

Opportunities to reduce gastrointestinal nematode parasitism through nutrition

Jos Houdijk

Animal Nutrition and Health Team

SAC, Edinburgh

- Background: nutritional consequences of gastrointestinal parasitism
- Direct effects: bioactive forages
- Indirect effects: protein supplementation
- Basket of options
- Conclusions

- **Background: nutritional consequences of gastrointestinal parasitism**

Direct effects: bioactive forages

Indirect effects: protein supplementation

Basket of options

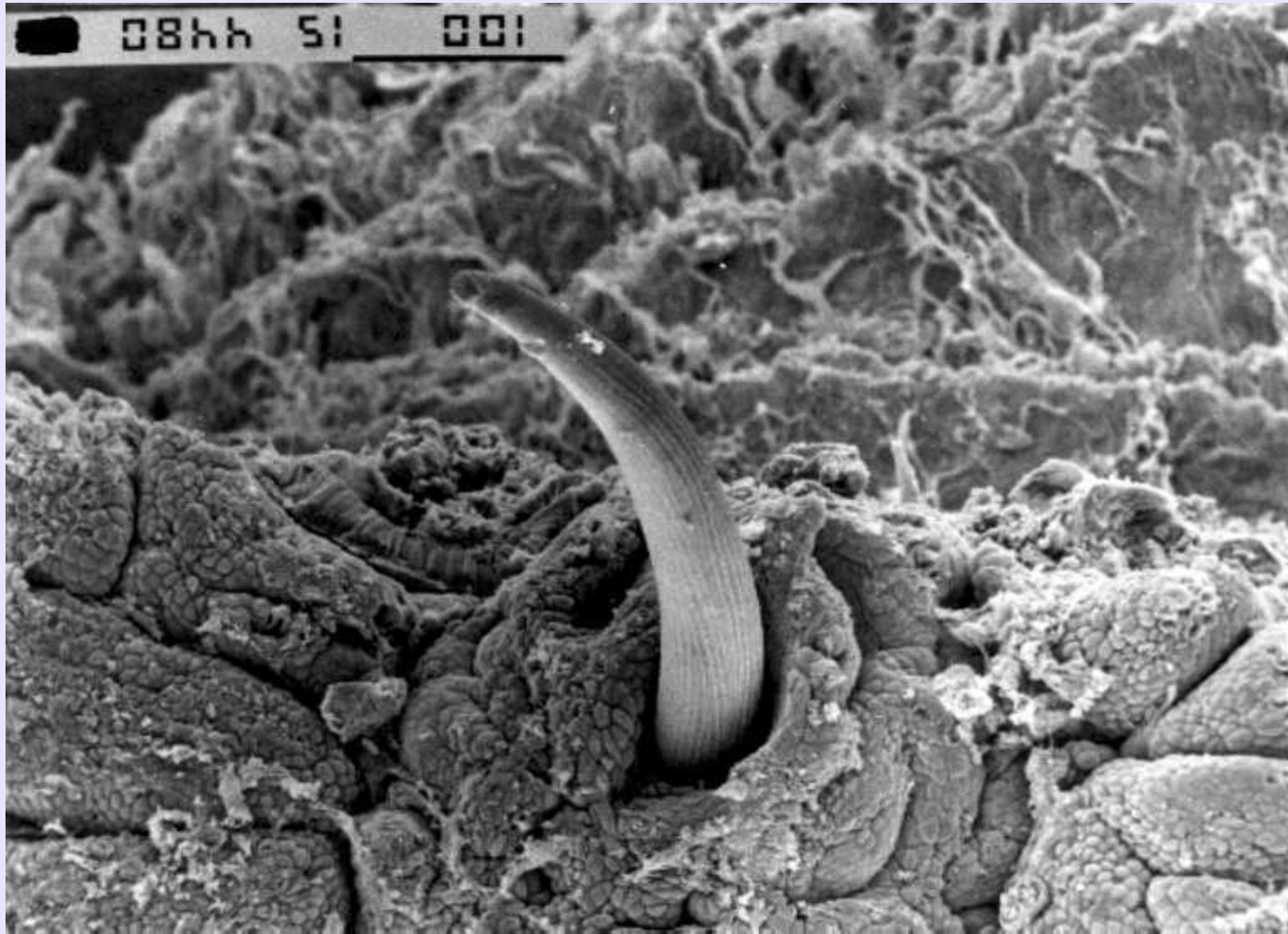
Conclusions

Nutritional consequences of gastrointestinal parasitism



- Reduced sheep performance
 - anorexia
 - reduced food efficiency
 - protein leakage, gut damage

Gut damage: abomasum



Gut damage: small intestine



Nutritional consequences of gastrointestinal parasitism



- Reduced sheep performance
 - anorexia
 - reduced food efficiency
 - protein leakage, gut damage
- Detrimental effects of parasites on host nutrition
 - nutrients are diverted away from production
- Detrimental effects of host nutrition on parasites
 - direct effects of bioactive forages
 - indirect effects of protein supplementation

Background: nutritional consequences of gastrointestinal parasitism

- **Direct effects: bioactive forages**

Indirect effects: protein supplementation

Basket of options

Conclusions

Bioactive forage: a definition

- Plants are referred to as bioactive forages if their intake results in anti-parasitic activity
- Examples of bioactive forages

