Copepod survival in water bowls exposed to typical Chadian ambient temperatures

Population Biology of Infectious Diseases
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SOUTHEASTERN COOPERATIVE WILDLIFE DISEASE STUDY

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ABSTRACT

Guinea Worm Disease (GWD), caused by the nematode *Dracunculus medinensis,* has been detected with increasing incidence among dogs in Chad, Africa. Cyclopoid copepods (freshwater crustaceans) are intermediate hosts for *D. medinensis*. Currently the route(s) of *D. medinensis* transmission to dogs is still unknown but drinking from unprotected water sources would pose a risk. Dogs have access to water dishes provided for domestic animals and depending on the source of water, these dishes could harbor infected copepods, thereby acting as a source of transmission. To determine how long copepods survive in water dishes when exposed to Chadian ambient temperatures (41.1°C), copepods were placed in three different container types (plastic, glass, and metal) and heated to 40°C. Our results indicate that under simulated Chadian temperatures, metal dishes result in the highest rate of copepods death in the shortest period of time (2hrs) and were the only container to reach 100% copepod mortality. Conversely, plastic dishes exhibited the lowest mortality of copepods. These results indicate that the type of dish used when supplying water for animals in Chad is an important consideration in terms of preventing or interrupting transmission of *D. medinensis* among dogs.

INTRODUCTION

Guinea worm disease is a debilitating disease in humans caused by the parasitic nematode, *Dracunculus medinensis* or African Guinea Worm. Since April 2012, there has been an unusual increase in dog infections in Chad.[1] Classical transmission of *D. medinensis* occurs via consumption of water containing cyclopoid copepods infected with *D. medinensis* third stage larvae (L3s).[2]

People often have water dishes placed outside of their homes for livestock and domestic fowl and this water may be accessed by dogs.[3] Although some water may be acquired from safe sources, it is theoretically possible that providing water that has been acquired from unprotected or previously contaminated water-bodies may lead to transmission of guinea worm to dogs.[3]

Ambient temperatures in Chad during peak *D. medinensis* transmission season (March-June) can reach up to 41.1°C (110°F).[3] Extreme temperatures have proven to cause adverse effects in cyclopoid copepods.[4] Therefore to evaluate the possible risk of *D. medinensis* infection via water provisions, we measured the mortality rates of cyclopoid copepods under Chad ambient temperatures.

GOAL AND HYPOTHESES

Determine how long copepods survive in water bowls (metal, plastic, or glass) when exposed to simulated Chadian ambient temperatures.

Hypotheses: 1) Changes in water temperature will significantly influence copepod mortality and 2) Metal dishes, which absorb more heat, will have a higher mortality of copepods in the shortest amount of time compared to plastic and glass dishes

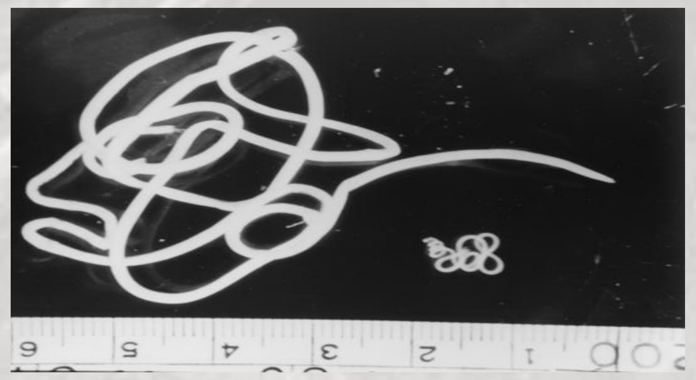

Fig.1 *Dracunculus medinensis*
Left: Female Right: Male[5]

Fig.2 Cyclopoid Copepod

Fig.3 Dog accessing local water source

METHODS

For each system, 100 copepods were added to 1 liter dechlorinated water (30°C) in each of the dish types (plastic, glass, and metal). Dishes were placed under UVA/UVB lamps and exposed to a maximum environmental temperature of 40°C (104°F). Sand was placed under each dish to further mimic the environment in Chad (and because we suspect that sand may absorb and transfer heat). The system temperature, water temperature, percent humidity, and copepod survival (via microscopy) were recorded during set time intervals (2hr, 4hr, 6hr, or 8hr). Live copepods were recovered, categorized by signs of external movement (ex. twitching, rapid propulsion), and enumerated. Five replicate trials per time interval were conducted.

