more frequently than the medium and low ranked hens in LF (both $P < 0.01$), while no significant difference was found between them in SF. The amount of time spent in the nest box was similar between each rank in SF and LF. However, the amount of time spent by LF low ranked hens performing pre-laying (sitting in nest) was lower compared with LF medium and high ranked hens (Social order \times Cage design, $P = 0.08$). Concerning hens in the nest box, more than 90% of SF hens, LF high and medium ranked hens performed pre-laying. Conversely, LF low ranked hens spent their time escaping (33.1%), pre-laying (27.7%), standing-resting (25.7%) and moving (13.5%) in the nest. In conclusion, under the condition that aggressive interaction occurred frequently, higher ranked hens would have priority using the dust bath. In contrast, low ranked hens would spend more time in the nest box for 'refuge' rather than for laying. It was also suggested that allowances for the size and/or arrangement methods of each resource be made in furnished cages, especially large ones.

Key Words: Furnished Cage, Social Order, Resource

T7 Effects of dust bath and nest box arrangement on behavior of high-, medium- and low-ranked hens in furnished cages. T. Shinmura*, Y. Eguchi, K. Uetake, and T. Tanaka, *Azabu University, Sagamihara, Japan*.

In our previous studies, it was confirmed that aggressive interaction occurred frequently in the dust baths in furnished cages. In later research, we demonstrated that dominant hens had priority in using the dust bath. Also, it was reported that this tendency was more pronounced in the larger furnished cages. Therefore, we contrived a new medium furnished cage with separated resources. The objective of the present study was to evaluate the effects of dust bath and nest box arrangement on the behavior of hens from each rank in the new furnished cages compared with small and medium furnished cages with concentrated resources. In total, 150 White Leghorn layers were used. At the age of 17 weeks, the hens were randomly divided into three groups consisting of small furnished cages (SF, 90 cm wide \times 46.5 cm deep; six cages; five birds per cage) and two types of medium furnished cages (180 cm wide \times 46.5 cm deep; six cages; 10 birds per cage) with separated resources on both sides (MFS) and concentrated resources on one side of the cage (MFC). The dominance hierarchy was determined, by which high, medium and low ranked hens in each cage were identified. The behavior, use of resources and physical condition of these hens were measured. Data were analyzed by using repeated measure ANOVA. Significant interaction between social order and cage design were found in reference to the amount of time spent in the dust bath and on performing dustbathing (both $P < 0.001$), and these proportions of time were higher among the SF high ranked hens, MFC high and medium ranked hens than in the low ranked hens. Conversely, the MFS low ranked hens used the dust bath more than the SF and MFC low ranked hens. In MFS, hens from each rank used the dust bath equally, though the high ranked hens used this resource less than the SF and MFC high ranked hens. In conclusion, higher ranked hens had priority over use of the dust bath in SF and MFC. In contrast, it was confirmed that each rank of hens used the resources equally in MFS. It was suggested that separation of the resources in furnished cages is an effective measure in improving hen welfare.

Key Words: Furnished Cage, Social Order

T8 Effect of stocking density on the short-term behavior of dairy cows. C. T. Hill^{1,2}, P. D. Krawczel^{*1,2}, H. M. Dann¹, C. S. Ballard¹, R. C. Hovey², and R. J. Grant¹, ¹*W.H. Miner Agricultural Research Institute, Chazy, NY*, ²*The University of Vermont, Burlington*.

The objective of this study was to determine the effect of stocking density on the short-term behavior of dairy cows. Holstein cows ($n = 136$) were housed in a freestall barn, fed a total mixed ration daily and milked 3 \times daily. Cows were assigned to 4 pens with stocking densities (100, 113, 131, and 142%) imposed in a 4 \times 4 Latin square for 7 d. Each cow was provided a stall and headlock at 100% stocking density while the greater stocking densities were simulated by denying access to freestalls and headlocks. The mean percentage of cows feeding, lying, and standing was determined using 10-min scan samples from digitally-recorded video data collected during the final 2 d at each stocking density. Milk composition was determined for all cows during a 24-h period at each stocking density. Although the mean percentage of cows feeding during a 24 h period (20.5%) did not differ among treatments ($P = 1.0$), increased stocking density reduced the percentage of cows feeding following their return from milking (67.2 at 100% stocking density versus 54.8 at 142%; $P = 0.009$). The percentage of cows lying decreased from 50.8 at 100% stocking density to 47.4 at 142% ($P = 0.007$). The percentage of cows standing in an alley increased from 8.8 at 113% stocking density to 12.6 at 142% ($P < 0.001$), while the percentage standing in stalls decreased from 10.8 at 100% stocking density to 9.2 at 142% ($P = 0.02$). Milk fat was reduced from 3.8% at 100% stocking density to 3.6% at 142% ($P = 0.03$). The decreased percentage of cows lying, increased percentage of cows standing, and reduced milk fat percentage suggest that increased stocking densities were detrimental. However, similar behavioral responses at 100% and 113% stocking density indicate cows can be housed at 113% before observable changes in behavior occur.