chicory



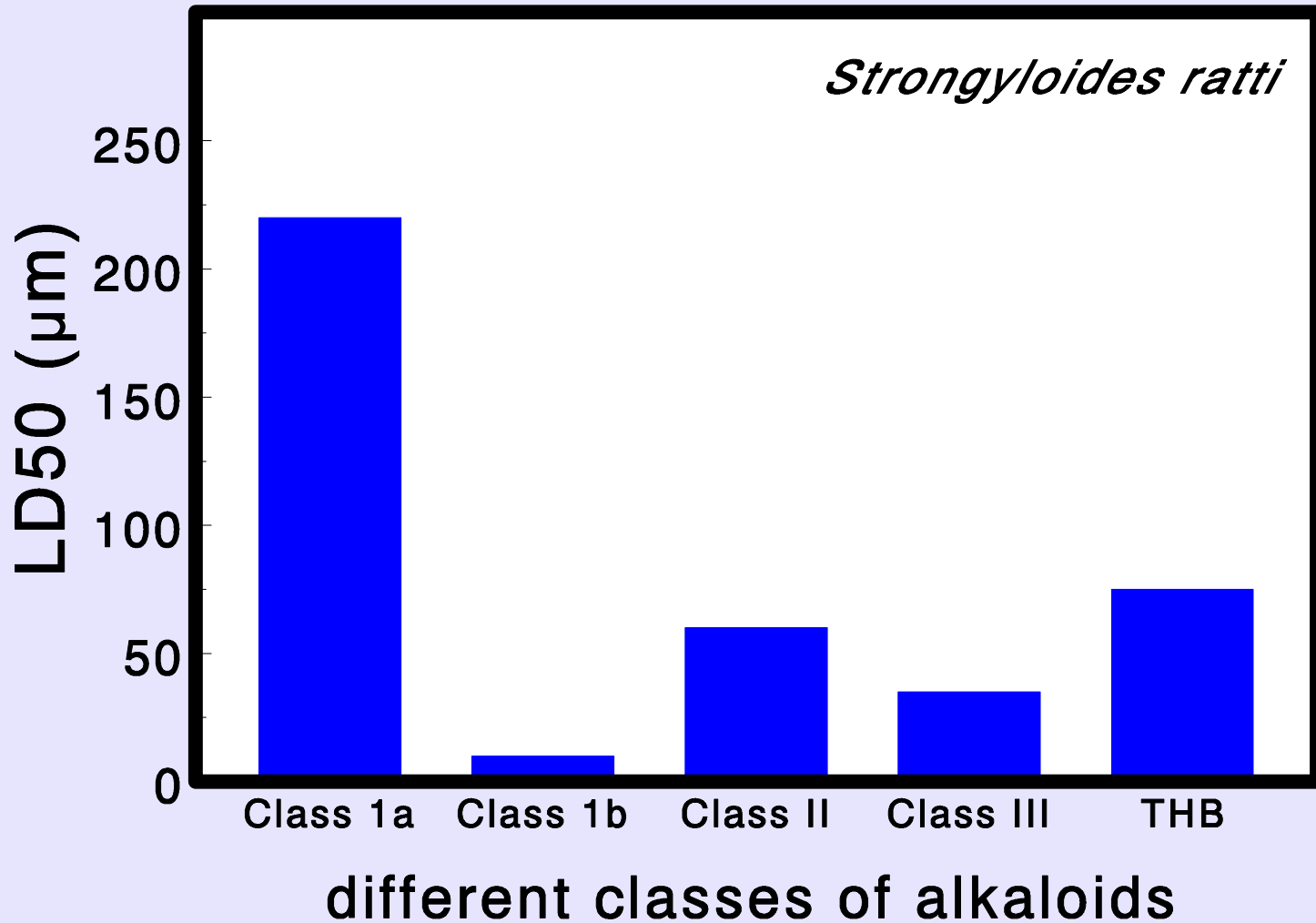
sainfoin



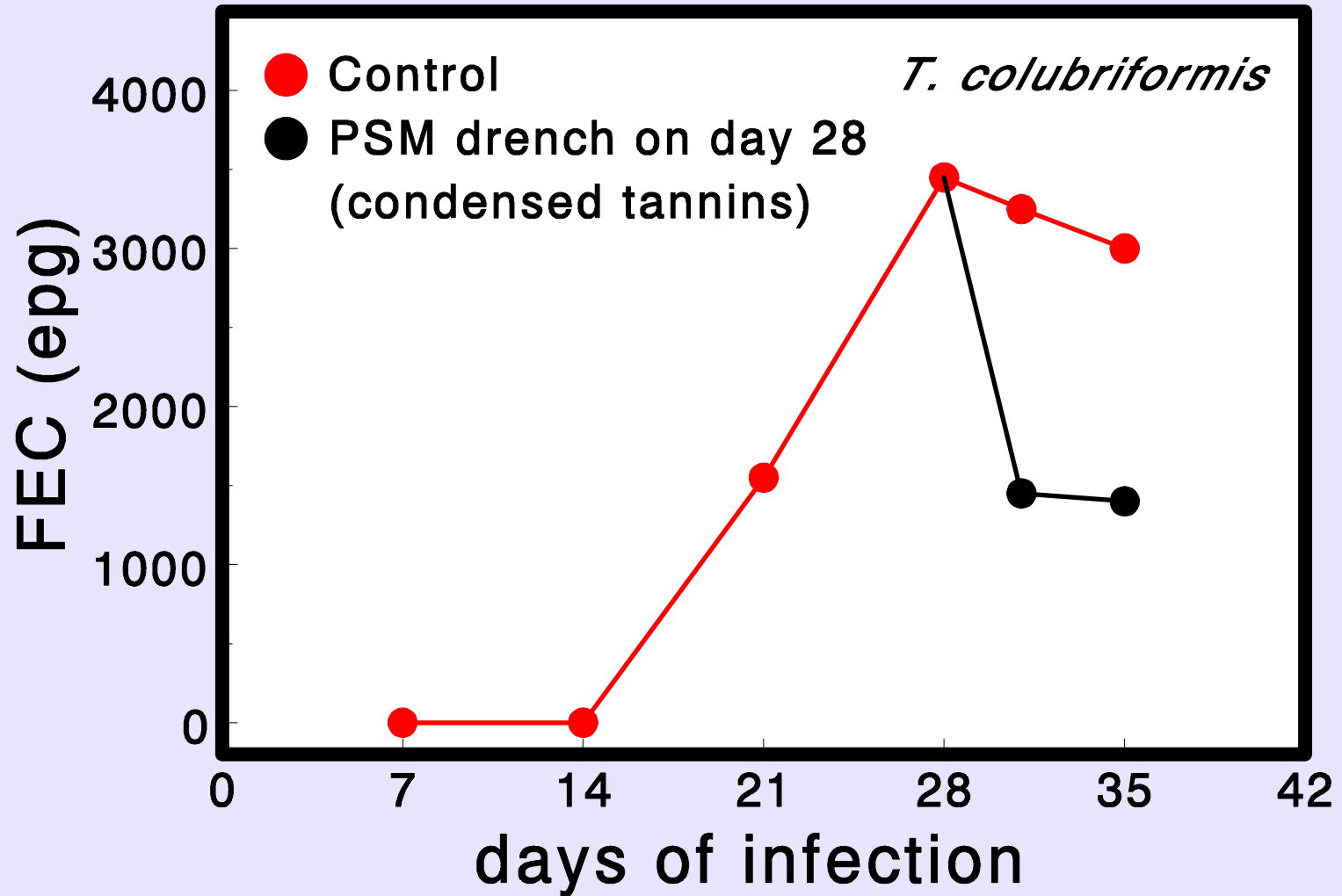
lotus



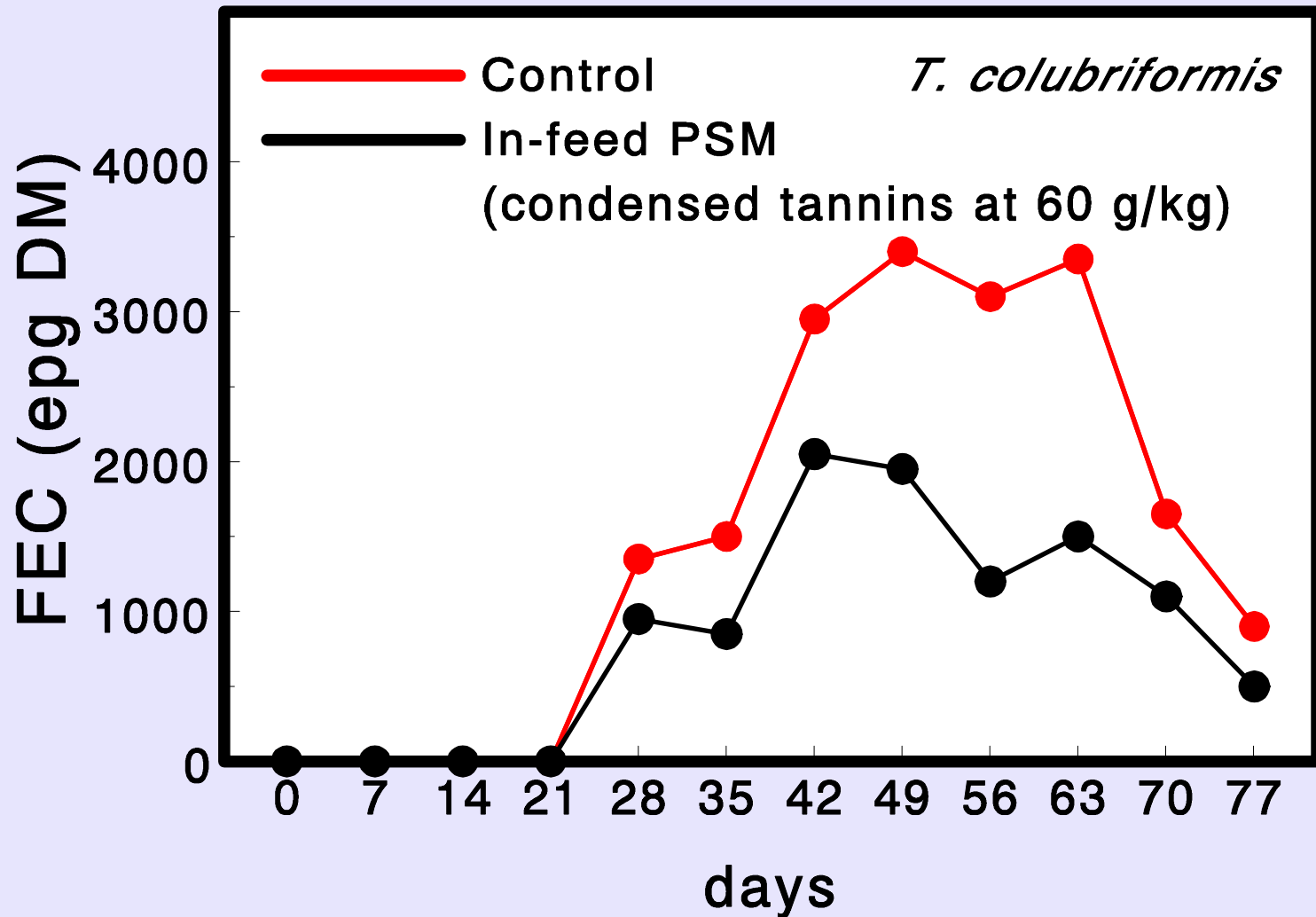
- Plant secondary metabolites (PSM)
- Wide range of anti-parasitic PSM
 - including saponines, alkaloids, glycosides, polyphenols and terpenes
- *In vitro* and *in vivo* studies have demonstrated PSM's anti-parasitic properties