Max: 40 °C

2hr 4hr 6hr 8hr

Fig.4 Three systems (plastic, glass, metal) under lamps with UVA/UVB light bulbs.

Fig.5 Collection of copepods from a freshwater lake

RESULTS

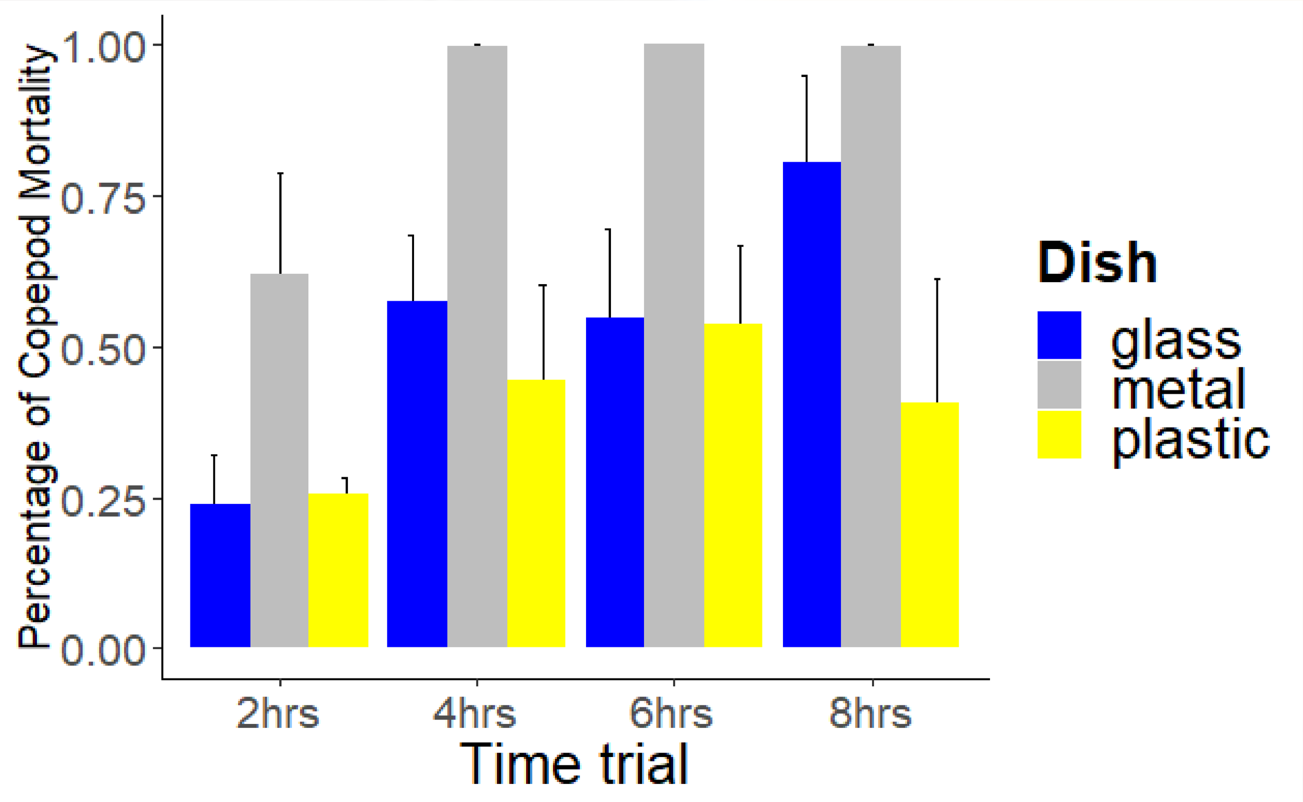

Fig.6: Copepod Mortality in Different Dish Types during Set Time Intervals

- Metal dishes had the highest percentage of copepod mortality in the shortest amount of time.
- 100% of copepods died in metal dishes after 4hrs of exposure.
- Copepod mortality remained <50% in plastic dishes even after 8hrs of exposure to a 40°C heat source.

