Effects of a Dipterous Parasite upon the Grasshopper, *Oxya yezoensis* Shiraki[1)]

By

Tohru Uchida and Shôzô Ehara

(Zoological Institute, Faculty of Science, Hokkaido University)

(*With 4 Text-figures*)

While studying on parasites to the orthopterans the writers came across a dipteran parasite on the grasshopper, *Oxya yezoensis* Shiraki. The parasite is *Phorocerosoma forte* Townsend belonging to the Tachinidae and was also found in another orthopteran, *Podisma sapporense* Shiraki. So far as the writers have observed, the host indicates no change in external structure and size, but undergoes degeneration of the gonads in both sexes.

Before proceeding further, the present writers must express warm thanks to Prof. S. Takano of the Obihiro Zootechnical College, who kindly identified the specific name of the parasite and also to Dr. M. Okada for the photomicrographs used in the paper.

Observations

The grasshopper is very common and abundantly found in rice fields near a meadow of our University from the middle of July to the end of October. Most of them complete their metamorphosis by the end of August, thence the nymphs are very rare in September. The last nymph of them was collected on Oct. 11. The collection was made once or twice per week from Aug. 10 to Nov. 1. The grasshoppers used in the study were 893 in number, including 757 adults and 136 nymphs. These materials, after fixation with Bouin's solution, were preserved in 70% alcohol for further studies.

The rate of the parasitism is rather low ; out of 893 specimens examined, only six individuals were found to harbour the parasites, showing the value of 0.67%, and in one specimen the respiratory funnel alone of the parasite was found. In all cases each host was parasitized by a single parasite (Fig. 1).

---

1) Contribution No. 292 from the Zoological Institute, Faculty of Science, Hokkaido University, Sapporo, Japan.

Jour. Fac. Sci. Hokkaido Univ., Ser. VI, Zool. ***11***, *1953.*

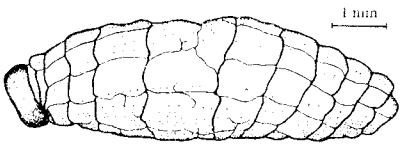

Fig. 1. Larva of the parasitic dipteran, *Phorocerosoma forte*

The following table shows the rate of the parasitism.

Date	Grasshoppers examined	Grasshoppers habouring the parasite
Aug. 10	53(6 adults & 47 nymphs)	0
Aug. 18	70(16 adults & 54 nymphs)	1
Aug. 23	62(49 adults & 13 nymphs)	2
Aug. 27	109(95 adults & 14 nymphs)	1
Aug. 30	96(91 adults & 5 nymyhs)	1
Sept. 3	27(27 adults)	0
Sept. 7	82(81 adults & 1 nymph)	1
Sept. 12	70(69 adults & 1 nymph)	0
Sept. 21	60(60 adults)	0
Sept. 26	56(59 adults)	0
Oct. 5	61(61 adults)	0
Oct. 11	56(55 adults & 1 nymph)	0
Oct. 18	50(50 adults)	0
Oct. 27	22(22 adults)	0
Nov. 1	16(16 adults)	0
Total	893(757 adults & 136 nymphs)	6

The difference between the male and female of the grasshopper lies in size and copulatory organs. These sexual characters of the grasshoppers harbouring the parasite seemed not to be altered at all. But the internal part of the sexual characters has been transformed in both sexes. The parasite was found in the abdomen, lying around the alimentary tract, attached to the body wall by means of the respiratory funnel. By the presence of the parasite the alimentary canal is often pressed down.

