Does the Sexual Female of *Schlechtendalia chinensis* (Bell) (Homoptera: Pemphigidae) "Viviparously" Produce the Fundatrix?¹

Hajimu Takada

Laboratory of Entomology, Faculty of Agriculture, Kyōto Prefectural University, Shimogamo, Kyōto 606, Japan

(Received June 19, 1990; Accepted July 31, 1990)

I confirmed that the sexual female of *Schlechtendalia chinensis* (Homoptera: Pemphigidae) produced the fundatrix viviparously 18-23 days after mating. This "viviparity" was regarded as ovoviviparity because of circumstantial evidence. The origin of this mode of reproduction is discussed in relation to a unique one-year life cycle.

Key words: *Schlechtendalia chinensis*, *Rhus javanica*, ovoviviparity, sexual female, fundatrix

INTRODUCTION

Takagi (1934, 1937) stated that the sexual female of *Schlechtendalia chinensis* (Bell) produced the fundatrix viviparously. Tang (1976) also reported the same observation. Shibata (1955, 1987) expressed strong doubt about Takagi's analysis as the fundatrix usually develops from an egg deposited by the sexual female.

I observed and have confirmed that the sexual female of this aphid does in fact viviparously produce the fundatrix.

LIFE CYCLE

The life cycle of *S. chinensis* in Kyōto, as observed at Uryū-yama and Daimonji-yama, Kyōto, from 1983 to 1990, is shown in Fig. 1. The fundatrix appears on the sumac tree, *Rhus javanica* L., in mid to late May. It crawls up, immediately after birth, from the trunk to a terminal bud and feeds on the upper surface of the leaflet, usually the wing, to form a small primitive gall. Two or three generations of apterous viviparae develop within the closed gall during the summer before alate viviparae appear. The gall is gradually enlarged with increasing numbers of aphids. In late October and early November gall slits open and alate viviparae migrate to *Mnium microphyllum* Dozy et Mølkenboer moss, where one generation of the sexuparae develops. The sexuparae hibernate in the larval stage and become alate adults, usually in mid to late April of the following year. They return to the sumac tree and deposit apterous males and

¹ Contribution No. 239 from Lab. Ent., Kyōto Pref. Univ.
sexual females, which settle in bark crevices of the trunk. After mating, the sexual female produces one fundatrix. This aphid therefore has three phases in its life cycle: three or four parthenogenetic generations within the gall on the leaves of the sumac tree, one parthenogenetic generation on moss and one sexual generation on the sumac tree trunk.

**SHIBATA (1955, 1987)** suggested from his observations at Utsunomiya and Hatano that anholocycle occurs on the moss, but I never saw aphids on there during the summer at Kyôto.

**MATERIALS AND METHODS**

Hibernating larvae of sexuparae of *S. chinensis* were collected from mosses at Uryû-yama and Daimonji-yama, Kyôto, from January to March of 1986, 1987 and 1988 and used for rearing experiments. These sexuparae and their progeny, sexuales, were reared in an insectary at 15L:9D, 18±1°C. Sexuales were maintained in a plastic cage (60 mm × 95 mm × 25 mm ht) containing a sheet of damp cardboard (55 mm × 90 mm) with narrow slits in which sexuales could hide.
Production of Fundatrix in *S. chinensis*

RESULTS

1. Development of the sexuales and copulation

   The sexupara produced two to five sexuales, usually including both females and males, but sometimes only males. The sexuales settled in the slits in the cardboard. They moulted four times within five to six days and matured into adults. Males then wandered actively on the cardboard to locate females, which remained stationary at the same site. After mating, males soon died. Females survived for about three more weeks, their bodies covered with whitish wax.

2. Production of the fundatrix by the sexual female

   The inseminated female produced one fundatrix 18–25 days after mating. The process is shown in Fig. 2, with elapsed time. The female usually walked out of a slit in the cardboard just before larviposition. She then firmly attached the posterior tip of the larva, which was enveloped in a membrane, to the cardboard surface with sticky fluid she excreted (1). The larva was then produced with the forward body movements (2–8) of the parent. The parent then moved away (9). The larva, though still enclosed in a membrane, stood erect upon its fixed posterior tip (10) and moulted. As the membrane was shed, the appendages gradually lifted away from the body; first the antennae, then the legs (11). The larva stood erect after about 25 min. (12), beginning to walk about 45 min after the start of moultng.

   The body lengths of the sexual female before larviposition and the fundatrix just after birth were 0.5 mm and 0.4 mm, respectively. Relative to the size of the parent, this is a very large larva. The parent's body deteriorated after larviposition (9–12) but remained alive for several days.

DISCUSSION

1. The meaning of "viviparity" in the sexual female of *S. chinensis*

   The sexual female of *S. chinensis* apparently produced the fundatrix "viviparously" as TAKAOI (1934, 1937) described. But it is certain that viviparity in the sexual female of the species is not homologous with that in the parthenogenetic female. In the latter the embryo starts to develop after ovulation in the ovarioles; in the former this possibly occurs after fertilization. It seems that embryonic development concludes within about three weeks during the time in which the female remains stationary after mating in the crevice of the bark of the sumac tree. Although it has not yet been confirmed whether the embryo obtains nutrition for development only from yolk, "viviparity" in the sexual female of this aphid might be called ovoviviparity. Incidentally, ZHANG and ZHONG (1983) stated that the *S. chinensis* female deposited one "egg" (not larva) 15–20 days after mating, which immediately "hatched" and developed into the fundatrix.

2. The origin of the one-year life cycle without embryonic diapause

   Another feature of *S. chinensis* is the lack of diapause in the embryonic stage. The sexual female always produced the fundatrix in about three weeks after mating in all of my observations done under natural conditions. It seems, therefore, that this aphid does not display embryonic diapause. Alternatively, it undergoes larval diapause
through the winter. This will be the subject of future reports.

In many holocyclic, heteroecious species of Fordinae, the sexuales appear in spring (Wool, 1984), as in *S. chinensis*, perhaps due to a prolonged stay in the gall. In the species other than *S. chinensis*, the sexual female produces a single diapause egg, and the fundatrix emerges in the following spring. This is a two-year cycle (Bodenheimer and Swirski, 1957). *Melaphis rhois* (Fitch), which also migrates from *Rhus* to *Mniium* mosses in North America, has a typical two-year cycle (Moran, 1989).
It is possible that *S. chinensis* has evolved from an ancestor with such a two-year life cycle and subsequently developed an one-year cycle without embryonic diapause. This ancestral female would not have deposited her egg and died with it inside the body, as in *Geocica utricularia* (Pass.) and *Baizongia pistaciae* (L.) (Wool, 1977). In *S. chinensis* the embryo, not undergoing diapause, matures in the body of the parent female before death; and the parent inevitably must deposit it ovoviviparously.

ACKNOWLEDGEMENT

I thank Dr. M. Miyazaki for commenting on the manuscript.

REFERENCES


