Observations of Swimming Grasshoppers in an Acid Pool in Epping Forest

Author: Gardiner, Tim

Source: Journal of Orthoptera Research, 18(2) : 237-239

Published By: Orthopterists' Society

URL: https://doi.org/10.1665/034.018.0210

Journal of Orthoptera Research, December 30, 2009,18(2): 237-239

Short Communication

Observations of swimming grasshoppers in an acid pool in Epping Forest

Submitted June 19, accepted October 24, 2009

TIM GARDINER

2 Beech Road, Rivenhall, Witham, Essex, UK, CM8 3PF. Email: tg@writtle.ac.uk

Abstract

Swimming behavior of the meadow grasshopper *Chorthippus parallelus* (Orthoptera: Acrididae) was observed in an acid pool on Sunshine Plain in Epping Forest, UK. To quantify the success or otherwise of attempts at swimming by grasshoppers, I spent 2 h watching *C. parallelus* nymphs on 7 June 2009. Early-instar nymphs of *C. parallelus* were observed to commonly use their hind legs in a kicking motion to swim in the surface film of the pool. These nymphs managed to reach the edge of the pool, whereas two late-instar nymphs (probably 3-4) after becoming submerged for more than 3 min, did not manage to exit the pool. Various escape strategies were used by late-instar nymphs that became submerged, including an underwater 'hop' and climbing up rush (*Juncus*) stems.

Key words

Acrididae, nymphs, survival, immersion tolerance, mortality

Introduction

While surveying for grasshoppers at Sunshine Plain in Epping Forest, Essex, UK, on 7 June 2009, I observed swimming behavior of nymphal and adult grasshoppers. Sunshine Plain (Ordnance Survey grid reference: TQ 422991) is acidic heathland containing boggy areas composed of *Sphagnum* moss spp. and Purple Moor-grass, *Molinia caerulea*, with numerous shallow pools (*ca* 20 cm depth).

As I walked past a particularly large pool (2 × 3 m; Fig. 1), I observed numerous meadow grasshopper nymphs, *Chorthippus parallelus* (Orthoptera: Acrididae) jumping into the water, only to swim to the marginal vegetation, before climbing out. The initial jumps were in response to my disturbance of the sward next to the pool. I assume this escape behavior is frequent when the heathland is grazed by cattle. Swimming behavior in grasshoppers seems to have a genetic or instinctive basis (Lockwood & Schell 1994), particularly as it is commonly observed in species which have little or no connection with aquatic habitats (Lockwood *et al*. 1989). Diving into water may also be an effective escape mechanism from predators, for orthopterans such as the New Zealand tusked weta *Motuweta riparia* (McCartney *et al*. 2006).

The observations of nymphal submergence at Sunshine Plain were consistent with experiments conducted by Brust *et al*. (2007), who observed a degree of tolerance to immersion in hypoxic water among several species of rangeland grasshopper in the USA. They speculate that drowning due to intense periods of precipitation is rare in the field, as grasshoppers can tolerate immersion in hypoxic water between 3 to 21 h depending on their life stage; nymphs immersed in hypoxic water were killed more quickly than adults.

However, in their paper, Brust *et al*. (2007) do not relate the immersion tolerance of grasshoppers to survival in freshwater ecosystems such as ponds and pools, where individuals could drown if they entered the water body. Swimming behavior has been frequently observed for all three groundhopper species in the UK (Orthoptera: Tetrigidae) (Marshall & Haes 1988). There have been two reports of adult slender groundhoppers *Tetrix subulata* swimming in Essex: the first was from a stream at Marks Hall near Coggeshall in 1994 (J. Bowdrey pers. comm.) and the second from a pond at Layer Breton Heath in 1999 (U. Broughton pers.comm.). At Layer Breton Heath, adult groundhoppers were observed swimming strongly underwater and on the surface of a pond. Their small size (Table 1) means that they have low body mass and good buoyancy.

In contrast, there seems to be very little information on the swimming behavior of acridids in the UK. It is the aim of this short communication to detail observations of swimming behavior of grasshoppers in an acid pool on Sunshine Plain. This 'experiment' was just an uncontrolled set of field observations, but perhaps it may instigate a more thorough investigation of the swimming abilities of British grasshoppers.