Key Words: Stocking Density, Behavior

T9 Survey of calf and heifer husbandry practices on dairies in the mid-western and eastern U.S. W. K. Fulwider*, T. Grandin, D. J. Garrick, T. E. Engle, W. D. Lamm, N. L. Dalsted, and B. E. Rollin, *Colorado State University, Fort Collins*.

The objective was to determine how heifers are being managed on dairies up until the time of calving. Dairies were visited during the fall and winter in WI, MN, IN, IA, and NY. Data were collected on 113 dairies regarding colostrum feeding, dehorning, tail docking, custom calf-raising, and the level of satisfaction with calf-raising by producers. Three feedings of colostrum were received by calves on 24% of dairies, 2 feedings on 62% of farms, 1 feeding on 30% of farms, and no colostrum fed on 4% of farms. Many farms (62%) administered 3.8 L at first feeding. Calves were dehorned at various ages by various methods. Between 2 and 4 wk was the most common time to dehorn, with 25% of calves processed. By 20 wk, 83% of calves were dehorned. The majority of calves were dehorned by burning (66%). The remainder was dehorned by gouging (9%), paste (10%), saw (4%), and unknown by calf owner (12%). Anesthetic use was reported by 12% of dairy owners, and analgesia use by 2%. Tail-docking was reported on 86% of dairies. None of the dairies trimmed switches. The most common reported docking period was pre-, or post-calving (27.68%). The second most commonly reported period was day 1 of life (13%). Banding was the most common method (75%) followed by pruning (25%). Three dairies pruned pre-calving, one at 2-mo, and

two at day 1. Cleanliness was the most common reason to dock (73%), parlor milking (17%), and udder health (1%). Calves were raised by the owner on 50% of dairies, while 44% custom raise calves for at least a portion of the growing period. Only one producer sold calves and purchased heifers back pre-calving. Only 29% of dairies had heifers'

custom raised during a portion of the milk feeding period. Satisfaction reported by producers regarding calf-raising was highly satisfied (51%), satisfied (31%), okay (8%), less than satisfied (6%), and need to change (3%).

Key Words: Calf, Dehorn, Tail-dock

Animal Health - Livestock and Poultry: Poultry/Swine/Goat/Sheep

T10 Colicin E1 prevents *Escherichia coli* F18 caused post-weaning diarrhea in pigs. S. A. Cutler*, N. Cornick, S. M. Lonergan, and C. H. Stahl, *Iowa State University, Ames.*

The use of dietary prophylactic antibiotics to prevent post-weaning diarrhea (PWD) in pigs is common practice in the U.S. swine industry. Despite this preventive measure, PWD still causes substantial losses to the swine industry due to both mortality and reduced growth performance in surviving pigs. With world-wide concern over the use of antibiotics in animal agriculture, alternatives to conventional antibiotics are desperately needed. The bacteriocin, Colicin E1 (ColE1), is effective against the *E. coli* strains responsible for PWD in vitro. In this study, we examined the efficacy of dietary inclusion of ColE1 in preventing experimentally induced PWD. Weaned pigs (n=16, 18d of age), all genetically susceptible to *E. coli* F18, were allocated into 2 groups, based on body weight, and fed corn-soy diets containing either 0 or 16.5mg ColE1/kg diet. After 2d on the treatment diets, all animals were orally inoculated with 1×10^9 CFU of 2 *E. coli* F18 strains isolated from pigs with PWD. Body weight (BW) and fecal scores were recorded daily, and *E. coli* coli from rectal swabs were enumerated daily. All animals were euthanized 4d post-inoculation and sections of the ileum were collected for histology, *E. coli* enumeration, and gene expression. The inclusion of ColE1 decreased ($P \leq 0.05$) the incidence and severity of PWD as demonstrated by the reduction ($P \leq 0.05$) in incidence of diarrhea (none in ColE1 fed pigs vs. 6 out of 8 in the controls). Inclusion of ColE1 improved ($P \leq 0.05$) BW gain for ColE1 fed pigs compared to the controls (940g/d vs. 380g/d, respectively), and it is interesting to note that 3 control pigs, but none of the pigs fed ColE1, lost weight during this trial. Additionally, dietary addition of ColE1 reduced the gene expression of the cytokines *IL1 β* ($P \leq 0.02$), *iNOS* ($P \leq 0.08$), and *TNF β* , ($P \leq 0.06$) in ileal tissue compared to the control animals, suggesting a decreased inflammatory response in these pigs. Dietary inclusion of ColE1 appears to be an effective alternative to conventional antibiotics in the diet of swine for the prevention of PWD.

