LABORATORY OBSERVATIONS ON THE LIFE CYCLE OF *HISTER NOMAS* (COLEOPTERA: HISTERIDAE)

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(Accepted for publication 2 October 1987)

ABSTRACT

The biology of *Hister nomas* Erichson was studied in the laboratory to define the developmental history of this bovine dung attracted predator. Female beetles deposited eggs singly 0.5-3.0 cm deep in the soil beneath dung. Embryogenesis was completed in 2.8 days after oviposition. There were two larval instars; each stage required ca. 6.1 and 6.2 days, respectively, for full development, and pupation to adult emergence averaged 17.5 days. Developmental time from oviposition to adult averaged 32.6 days.

Key Words: Biology, predator beetles, dung-breeding, fly, horn fly, biological control, *Hister nomas*.

J. Entomol. Sci. 23(2): 124-130 (April 1988)

INTRODUCTION

Predators, including histerid beetles, are being evaluated along with several species of parasites and competitors of dung-breeding Diptera as potential biological control agents of the horn fly, *Haematobia irritans* (L.). The horn fly, an introduced, hematophagous parasite that oviposits in fresh cattle dung, is a major pest of cattle in the United States. Most control practices have been limited to conventional insecticides. However, horn fly resistance to insecticides has recently become a problem (Sparks et al. 1985). This resistance problem has generated increased interest in biological methods of control. Thus far, 14 exotic species of competitors (dung-burying scarabs) have been released in the United States (mostly in Georgia and Texas) to compete with immature horn flies for the same food source (Fincher and Morgan 1988). Several exotic species of predators and parasites of dung-breeding flies have also been imported and are awaiting release (Fincher et al. 1986).

Most histerid beetles are predaceous and feed on larvae of other insect species found in decomposing organic matter such as animal excrement (Balduf 1935). Some species of histerids have been reported to be predators of dipterous larvae in dung (cowpats) and are thought to contribute to the suppression of dung-breeding flies (Bornemissza 1968, Summerlin et al. 1981, 1984). Summerlin et al. (1982a, 1984) reported that three native species of histerids, *Hister coenosus* Erichson, *Hister incertus* Marseul, and *Hister abbreviatus* F., were effective predators of immature horn flies in laboratory tests. However, field studies revealed that adult histerids invade only about 50% of the cowpats dropped on pasture and that seasonal occurrences varied considerably between species (Summerlin et al. 1982b).

An established breeding colony of *Hister nomas* Erichson, an African histerid established in Hawaii, is currently under investigation in our laboratory to determine if the common occurrence of this beetle in cowpats (Toyama and Ikeda 1976) contributes to horn fly suppression. Thus, a thorough knowledge of the life history of a predator species is of primary importance in order to determine if it will be a useful biological control agent in an integrated control program. Since nothing was found in the literature on its biology, we report here results of investigations on the life cycle of *H. nomas.* If *H. nomas* is determined to be an effective predator of horn flies in laboratory studies, it will then be released for field studies on the mainland.

MATERIALS AND METHODS

A colony of *H. nomas* was established in the laboratory from 21 adults collected from cowpats in Hawaii on the islands of Hawaii and Maui in September 1985. The colony was maintained by placing 6-8 beetles (males and females are morphoplogically indistinguishable) in round plastic containers (8.5 × 25 cm diam) filled to a depth of ca. 2.0 cm with moist sandy soil (ca. 5% moisture). The containers and subsequent experiments were held in constant light at 25-28°C and 40-60% RH. The containers were fitted with lids constructed partially of cotton muslin to provide adequate ventilation. Approximately 100 g of fresh cattle dung was placed on the soil surface in each container and 1,000-1,500 stable fly, *Stomoxys calcitrans* (L.), eggs were added on top of the dung daily as food for the adult beetles and ensuing beetle larvae. The stable fly eggs were suspended in water and placed on the manure with a rubber bulb and pipette. Fresh manure was added every 5-7 days as aged and dried manure became unsuitable for maturing fly larvae. The soil surrounding the manure was sprinkled every 3-4 days with 5-10 ml water to maintain adequate moisture. The containers were cleaned every 4 wk. Beetles and manure were removed from the rearing containers and the soil was carefully sifted to recover beetle eggs and larvae. The containers holding the sifted soil and the inspected manure were then flooded with tap water which caused undetected adults and larvae to float to the surface for subsequent recovery. Adult *H. nomas* were then set up in similar containers with soil, dung, and fly eggs as above. Histerid eggs and/or larvae recovered during the cleaning process were transferred to similar rearing containers.