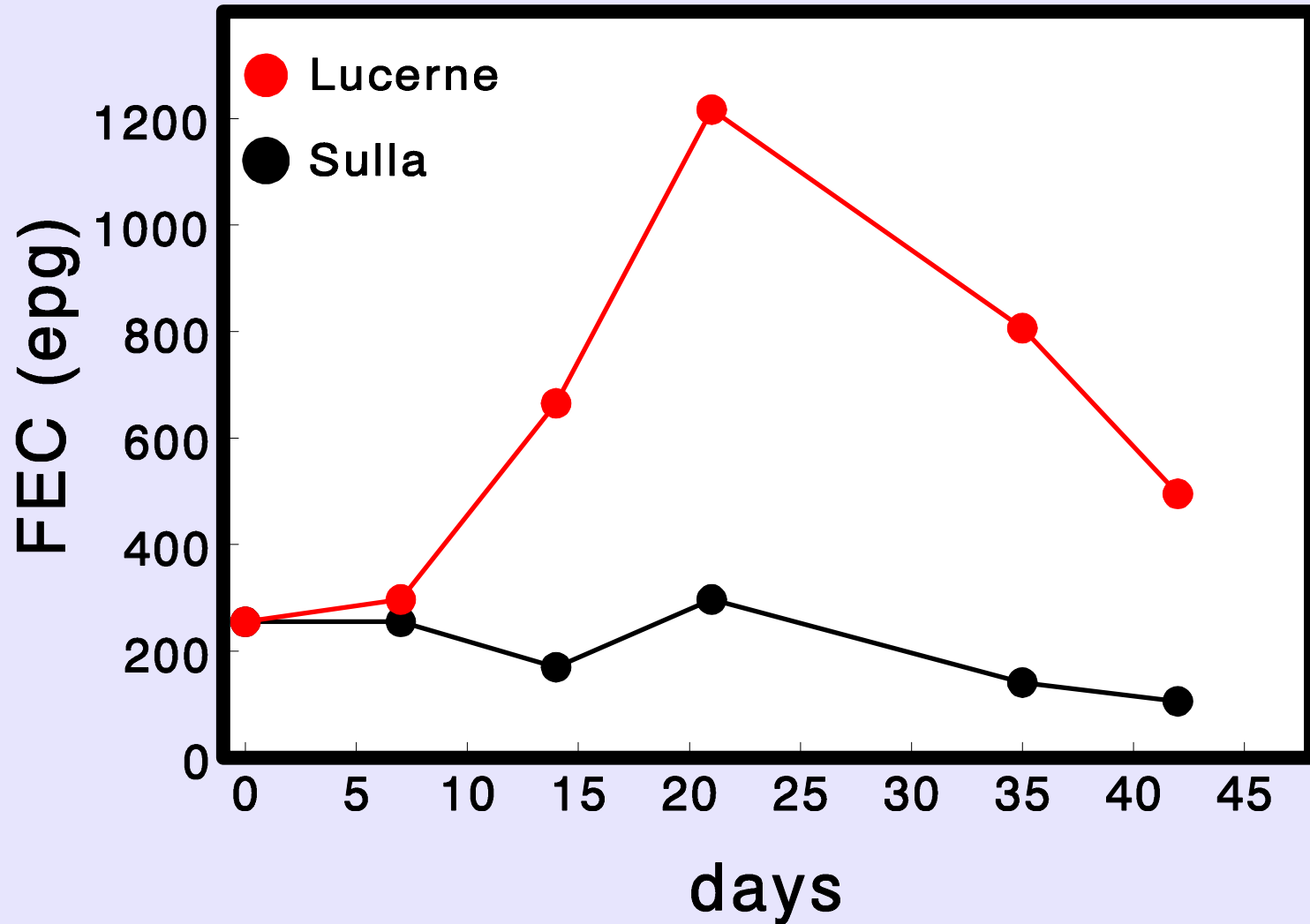
FEC reduction test



FEC in growing lambs (indoors)



FEC in growing lambs (outdoors)

