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2012

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### **Recommended Citation**

Riddle, Heidi, David Miller, and Dennis Schmitt. "Tuberculosis in Elephants: Assessing Risks Versus Resources." *Gajah* 37 (2012): 31-33.

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## Tuberculosis in Elephants: Assessing Risks Versus Resources

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Over the past years, periodic meetings to discuss various elephant health concerns have been hosted in the U.S. These meetings have brought together elephant managers, veterinarians, scientists, federal and state regulatory veterinarians, public health officials, and human infectious disease experts. Tuberculosis (TB; mostly *Mycobacterium tuberculosis* in the U.S.) in elephants has been a focus of some of these meetings because of its high profile and the extensive resources currently invested in this issue. Nevertheless, the degree to which TB compromises elephant health remains unclear; yet large sums of funding are spent on the diagnosis, treatment, and management of TB, diverting potential resources from conservation.

In the context of Asian elephant conservation, managing disease and other health issues calls for an assessment of the risks to the species versus the allocation of available resources. Epidemiologists view disease as the interactions between hosts (i.e. immune system function), agents (i.e. TB and other infectious and noninfectious causes of disease), and the environment. Environmental contributions to the development of disease in elephants include poor nutritional resources, and presumed stress associated with factors such as habitat loss, increased habitat sharing with domestic animals, and human-elephant conflict. Environmental contributions to disease are particularly important to consider for free-ranging wildlife, including elephants, because they are often the most realistic points of intervention for disease control in these populations. It is more practical to manage the environment to optimize elephant health and minimize transmission of infectious agents, than it is to treat free-ranging elephant populations for diseases such as TB.

Elephant conservation should always consider overall elephant population health and welfare, and objectively apply sound science to balance health risks and resources to achieve the most benefit. While evidence-based medicine is increasingly accepted as a sound approach for animals and humans, there are substantial challenges in conducting rigorous research for many of the problems faced by elephants. This often results in basing management decisions on research studies with designs that have limited application to the question at hand.

The extent to which elephant (population and individual) health is affected by TB has not been clearly documented, yet in recent years large amounts of resources have been spent on this specific issue. This is a concern in Asian range countries where resources are very limited. Elephant health management programs that emphasize the risks of a single disease without first assessing the risks of other health and conservation concerns, relative to the benefits of various management strategies, will result in misallocation of resources and ultimately undermine elephant conservation efforts. In other words, disease management strategies need to consider "the big picture", be based on rigorous science, and use transparent and objective strategies for balancing risks and benefits for various management plans and the corresponding allocations of funding. Comprehensive assessments of TB, relative to other health and conservation challenges, have not been conducted for elephants.

Central concerns since the first recognition of TB in elephants include: individual elephant

welfare, occupational risks to those working with elephants, and public health risks. These concerns present complex challenges. In part, this is due to the biology of the organism (a chronic infection that is difficult to diagnose); differing viewpoints on animal welfare in a dynamic animal welfare and animal rights environment; perceived or real human health risks; the challenges of developing rigorous scientific projects on small populations of endangered species; and a complex regulatory environment in some countries. Much confusion has resulted from debate regarding the strengths and weaknesses of various testing methods (culture and serology/blood testing); incorrect published estimates of TB prevalence; uncertainty about effective drugs and side effects for elephants with TB; and other factors. This confusion is of particular concern where elephant or human welfare, and elephant conservation can be compromised or limited.

There is a need for improved information and clarity on the key issues. In order to objectively and scientifically address concerns about TB, professional elephant stakeholders have discussed and support the implementation of several focal studies, currently underway. Additionally, a comprehensive study has been initiated that will review animal welfare, experimental design, current elephant TB literature, and regulatory concerns, with the intent of providing focus to future research and TB management guidelines.

### **Some key points about TB and elephants**

\* Incorrect information has been presented in the literature (e.g. Mikota & Maslow 2011) regarding the prevalence of TB in elephants. It has been stated that 18% of the U.S. Asian elephant population is infected with TB. However, this is a cumulative figure that does not use accepted epidemiological calculations because it includes elephants that are no longer living, while also failing to retroactively exclude elephants that have been “cleared” of active TB infection post treatment. As of January 1, 2012, the prevalence of TB in Asian elephants in the U.S. is closer to 5%. There have been no significant changes in the number of newly culture positive animals on an annual basis over the past decade, and this

number corresponds to about one new case per year. Consequently, incorrect estimates of the percentage of TB infected elephants inaccurately skew perceptions and understanding of the actual prevalence of active TB infections in elephant populations.

