Growth of *Echinococcus multilocularis* in gerbils exposed to different environmental temperature

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Summary. Gerbils kept at high (35 °C) temperature harbored a significantly larger *Echinococcus multilocularis* cyst biomass than those kept at room (21 °C) and low (5 °C) temperature. Parasite induced adrenomegaly was observed in all temperature groups.

It has been demonstrated that changes in the environmental temperature affect the growth of proliferating cestode larvae *Taenia crassiceps*[2] and *Mesocestoides corti*[3] in their homeothermic hosts. Mice acclimated to and maintained at 5 or 35 °C harbored significantly less *Taenia crassiceps* cysticerci than controls kept at 21 °C. In *Mesocestoides corti* infection, mice kept at low temperature contained significantly larger tetrathyridial populations than controls, those kept at high temperature had significantly smaller tetrathyridial populations in males but not in females. Here results are presented which indicate that environmental temperature also influences growth of another proliferating cestode *Echinococcus multilocularis* in gerbils.

Meriones unquiculatus, of both sexes and 4 months old, were slowly acclimated to their respective environmental temperatures, as described earlier[3]. Following acclimation each gerbil received an inoculum of 0.5 ml of *E. multilocularis* nonfertile cyst suspension, prepared by the method of Lubinsky[4]. 20 days later all animals were killed and the cyst and adrenal weights were determined.

Two experiments were performed and the results are summarized in the table. The mean weights of cysts, infected adrenals (except for those exposed to high temperature, $p < 0.02$), and uninfected adrenals between male and female gerbils were not significantly different. Cold temperature had no effect on the cyst biomass. The mean weights of cysts recovered from gerbils of either sex kept at 5 °C were comparable to those in controls. However, high temperature drastically increased the parasite growth. Gerbils kept at 35 °C had about 115% more parasite biomass in males and about 61% more in females than control animals maintained at room temperature (21 °C). This increase in the cyst weight was significant for both sexes of hosts. In order to determine if low or high temperatures were stressful to the host, the adrenals from all temperature groups from infected and uninfected animals were collected and weighed. The adrenal glands from uninfected gerbils of both sexes were significantly heavier in cold-acclimated hosts, when compared to control or heat-acclimated groups. In a hot environment, where cyst biomass grew significantly larger, no significant increase in adrenal weights due to the temperature effect was detected. However, adrenals of infected animals were in all temperature groups significantly heavier than those of uninfected animals, indicating that the parasite itself induced changes in this organ. Undoubtedly, the temperature effect is indirect and the parasite responds to some temperature induced change in the host's metabolism. It is known that both cold and hot environments change the physiology of the host[5]. In a cold environment, the metabolic rate is increased, compensating for heat loss. This is manifested primarily by elevated levels of thyroxin and adrenocortical hormones. Though this might account for the increased weight of the adrenals of uninfected, cold-exposed animals in the present experiments, the growth of the parasite in these hosts was not altered, when compared to that of controls (21 °C). Exposure to a hot environment depresses the metabolic rate and decreases food consumption in mammals[6,7]. It is possible that the reduced food intake and decreased metabolism acted as stress factors, resulting in lowered host resistance and increased biomass of larval *Echinococcus.*

Thus the present study revealed that high temperature, unlike in other cestode species studied (see above), accelerates the growth and proliferation of *E. multilocularis* cysts in gerbils, and that this parasite, regardless of the host's environmental temperature, induces adrenomegaly. It is known that the host immunity in this parasitic infection is, due to an incessant antigenic exposure, ineffective[8,9]. Since the immunosuppressive effect of adrenal glucocorticoids is now well established, it could be hypothesized that these hormones could have an effect, direct or indirect, on the cells of the immune system. However, the role of hormones in various immune reactions is a new and as yet unexploited area and the answer to this proposition must therefore await the future.

Group	Sex	No. gerbils	Cyst weight (g) mean ± SE		p	No.	Adrenals Infected weight (mg) mean ± SE		p	No.	Adrenals Uninfected weight (mg) mean ± SE		p	Infected vs uninfected adrenals p
5 °C	M	24	1.00 ± 0.09	NS		24	48.06 ± 0.76	*		20	44.78 ± 1.34	*		***
21 °C	M	25	0.96 ± 0.08	*	*	25	39.82 ± 1.04	**	***	19	34.30 ± 0.90	NS	*	*
35 °C	M	22	2.06 ± 0.15			22	44.82 ± 1.37			17	36.90 ± 1.39			*
5 °C	F	24	0.91 ± 0.10	NS		24	50.39 ± 1.17	*		18	46.09 ± 1.66	*		***
21 °C	F	25	1.06 ± 0.12	**	*	25	39.17 ± 1.31	NS	*	18	34.07 ± 0.97	NS	*	**
35 °C	F	25	1.71 ± 0.14			25	40.58 ± 1.02			18	34.07 ± 1.23			**

Summarized results from 2 replicate experiments. *$p < 0.001$; **$p < 0.01$; ***$p < 0.05$. NS, Not significant.

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