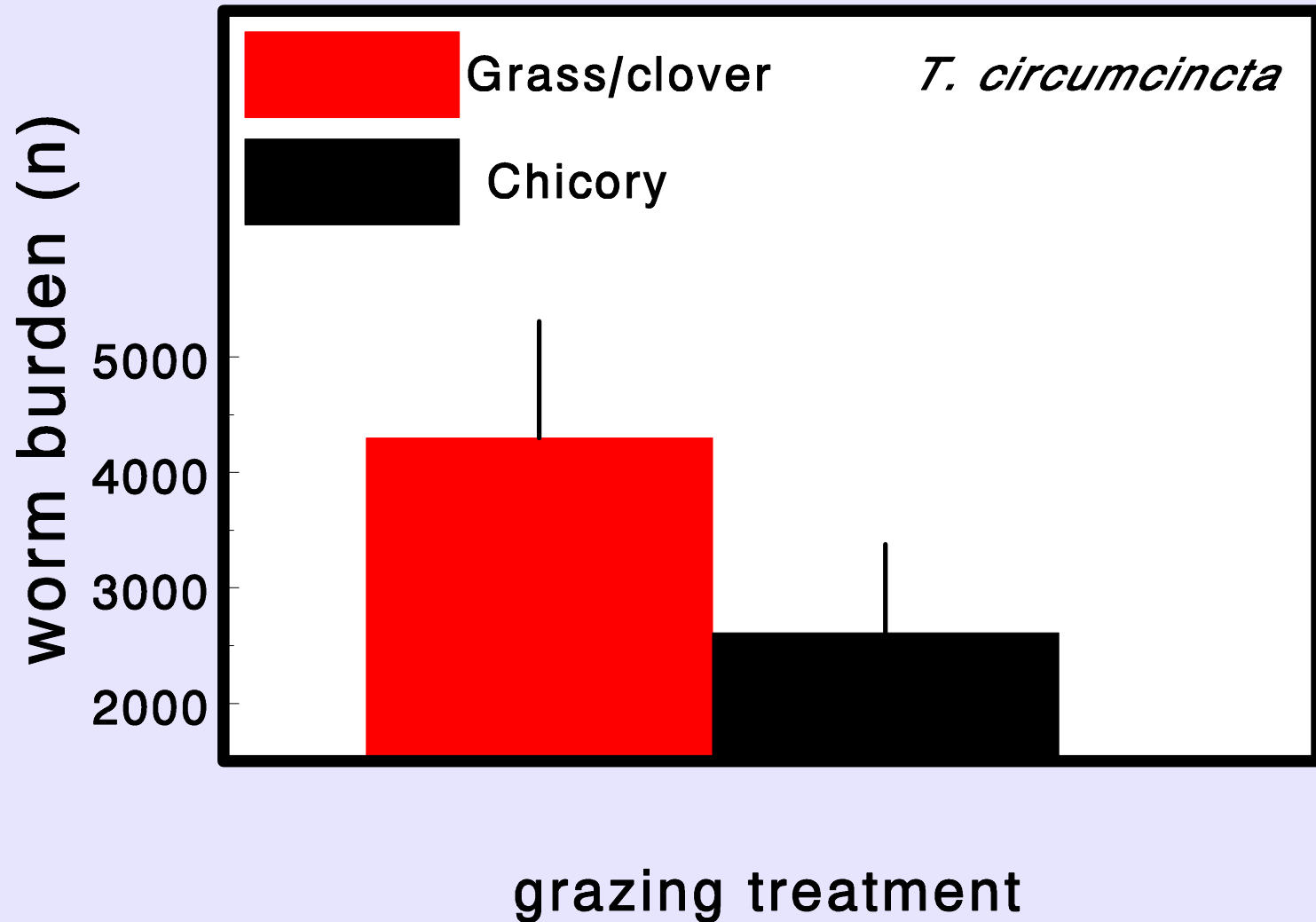


Experience with chicory

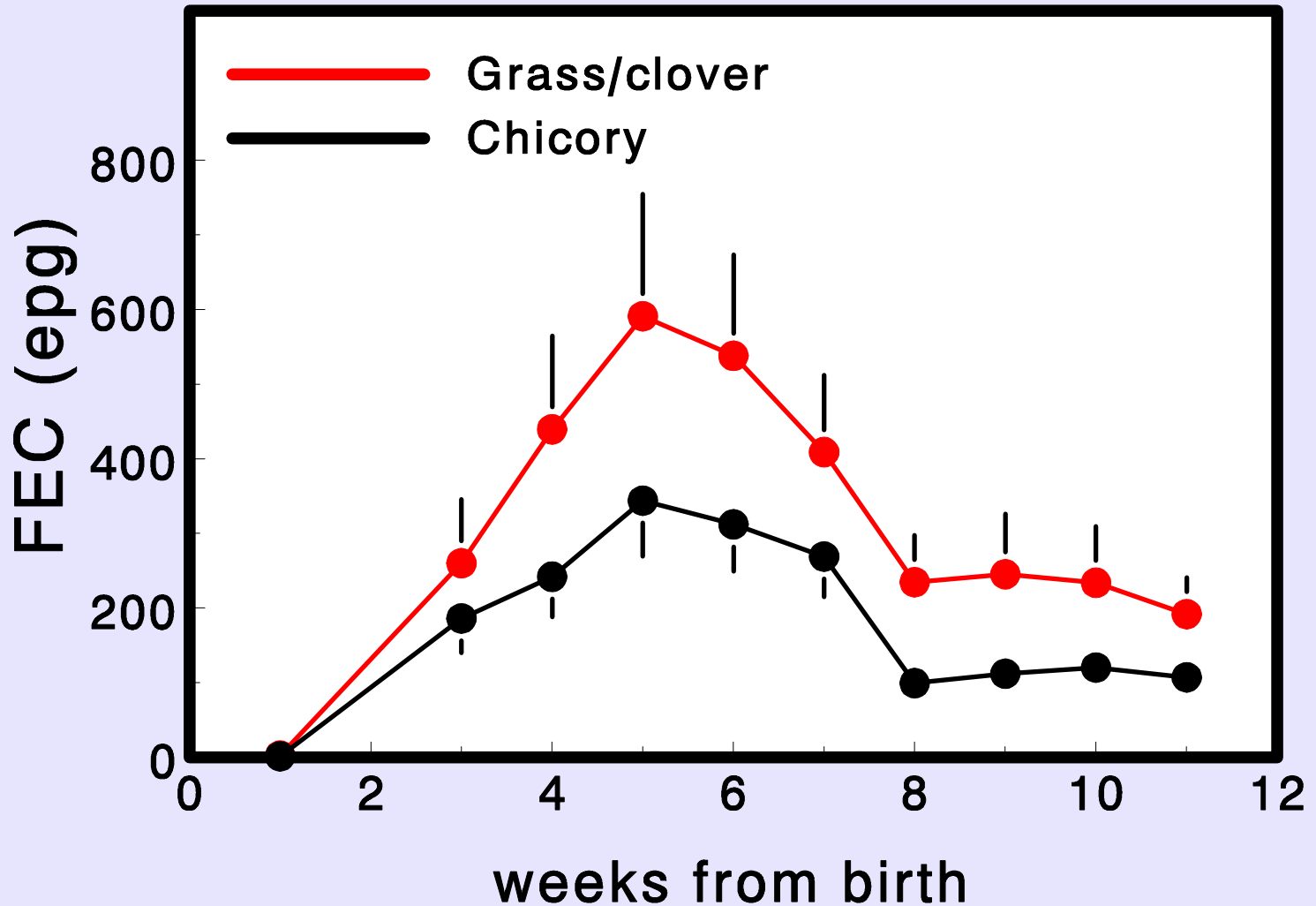


- Highly palatable
- Good nutritional value
- Readily grown in Scotland
- Chicory's anti-parasitic benefits have been shown in short and long term grazing studies