\* To date, there is no science-based definition of “exposure” to differentiate high-risk transmission situations for elephants from those with little or no risk. There is a gap in knowledge about factors that assist in decisions affecting the management of TB infected or exposed elephants. To address this topic, an epidemiological survey of all elephants in the U.S. is currently underway. The results of this survey will provide information to assist with management of TB in this population, and serve as a guide for resolving this issue.

\* Risks of TB transmission are also relevant to humans. Human exposure risks must clearly distinguish between the risks for those working with and handling elephants (occupational health), and health risks for members of the public that are near to but not in close contact with elephants, particularly in open air settings. Anecdotally, elephant managers and veterinarians, most of whom are regularly tested for TB, say that the occupational health risks are low for elephant handlers working with TB infected elephants in the U.S. However, objective data should answer this question, and this will be addressed with a retrospective study of the occupational health risks that is now in progress.

\* There is still no conclusive evidence to show the definitive direction of TB transmission between humans and elephants. In humans, *M. tuberculosis* is not highly transmissible, even within a household. It is well understood in human medicine that the disease spreads exclusively through aerosolization; this suggests that the same applies to elephants and that fomite (i.e. from touching objects such as feed tubs) transmission may be minimal or nonexistent. Furthermore there have been no documented cases of members of the public becoming TB infected from an elephant. Therefore it appears that elephants with *M. tuberculosis* infections pose a very low public health risk.

\* Serology has not proven to be an effective diagnostic tool for TB in humans or for *M. bovis* control programs. Serology is not a part of *M. bovis* control programs for cattle in the U.S. Similarly, a World Health Organization (WHO) report (2011) on the use of serology for detection of active TB infection in humans indicates that they are not accurate or consistent predictors of infection. As a result, in 2012 India became the first country to ban TB serology diagnostic tests for humans, with a notification issued by the Ministry of Health and Family Welfare. Serology tests for TB in elephants, the StatPak and MAPIA, have been heavily promoted and proposed to be highly accurate. However the sensitivity and specificity of these tests have been evaluated only at the extremes of known non-infected and known late stage infected elephants. For all other elephants, the sensitivity, specificity, and predictive value have not been determined. Based on other species and anecdotal evidence of false positives and negatives in U.S. captive elephants, it is likely that the accuracy of serologic tests for elephants is less than is currently marketed. Therefore, serology results alone should not be the basis for classifying elephants as TB “positive”, and treatment based on serology alone can be questioned in the absence of supporting evidence or concerns.

\* While there has been considerable focus on diagnostic tests for TB in elephants, little attention has been given to treatment. The current treatment regimen for TB in elephants is very costly, long term, can have severe side effects on the elephant being treated, and requires significant veterinary oversight. There is still insufficient identification of pathologies resulting from adverse anti-tuberculosis drug effects; optimal routes for administration of medications have not been clarified; and better parameters for evaluating treatment success (blood levels of drugs are currently used) have not been addressed. Maintaining open communication for updates on recent developments in human TB treatments is useful. A new pharmacokinetic study of the drugs used in treating tuberculosis in elephants is currently underway in the U.S, and resulting data will contribute to the development of improved treatment protocols.

In Asian elephant conservation, an existing and important concern is how to best invest resources to improve elephant health. Limited resources are available for use on broad elephant conservation issues, i.e. habitat protection, conflict mitigation, etc. While individual animal welfare needs often gain attention, the challenge is balancing large investments in individual animals’ needs as well as use of resources to more broadly benefit elephant populations. To better assess factors that limit the ability to address overall elephant health and management concerns in Asia, a study surveying local veterinarians was initiated to place various medical conditions and infrastructure needs in context. Rather than focus on a single disease, as discussed above, the survey is intended to address all health and management concerns that impact captive and free-ranging elephant populations in Asia. Currently, almost fifty surveys from most of the Asian elephant range countries are being analyzed, and results will be published. Given the many challenges facing elephants in Asian range countries, such as habitat loss, human-elephant conflict, and other factors that increase elephant mortality rates and decrease reproduction, this survey will serve as a starting point for identifying resource investments that will provide the most population benefit. This is analogous to investing resources into preventive care and common diseases in human populations, rather than into uncommon but expensive diseases, to achieve the greatest benefit to the population with existing resources. Consequently, this survey’s broad-based approach is critical for placing potential health risks in perspective, and identifying strategies that will effectively improve the health and welfare of elephants in Asia.

When addressing elephant health, in particular where it impacts conservation strategies, we encourage the conservation community to carefully assess all of the factors that contribute to the development of diseases, and objectively and transparently evaluate the relative risks and allocation of resources. We anticipate that these aforementioned studies will not only clarify appropriate strategies for addressing TB concerns in elephants, but also identify the best ways to invest existing resources to truly benefit Asian elephant health and conservation.