Key Words: Pigs, Colicin, PWD

T11 Evaluation of photonic imaging in the gastrointestinal tract of swine following oral inoculation with lux-modified *Salmonella typhimurium*. K. Moulton*¹, P. Ryan¹, R. Youngblood¹, M. McGee¹, S. Laird¹, A. Harris¹, D. Moore¹, I. Kim¹, D. Lay², and S. Willard¹, ¹Mississippi State University, Mississippi State, ²USDA-ARS, West Lafayette, IN.

The objective was to evaluate photonic emitting bacteria through different segments of the gastrointestinal tract of swine. Pigs (~ 80 kg) were inoculated orally with 3.1 or 4.1×10^{10} CFU of *Salmonella typhimurium* transformed with plasmid pAK1-lux (*S. typh-lux*) for a 6 (n=6) or 12 (n=6) h incubation in vivo. Pigs were euthanized at 6 or

12 h. Intestinal regions (duodenum, jejunum, ileum, large intestine) were divided into 5 replicates of 4 segments (5 cm) each for imaging. For each replicate, two segments of each region were intact, while 2 segments were opened to expose the digesta. Sub-samples of digesta were analyzed for CFU, and images were analyzed for relative light units/sec (RLU/sec). At 6 h, a higher ($P < 0.05$) concentration of emitting bacteria and consequently higher ($P < 0.05$) detection of photonic emissions was observed in small intestine than large intestine. The correlations (6 h) of photonic emissions in opened segments to bacterial concentrations were $r = 0.73, 0.62, 0.56,$ and 0.52 ($P < 0.05$) in duodenum, jejunum, ileum, and large intestine, respectively. Photonic emissions were higher ($P < 0.05$) in jejunum, ileum, and large intestine than in duodenum of intact segments post 6 h incubation. At 12 h, a higher ($P < 0.05$) concentration of emitting bacteria in jejunum and ileum of open segments was observed than in duodenum and large intestine of open segments. Photonic emissions were higher in ileum than duodenum, jejunum and large intestine of open segments ($P < 0.05$). The correlations (12 h) of photonic emissions in opened segments to bacterial CFU's were $r = 0.71$ and 0.62 for jejunum and ileum, respectively ($P < 0.05$). At 12 h, a higher ($P < 0.05$) concentration of emitting bacteria in jejunum and ileum of intact segments was observed than in duodenum and large intestine. These data indicate CFU were higher in small intestine after 6 and 12 h incubations, and a minimum of 2.0×10^5 CFU yields detection through these tissues (~ 1.0 to 21.0 RLU/sec). This study demonstrates feasibility of using biophotonics in research models for evaluating pathogenicity of *Salmonella* in swine.

Key Words: Swine, Biophotonics, *Salmonella*

T12 Development and optimization of species-specific PCR for rapid detection of *Dermatophilus congolensis*. S. Valipe, M. Amalaradjou, J. Nadeau*, A. Thirunavukkarasu, and K. Venkitanarayan, *University of Connecticut, Storrs.*

Dermatophilosis is a contagious and zoonotic disease in farm animals caused by *Dermatophilus congolensis*. Dermatophilosis is responsible for significant economic losses due to reduced milk production in cattle, wool losses in sheep, lameness and loss of days in showing horses. Accurate and rapid diagnosis of dermatophilosis is essential for specific therapeutic and preventive measures against the disease. The currently available methods for identification of *D. congolensis* are laborious and time-consuming; thus there is a need for a rapid method for detecting the bacterium. Polymerase chain reaction (PCR) is a highly specific and sensitive method used for the rapid detection of microorganisms. In this study, we developed a species-specific PCR to detect *D. congolensis* based on a 1029-bp internal, conserved region of its alkaline ceramidase gene. Chromosomal DNA from 8 strains of *D. congolensis* and 33 strains of negative control bacteria, including other common equine pathogens, environmental bacteria and