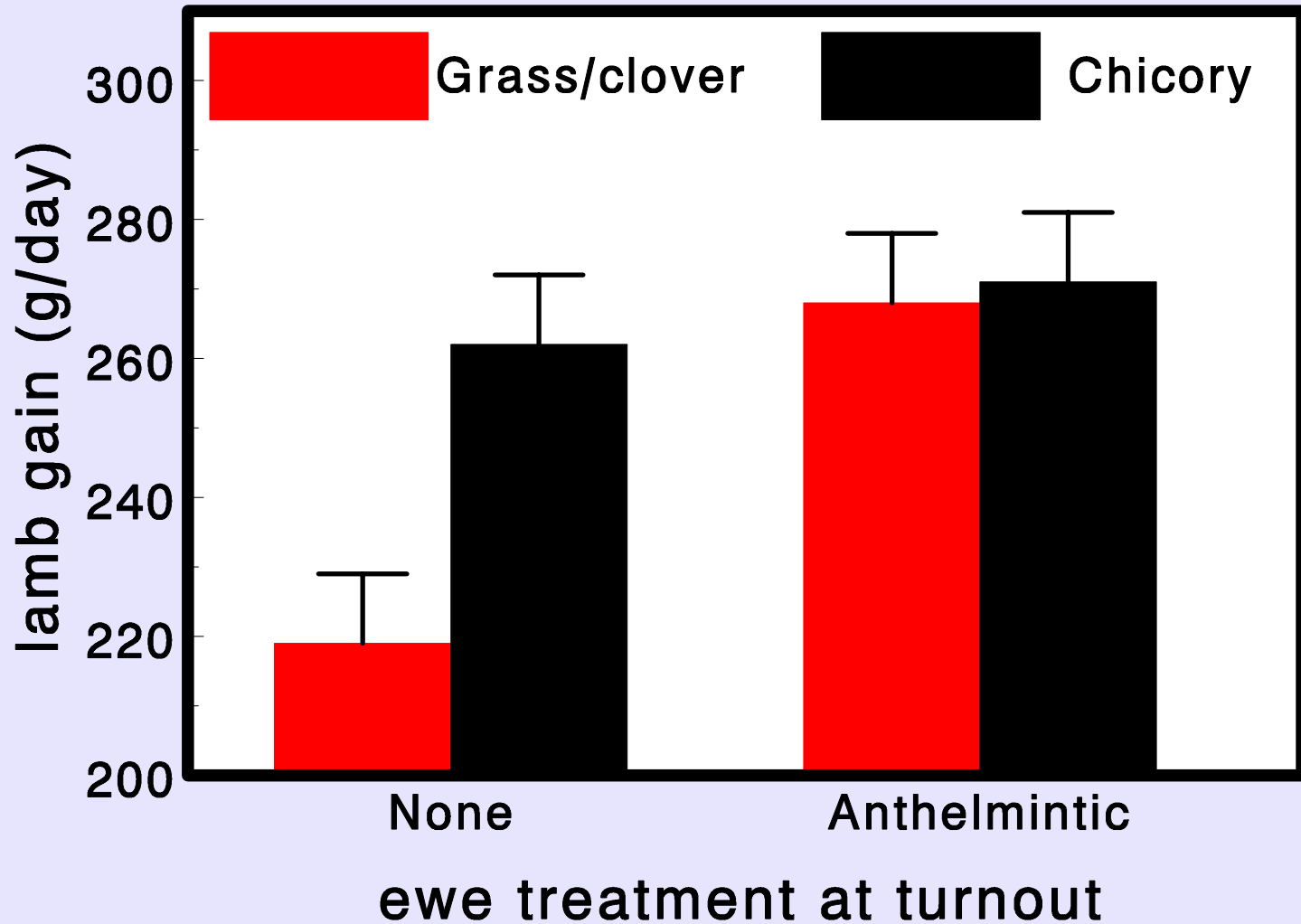
Short term grazing of lambs on chicory



Long term grazing of lambs on chicory



Long term grazing of lambs on chicory



Background: nutritional consequences of gastrointestinal parasitism

Direct effects: bioactive forages

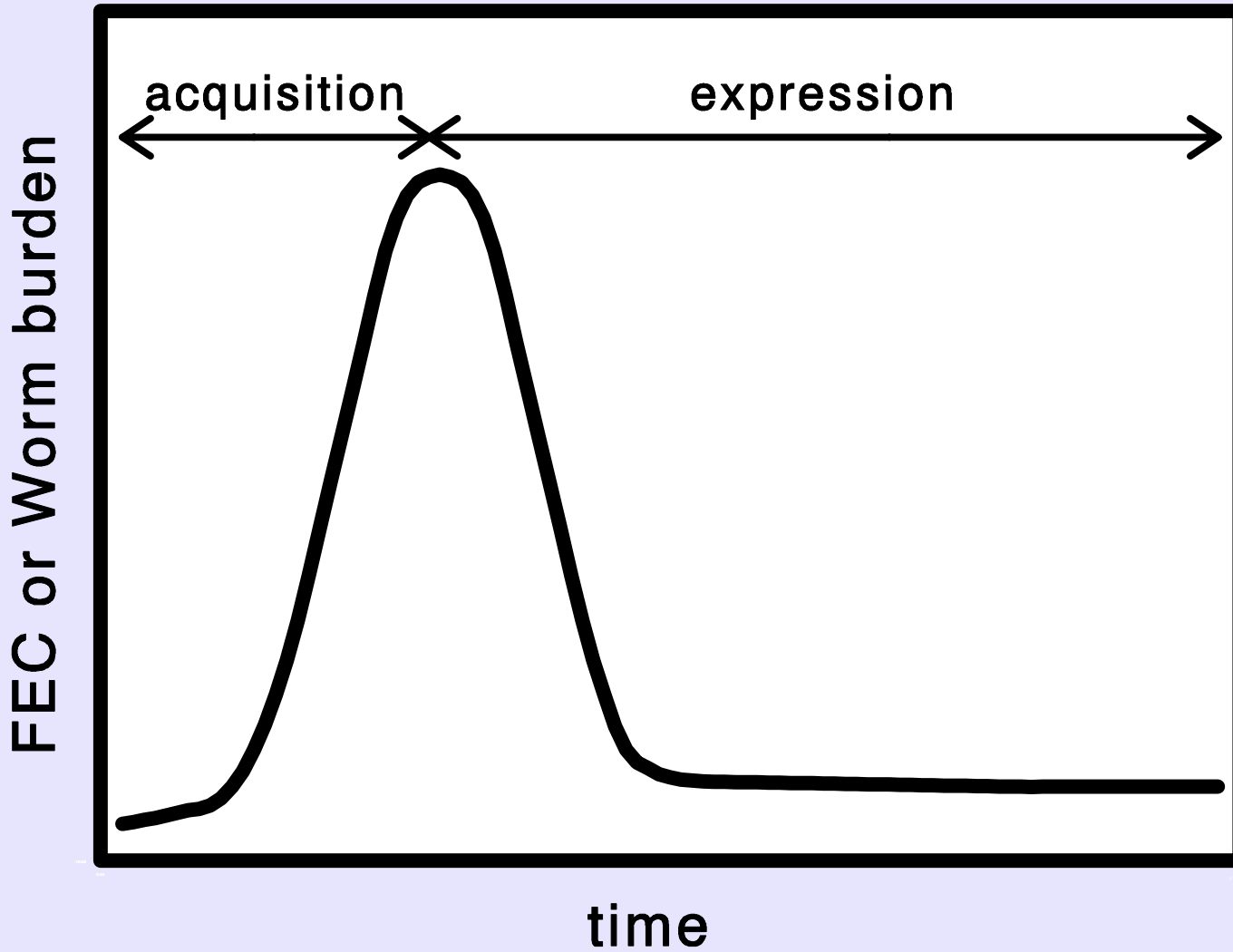
- **Indirect effects: protein supplementation**

Basket of options

Conclusions

- Gastrointestinal parasites are mainly controlled through acquired or adaptive immunity

Development of immunity



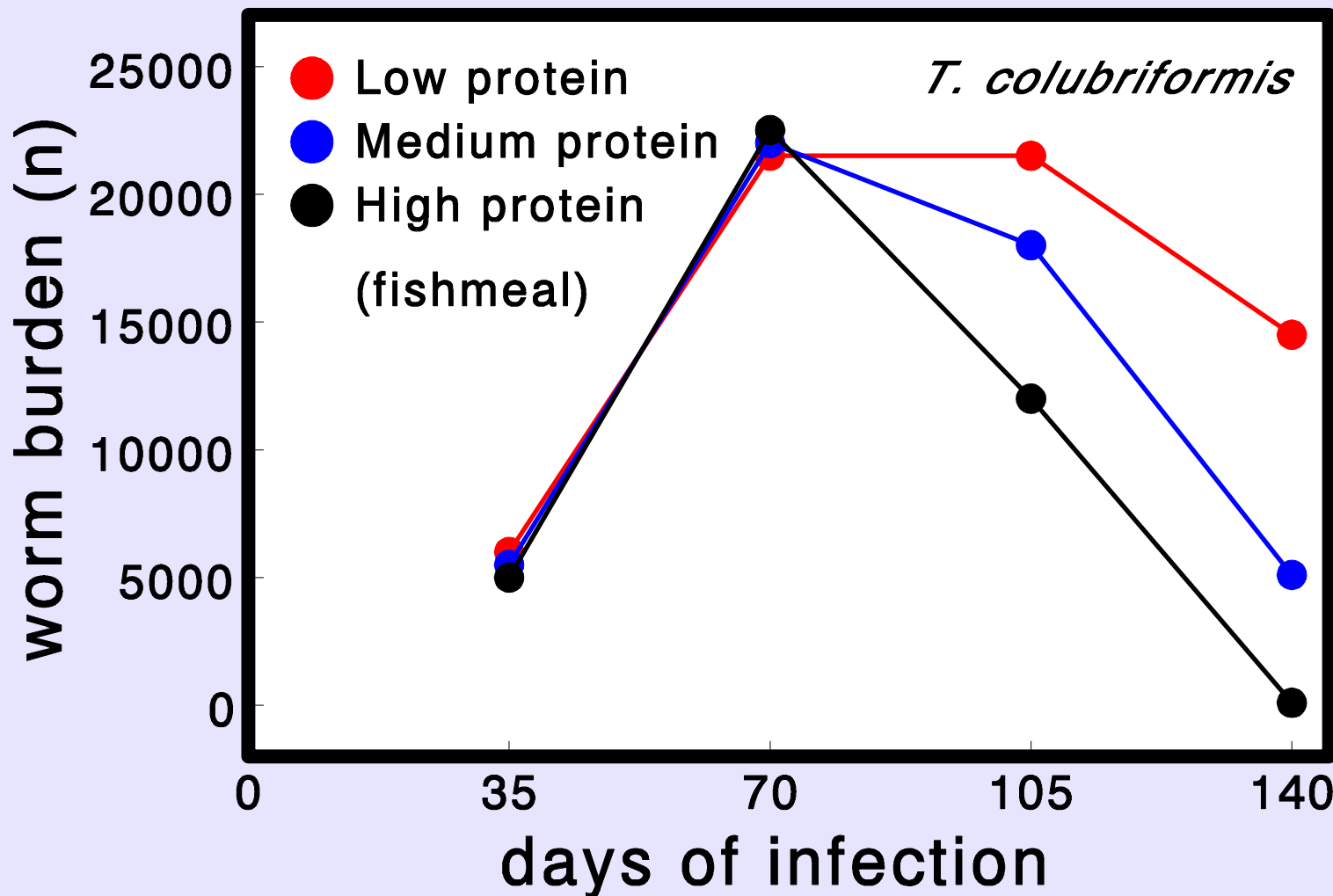
- Gastrointestinal parasites are mainly controlled through acquired or adaptive immunity
- Nutrient partitioning framework for allocation of scarce nutrients to bodily functions
 - acquisition of immunity to parasites takes priority over growth
 - expression of immunity to parasites has lower priority than growth and reproduction
- Expectations of effects of protein supply on parasites in growing lambs and periparturient ewes

Expected effects of protein supply on parasites in growing sheep



- Changes in protein supply
 - do not affect acquisition of immunity
 - strongly affect expression of immunity
- Temporal effects of protein supply on FEC and worm burden in growing lambs