Oviposition sites were determined for *H. nomas* by placing two to three adults in wood-framed cages (20×15×1 cm) with glass panels for observational purposes. Cages were three-fourths filled with sandy soil and ca. 50 g aliquots of bovine feces with fly eggs were added periodically (Summerlin et al. 1981). Daily observations were made to determine ovipositional activity. Eggs were removed from the soil with a small, moist brush, measured, and individually isolated in petri dishes (50 mm diam × 7 mm deep) containing ca. 6 mm of moist sandy soil. Each egg was placed in the soil in a preformed depression that was slightly larger than the egg which resembled natural oviposition cells. This holding method facilitated observation of the egg and protected it from desiccation. Measurements were made with a binocular microscope fitted with

an eyepiece micrometer. Width measurements were made at the widest portion of the egg. Eggs were inspected several times daily for hatching.

Newly hatched larvae were measured at the widest portion of the head capsule. Some of the neonates were transferred individually to petri dishes (9 cm diam × 1.2 cm deep) containing moist filter paper disks with 100-200 stable fly eggs so that observations of the larval instars could be achieved without obstruction. Each larva was transferred daily to a clean petri dish with new filter paper and fresh stable fly eggs. Some neonates were also transferred individually to plastic containers (5.0 cm diam × 3.5 cm high) containing moist sandy soil and bovine manure to provide a supplemental supply of larvae for observation. Fresh stable fly eggs (400-500) were added to each container twice weekly as a food source. Measurements were made periodically of the length and width at each larval stage. The pupae were not measured because of the risk of damaging the beetles. After eclosion, new adults were removed and placed in rearing containers under conditions given previously. Beetles from each of the seven generations studied were kept separate. Observations were made daily from oviposition to adult eclosion. The length of time required for egg hatch, development of larval instars, initiation of pupal cell formation, and pupation were recorded.

RESULTS AND DISCUSSION

The biological cycle of *H. nomas* is similar to that of the native *H. abbreviatus* (Summerlin et al. 1984). Adult *H. nomas* (Fig. 1) closely resemble adult *H. abbreviatus* morphologically, but they are generally larger than the latter species. Adult *H. nomas* averaged 6.9 mm in length and 5.0 mm in width (Table 1). *Hister abbreviatus* adults averaged 5.0 mm long and 3.5 mm wide (Summerlin et al. 1984). Both species have four entire elytral striae with a fifth stria apical and short in *H. abbreviatus* and long to almost complete in *H. nomas*. In both species, the outer margins of the anterior tibiae are 4-dentate, however, these tooth-like prominences are larger and more conspicuous in *H. nomas*.

Hister nomas mates in or under cowpats with females ovipositing single eggs in vertical or horizontal cells from 0.5-3.0 cm deep in the soil beneath the manure (Fig. 2). In most instances, eggs were deposited ca. 3 cm deep. Eggs averaged 3.2 mm in length and 1.3 mm in width (Table 1). Embryogenesis of *H. nomas* eggs held at 25-28°C was completed in 2.8 days after oviposition as compared to 2.3 days for *H. abbreviatus* eggs (Summerlin et al. 1984).

The newly hatched larvae of *H. nomas* appeared uniformly white, with only the apex of the mandibles brown; head capsules became fully pigmented (dark brown) within 6 h (Fig. 3). First instars at eclosion averaged 5.2 mm in length and the width of the head capsule averaged 1.0 mm (Table 1). The first larval molt occurred ca. 6 days after eclosion. At the beginning of the 2nd instar (Fig. 4), larvae averaged 8.9 mm in length and the head capsule width was 1.6 mm (Table 1). Our observation that *H. nomas* larvae pass through only two stages is consistent with the findings of Lindner (1967) in studies of six other species of histerids. The 2nd instars at maturity averaged 15.1 mm in length and were characterized by a uniformly pale yellow coloration when they become prepupae.

The prepupal larva was quiescent for 3-4 days and then constructed a broadly oval to elliptical pupal chamber of intricately woven manure particles and grass fibers. This pupal chamber was very similar to those constructed by *H. abbreviatus*

(Summerlin et al. 1984). The pupal chambers were highly variable in size and averaged ca. 12 mm long and 9 mm wide. Unlike *H. abbreviatus* prepupae which formed chambers beneath the cowpat, *H. nomas* prepupae formed pupal chambers on the fringes of the drying manure. This indicates that a dryer location is preferred or required for pupation of *H. nomas* than required for *H. abbreviatus*.