Methods

To try to quantify the success or otherwise of swimming attempts (swimming defined as kicking movements by the hind legs which induce motion of the insect through the water) by grasshoppers, I spent 2 h watching the response of *C. parallelus* nymphs from 16:00-18:00 h at Sunshine Plain on 7 June (air temperature 14°C, complete cloud cover). I walked past the acid pool (Fig. 1) until a grasshopper nymph was flushed. If no nymph was flushed into the water, a second or third pass was made as necessary. The heathland is grazed by cattle, indicating that flushing might often occur naturally in response to disturbance by grazing livestock (Fischer *et al*. 1996). I decided to study the responses to entering the pool of 10 early-instar (probably 1st or 2nd) nymphs and 10 late-instar (probably 3rd or 4th) nymphs, to ascertain the success of their swimming behavior once in the water. Instar stage was estimated from body length (head to end of abdomen subsequent measurement) of the flushed individuals.

Swimming success was defined as the grasshopper leaving the water body by reaching the edge. Failure ('drowning') was defined as the grasshopper sinking to the bottom of the pool and remaining motionless. This didn't necessarily mean the grasshopper had drowned, as Brust *et al*. (2007) showed that adult grasshoppers can regain their normal functions after submergence in hypoxic water for >7 h (dissolved oxygen content of their water samples: <0.3ppm temperature: 20˚C). Grasshoppers assumed to have 'drowned' were

Fig. 1. The acid pool at Sunshine Plain in Epping Forest where swimming behavior was observed (photo: Tim Gardiner). See Plates.

removed from the pool and placed at a considerable distance (>10 m) from the pool with the hope they could recover and to avoid repeated sampling of grasshoppers. No attempt was made to quantify the exact size or mass of each individual and there was no measurement of the duration between pool-entry and exit. Therefore, the results presented in this short communication can only be regarded as preliminary.

Results and discussion

For smaller grasshoppers (probably instar 1-2), all 10 nymphs managed to swim to the edge of the bank without too much difficulty. Generally, these early-instar nymphs did not become fully submerged in the pool once they landed on the water, which made swimming to the edge relatively easy. However, the larger (probably instar 3-4) nymphs found it slightly more difficult to extricate themselves from the pool, 8 out of 10 nymphs making a successful exit from the water. The two nymphs which drowned sank to the bottom of the 20-cm deep pool and could not manage to swim to the surface or to the marginal vegetation despite persistent efforts. I would speculate that their larger size and higher body mass led to their sinking upon hitting the pool surface. Late-instar nymphs of *C. parallelus* also have an enhanced jumping ability when compared to early-instar (Gardiner 2009); therefore they will jump to a greater height from the ground (*ca* 30 cm), leading to a higher velocity upon impact with the water surface. The better swimming ability of early instars is highly advantageous, as they may have a lower tolerance to immersion in water than late instars (Brust *et al*. 2007).

Most nymphs were able to use their hind legs to swim to the surface, using a series of powerful kicks. Late-instar nymphs were apparently able to rotate their bodies underwater so that they could move downwards or upwards in the pool. Two nymphs were observed to hop underwater. This behavior was exhibited when the grasshoppers located an underwater plant stem and could propel themselves to the surface in a distinct 'hop'. One nymph was also noted to climb from the depths of the pool to the surface up the stem of a rush, *Juncus* spp. Upon emerging from the water it continued to climb the stem before jumping onto the bank of the pool.

This fascinating behavior was also observed for adults of the common green grasshopper *Omocestus viridulus*, an Essex Red Data List species (Gardiner & Harvey 2004), with a stronghold in Epping Forest (Wake 1997). Of the two adults flushed into the water (accidentally while flushing *C. parallelus*), one managed to swim to the edge, while the other could not manage to swim to the surface, despite a persistent effort.

The function of body size and mass in determining the buoyancy of Orthoptera has not been investigated, despite a considerable increase in research activity on body size in recent years (Whitman 2008, Whitman & Vincent 2008). W. Wyatt Hoback (pers. comm.) suggests that grasshoppers breaking the surface tension is unusual, which contrasts with my observations at Sunshine Plain. He threw 4th instar melanopline grasshoppers into water in Nebraska, USA,

Table 1. Species of Orthoptera for which swimming behavior has been observed in the UK, in relation to body size (♀ and ♂ not distinguished) and life stage (G = good swimmer, W = weak).