Effect of protein supply on worm burdens in housed lambs

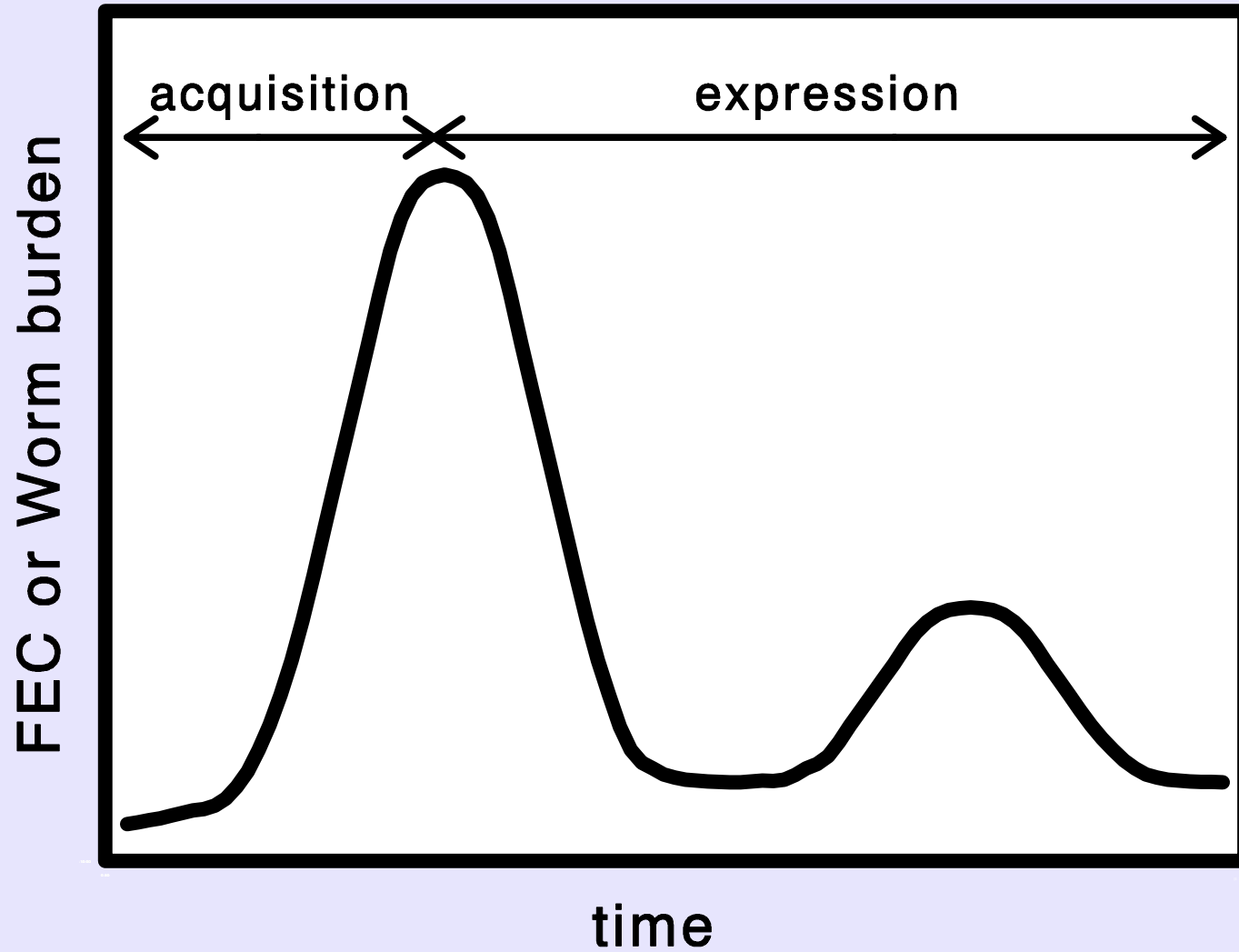


Protein supply improves expression of immunity to parasites in growing lambs



- A large number of studies show similar effects of protein supply on gastrointestinal parasitism
 - *T. colubriformis*, *T. circumcincta*, *H. contortus*
 - range of protein sources, including urea
- Protein supply affect immune effector responses
 - circulating and local inflammatory cells
 - sheep mast cell proteases
 - circulating antibodies

Periparturient breakdown of immunity

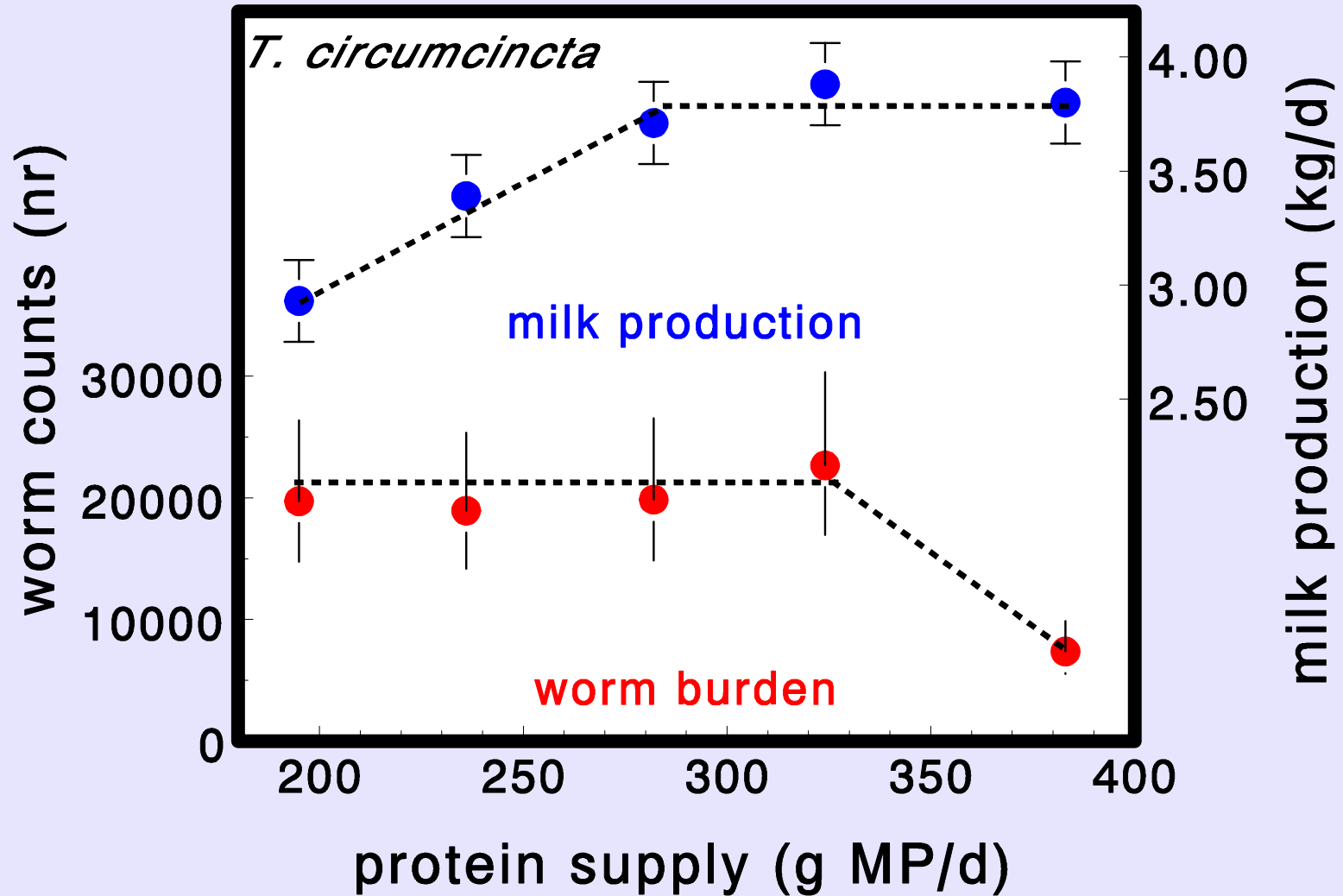


Expected effects of protein supply on parasites in periparturient ewes



- Reproduction takes priority over expression of immunity to parasites
- At times of protein scarcity, greater penalty on immunity than on reproduction
- Gradually increasing protein supply
 - first increments: increased milk production
worm burdens unaffected
 - later increments: milk production unaffected
worm burdens decreased