Newly formed pupae (Fig. 5) were white and characterized by depression of the head beneath the pronotum and a conical abdomen. The last segment of the pupae bears vestiges of anal urogomphi similar to those of *H. abbreviatus* (Summerlin et al. 1984). The pupal period was variable and lasted ca. 17.5 days. When newly formed adult beetles became fully pigmented (black) and hardened, they emerged from the pupal chamber by gnawing through the chamber wall. Developmental time from oviposition to adult averaged 32.6 days.

Table 1. Measurements (± S.D.) and developmental times (± S.D.) of different stages of *Hister nomas* reared in the laboratory at 25-28°C.

Stage	Number Observed	Length (mm) Range	Length (mm) Mean ± SD	Width (mm) Range	Width (mm) Mean ± SD	Developmental Time (Days) Min.	Max.	Mean ± SD
Egg	30	2.9 - 3.3	3.2 ± .16	1.1 - 1.4	1.3 ± .08	2	3	2.8 ± .47
1st instar	30	4.3 - 5.7	5.2 ± .40	1.0 - 1.1	1.0 ± .04	5	7	6.1 ± .73
2nd instar	17	8.3 - 10.0	8.9 ± .84	1.6 - 1.7	1.6 ± .05	4	9	6.2 ± 1.70
Pupa*	10					16	19	17.5 ± 1.08
Adult†	10	5.7 - 7.6	6.9 ± .40	4.3 - 5.6	5.0 ± .27	29	35	32.6 ± 1.90

* Pupae were not measured.

† Developmental time was determined for 10 individuals whereas measurements of adults included 50 additional individuals randomly selected from the colony.

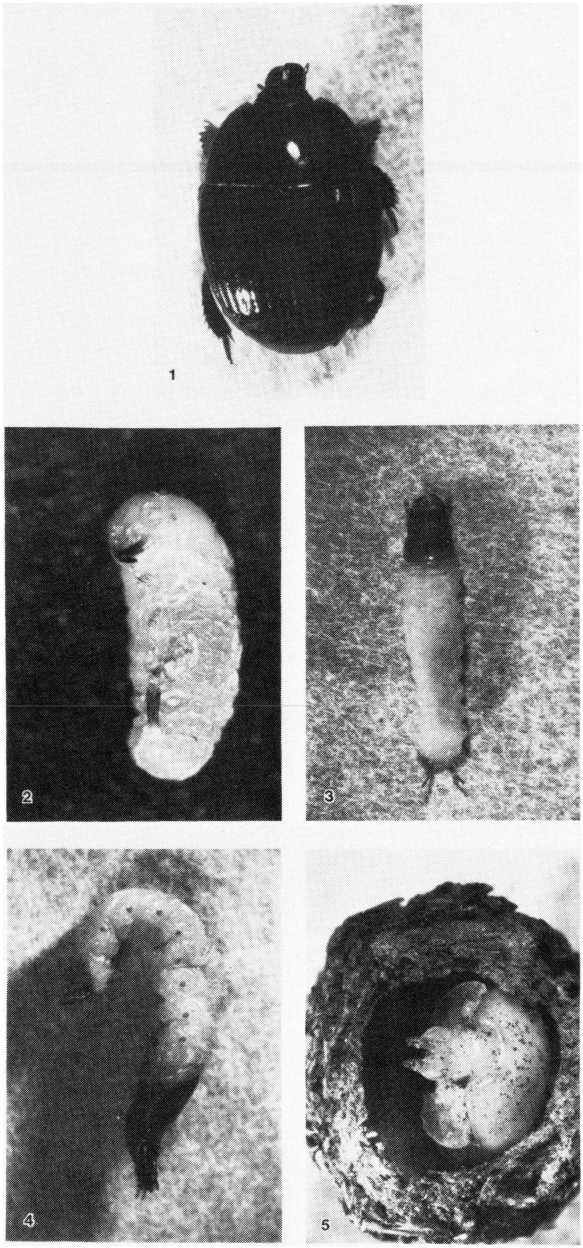

Fig. 1. Adult *Hister nomas*.
Fig. 2. Egg, just prior to hatching.
Fig. 3. First instar larva.
Fig. 4. Second instar larva at prepupal stage.
Fig. 5. Pupa within pupal chamber.

ACKNOWLEDGMENT

We are especially grateful to Dr. Rupert L. Wenzel, Curator Emeritus, Division of Insects, Field Museum of Natural History, Chicago, Illinois, for identifying the beetles studied, and to Mark Thompson, USDA, ARS, College Station, Texas, for his help with the photographs.

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