Family/species	Life stage observed	Body length (mm)*
Tetrigidae		
Tetrix ceperoi	Adult (G)	8-13
Tetrix subulata	Adult (G)	9-14
Tetrix undulata	Adult (G)	8-11
Acrididae		
Chorthippus parallelus	Nymph (G)	4-15
Omocestus viridulus	Adult (W)	15-22
Gryllotalpidae		
Gryllotalpa gryllotalpa	Nymph/adult (G)	35-46

*Body length taken from Marshall & Haes (1988) and measurements of captive grasshoppers by the author.

testing whether they would break the surface tension. However, none of the grasshoppers sank, even though they were large and thrown with some velocity. Hoback suggests that the acidic nature of the water at Sunshine Plain may affect the surface tension. A controlled laboratory experiment investigating the swimming behavior of grasshoppers in water with acid and neutral pH is needed to test this theory.

Grasshoppers which became submerged, had approximately 3 min to reach the pool surface, otherwise they ceased motion and 'drowned'. The dissolved oxygen (DO) levels of the acid pools at Sunshine Plain are likely to be low due to anaerobic conditions required during peat formation on bogs (Turrill 1948). Despite the possibility that grasshoppers may regain motility after significant periods of immersion in hypoxic water (Brust *et al*. 2007), it seems that they can enter a motionless state becoming unable to swim (apparent 'drowning') so unable to reach the surface. This means that any grasshoppers that are effectively submerged in ponds or streams will be unlikely to survive the experience. It seems that the ability of grasshoppers to use their hind legs to swim provides an effective survival mechanism once they enter aquatic habitats, often due to escape movements away from disturbance by livestock or predators.

These observations are evidence of the swimming ability of two grasshoppers commonly found on bogs and wet heathland in the UK. It seems both species can swim underwater and on the surface film, although swimming ability is better in early-instar nymphs than in the later instars, due to their small body size and mass. Adults of *O. viridulus* appeared to be able to swim, but only weakly due to their large body size and mass (Table 1). Lockwood & Schell (1994) also suggest that the early life stages (instars 1-2) of grasshoppers may be more proficient at swimming than late instars or adults. Further controlled investigations on the swimming ability of Orthoptera are needed to determine if bushcrickets (Tettigoniidae) and crickets (Gryllidae) can swim. The strong swimming ability of the endangered Mole Cricket *Gryllotalpa gryllotalpa* is known (Marshall & Haes 1988; Table 1), but the capability of other species is less well documented.

Acknowledgements

I would like to thank three anonymous reviewers and Dr. Glenn Morris for their helpful suggestions for improvements to this short communication.

References

Brust M.L., Hoback W.W., Wright R.J. 2007. Immersion tolerance in rangeland grasshoppers (Orthoptera: Acrididae). Journal of Orthoptera Research 16: 135-138.

Fischer S.F., Poschlod P., Beinlich B. 1996. Experimental studies on the dispersal of plants and animals on sheep in calcareous grasslands. Journal of Applied Ecology 33: 1206-1222.

Gardiner T. 2009. Hopping Back to Happiness? Conserving Grasshoppers on Farmland. VDM Verlag, Saarbrücken.

Gardiner T., Harvey P. 2004. Red data list for Essex Orthoptera and allied insects. Bulletin of the Amateur Entomologists' Society 63: 19–25.

Lockwood J.A., Clapp D.A., Conine J., Romberg M.H. 1989. Grasshopper swimming as a function of sexual and taxonomic differences: evolutionary and ecological implications. Journal of Entomological Science 24: 489–495.

Lockwood J.A., Schell S.P. 1994. Perceptual, developmental, experiential, and physiological parameters of swimming in Melanopline grasshoppers (Orthoptera: Acrididae). Journal of Insect Behavior 7: 183-198.

Marshall J.A., Haes E.C.M. 1988. Grasshoppers and Allied Insects of Great Britain and Ireland. Harley Books, Colchester.

McCartney J., Armstrong D.A., Gwynne D.T., Kelly C.D., Barker R. 2006. Estimating abundance, age structure and sex ratio of a recently discovered New Zealand tusked weta *Motuweta riparia* (Orthoptera, Anostostomatidae), using mark-recapture analysis. New Zealand Journal of Ecology 30: 229–235.

Turrill W.B. 1948. British Plant Life. Collins, London.

Wake A. 1997. Grasshoppers and Crickets (Orthoptera) of Essex. Colchester Natural History Society, Colchester.

Whitman D.W, Vincent S. 2008. Body size in Orthoptera. Journal of Orthoptera Research 17: 113-114.

Whitman D.W. 2008. The significance of body size in the Orthoptera: a review. Journal of Orthoptera Research 17: 117-134.