Milk production and worm burdens



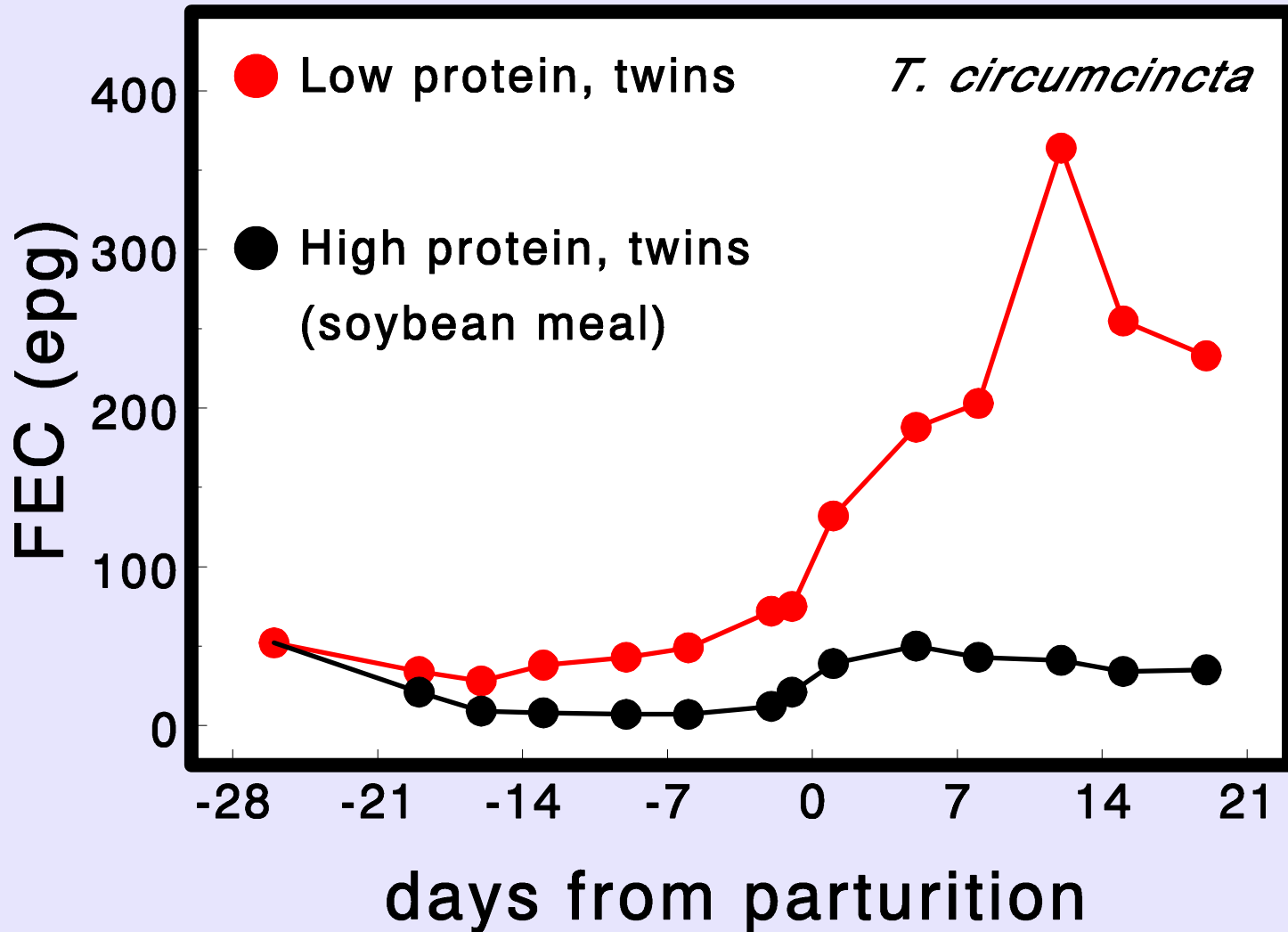
- Other protein supplementation studies have shown similar outcomes in ewes
- In contrast to lambs, effects of protein supply on effector responses seem inconsistent in ewes
 - exception: globule leukocytes
 - limited amount of quantitative data on immune responses associated with improved resistance in lactating hosts

How fast can protein supplementation improve resistance to parasites?

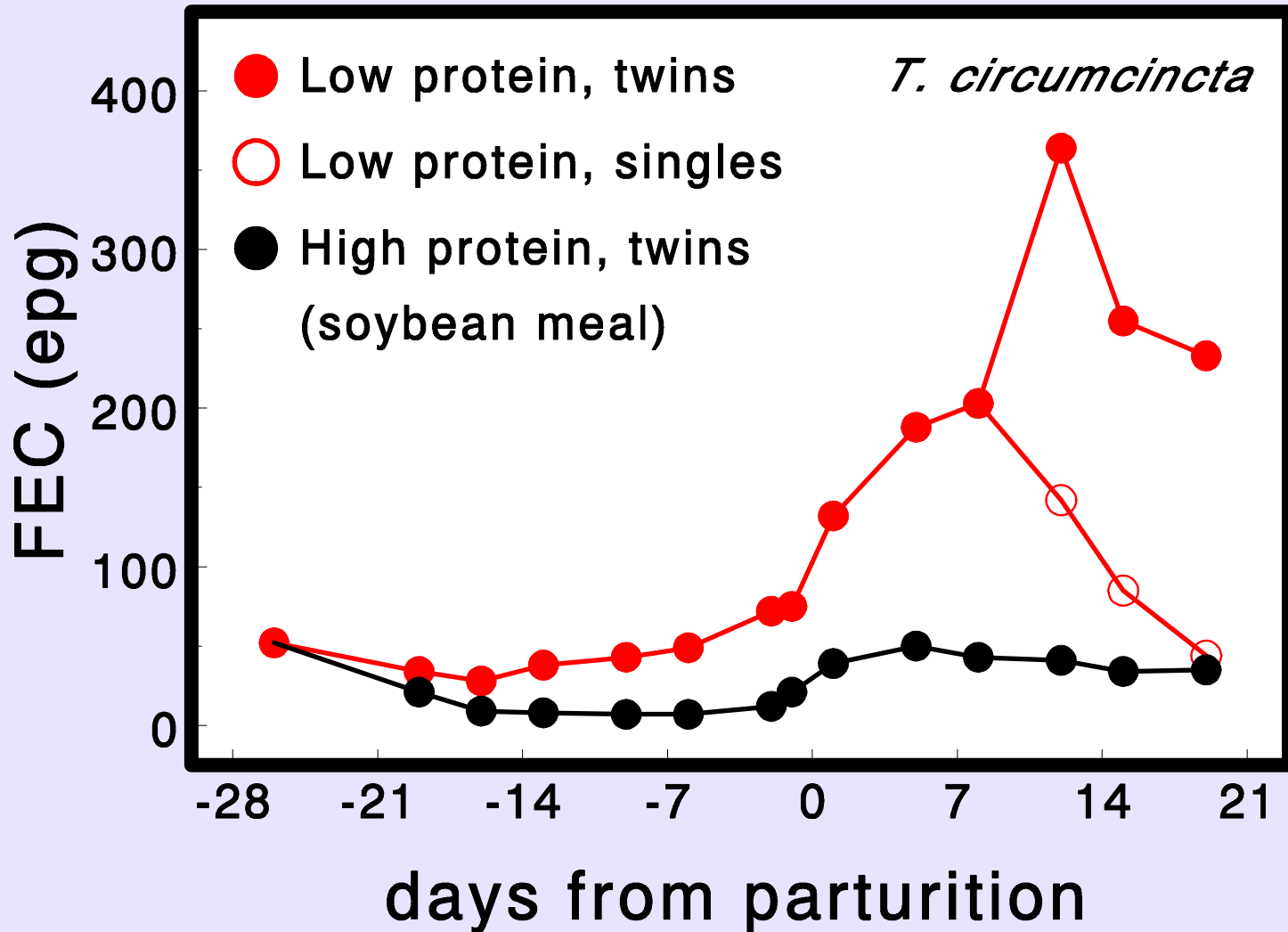


- Rate of improvement of resistance is important for uptake of nutrition in any control strategy
- Recent results indicate that improved protein nutrition can improve resistance within days