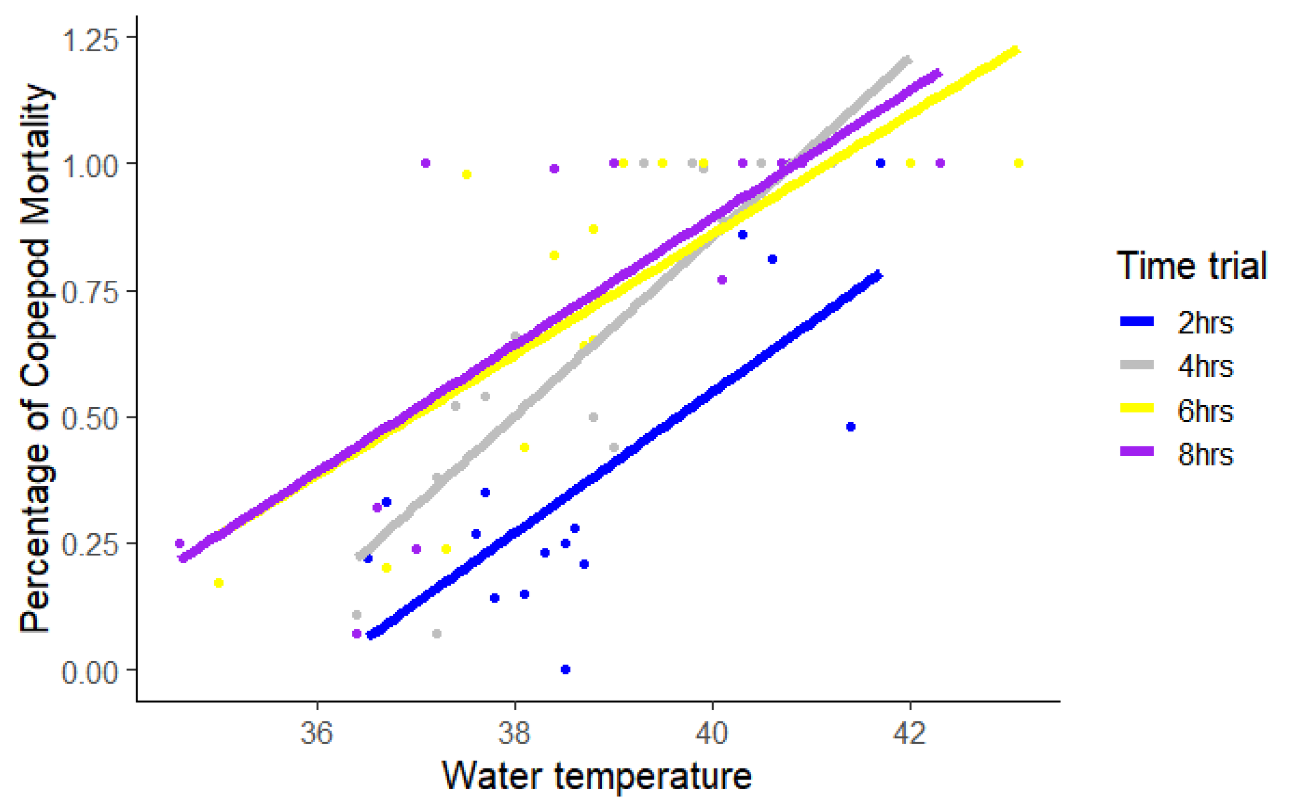

Fig.7: Relationship between water temperature and percentage of copepod mortality.

- Water temperature was a significant factor in copepod mortality ($t=8.076$, $P<0.05$)

*Data was analyzed via a generalized linear model using R statistical software

DISCUSSION

It is currently unknown how dogs are becoming infected with *D. medinensis* but with humans, most transmission is assumed to be via ingestion of water from unprotected sources. Dogs in Chadian villages may have access to water provided for domestic livestock and fowl, and although some of this water maybe from protected sources (i.e., bore well), it is possible that some water is acquired from unprotected water sources. Our data show that should water be acquired from unprotected sources, it is possible for copepods to survive in this provisioned water, although copepod mortality varied with time and container type. **Under simulated Chadian temperatures, metal dishes had the highest copepod mortality in the shortest amount of time.** Metal dishes were the only dish type that resulted in 100% copepod mortality rate after 4hrs and importantly, when plastic dishes were evaluated, half of the copepods remained alive after 8hrs of heat exposure. Overall, our data showed that increasing water temperature decreased copepod survival. High thermal conductivity of the metal dish (compared to the other dish types) likely influenced the water temperature. These data should be informative to local departments of health in Chad and other endemic countries that are focusing on the Guinea Worm eradication.

SUMMARY

- Increases in water temperature can cause death of copepods in provisioned water
- Metal dishes are the best choice for providing water for dogs due to the enhanced killing of copepods.
- Plastic dishes were the least useful as half of the copepods died after a near full day of heat exposure.

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