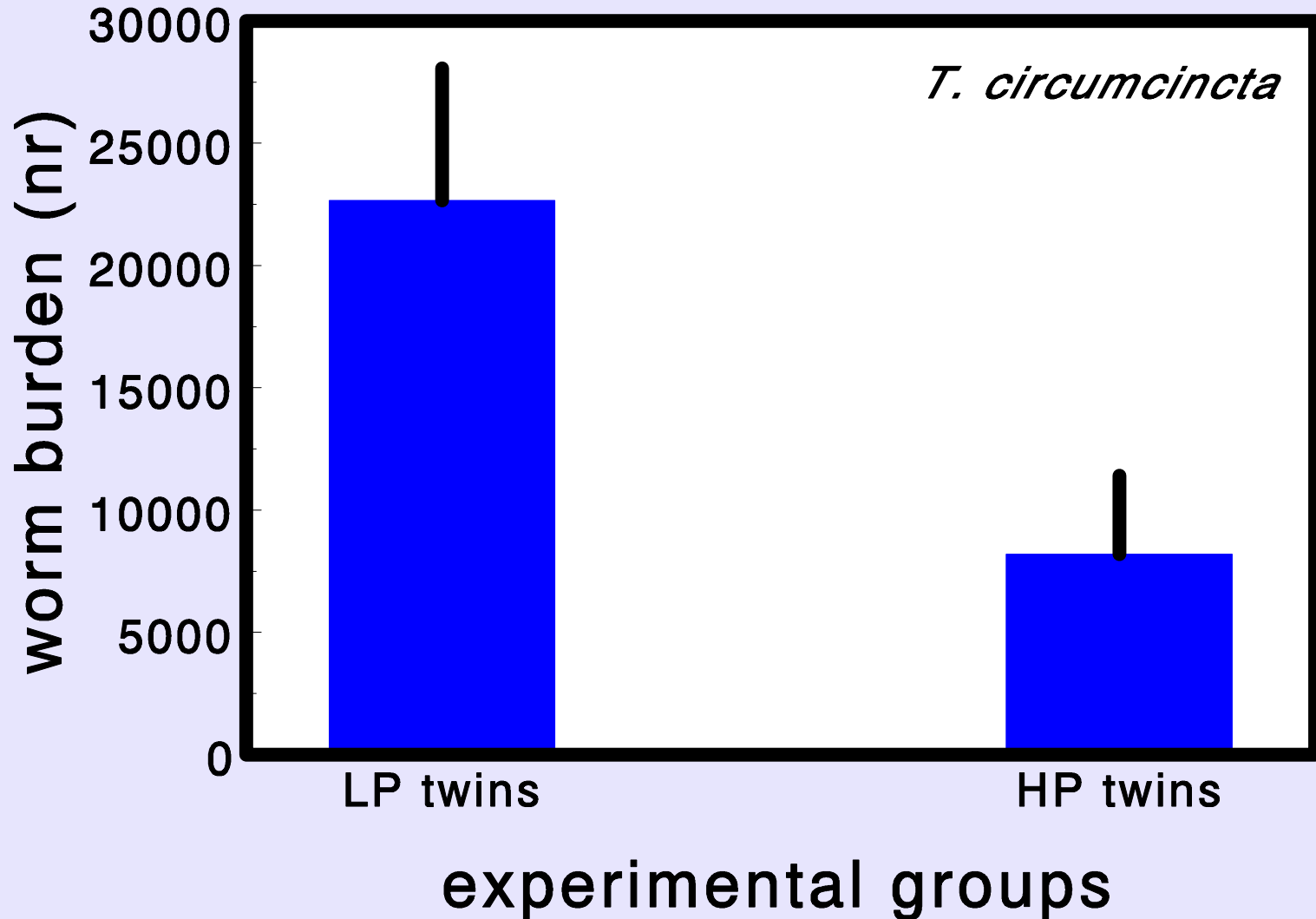
FEC in periparturient ewes



FEC in periparturient ewes

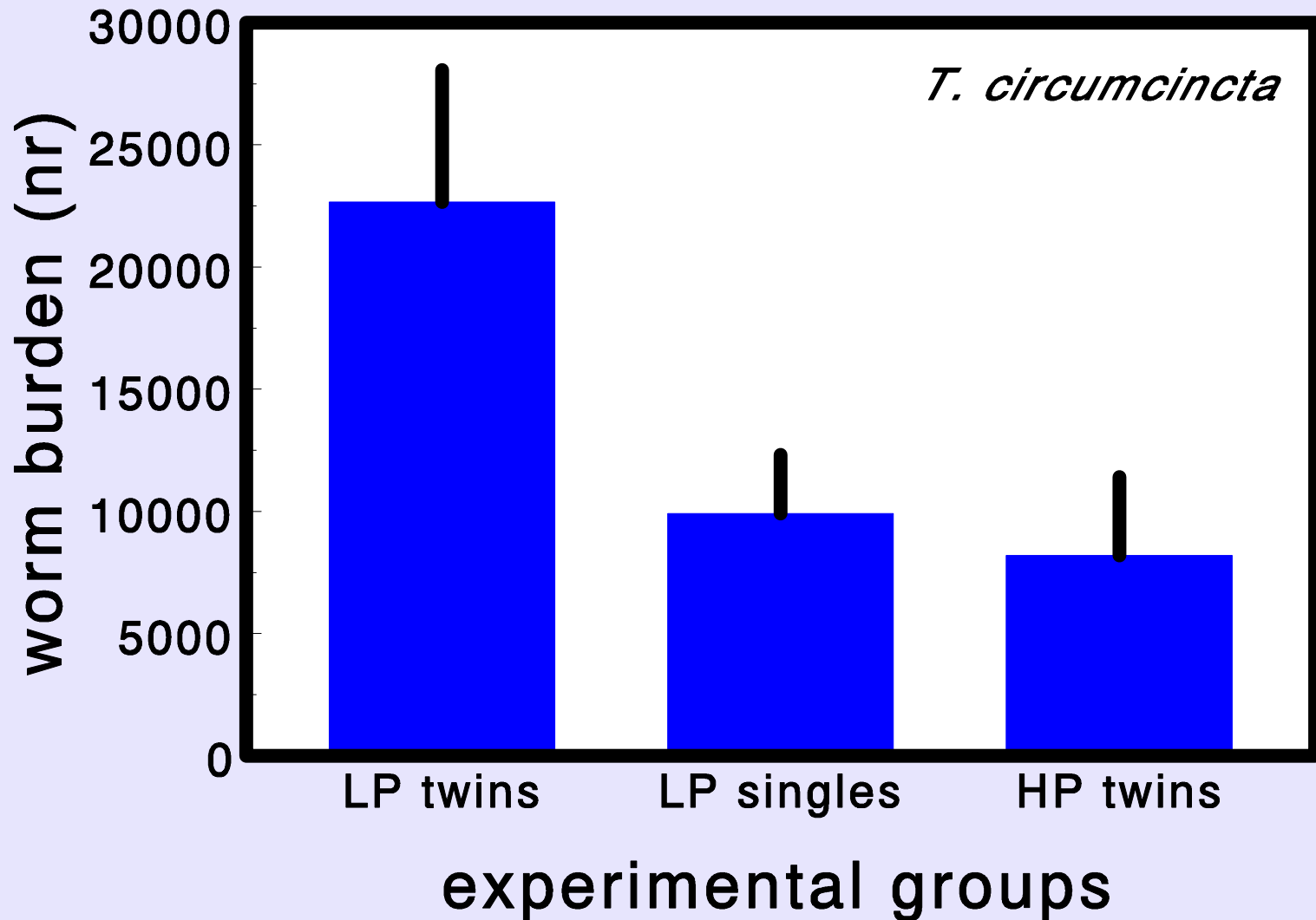


Worm burdens in lactating ewes



Houdijk et al. (2006)

Worm burdens in lactating ewes



Houdijk et al. (2006)

Background: nutritional consequences of gastrointestinal parasitism

Direct effects: bioactive forages

Indirect effects: protein supplementation

- **Basket of options**

Conclusions

- Non-chemical worm control
 - protein supplementation
 - bioactive forage
 - vaccination
 - biological control
 - breeding for resistance
 - grazing management

- Interactive effects with nutritional management remain to be established
- Part of an integrated, non-chemical parasite control strategy
- Multidisciplinary approach is required
 - close collaboration between nutritionists, parasitologists, immunologists, geneticists and veterinarians

Background: nutritional consequences of gastrointestinal parasitism

Direct effects: bioactive forages

Indirect effects: protein supplementation

Basket of options

- **Conclusions**

Conclusions



- Nutritional management can reduce the degree of gastrointestinal nematode parasitism
- Potential for exploiting bioactive forages, especially chicory, and protein supplementation
- Both strategies have reduced worm burdens and egg output, and increased lamb performance
- Nutritional worm control combined with other non-chemical strategies rather than used in isolation

Acknowledgements



- All my colleagues at SAC and at Moredun Research Institute, Edinburgh
- Funding bodies
 - SEERAD and Defra
 - BBSRC
 - EU

Thanks for your attention!



jos.houdijk@sac.ac.uk