In the male hosts, the vasa deferentia and accessory glands were found to be normal, but the testes were always greatly reduced in size and generally became thinner; sometimes represented by a thin membranous structure and rarely split in pieces. The testis and accessory glands of normal grasshoppers were figured in Fig. 2. In Fig. 2, a and b are given those of nymphs and in Fig. 2, c and d are indicated those of an adult. The testis gradually grows by the enlargement of the follicles. Along with the growth of the testis, the accessory glands enlarge. In the adults the dorsal side of testis is covered with a membrane and therefore the follicles are not distinctly visible and the accessory glands

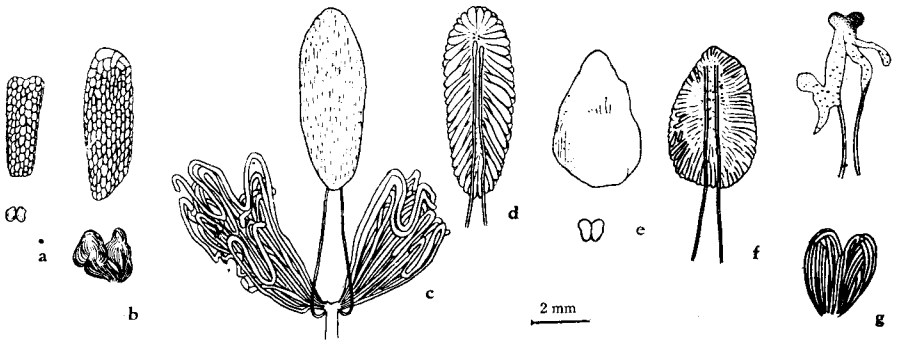

Fig. 2. Testes and accessory glands of normal grasshoppers (a-d), upper figures testes, lower figures accessory glands ; testes and accessory glands of grasshopper-hosts (e-g), upper figures testes, lower figures accessory glands, a, b, c, e, and g, dorsal view and d, f ventral view. e, f exceedingly flattened, g membranous except the apical part. Magnifications all same.

develop to a high degree as shown in the figure. The nymph victimized by the parasite always had testis thinned out to a lamella and the follicles were not clearly observable on the dorsal surface. An adult (No. 286) with only the respiratory funnel of the parasite which had probably already emerged, had only membranous pieces, at the apical end of which a small vestigial part of the testis was retained. The accessory glands were slightly smaller than those of the normal

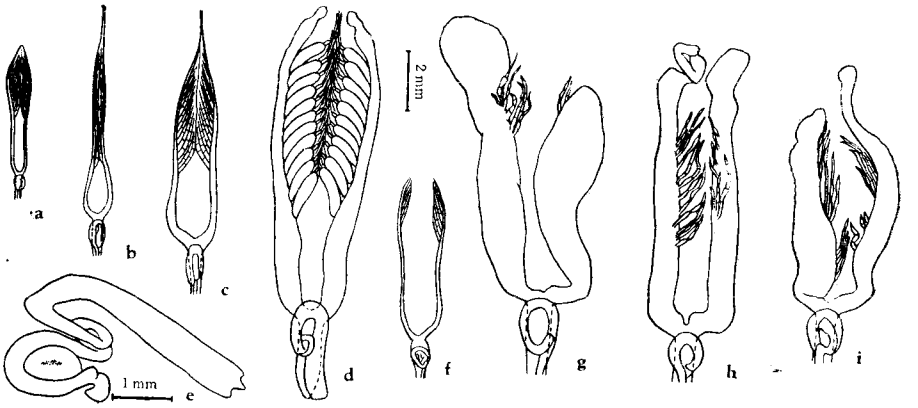

Fig. 3. Ovaries of normal nymphs (a-c), normal female (d) and of parasitized nymph (f) and parasitized females (g-i). All dorsal view. e. spermatheca of d. Magnifications all same except e.

insect. In this small vestigial part were contained a small number of spermatozoa. In the other hosts the testis, though diminished in volume, was found to contain male germ cells from spermatogonia to spermatozoa and the boundary of follicles was generally thicker than that of the normal male. Effected by the parasitism, the testis of hosts diminishes in size but passes through spermatogenesis completely in limited areas.

Fig. 4. a. The grasshopper, *Oxya yezoensis*, a part of thorax and abdomen dissected, showing the parasite. b. Cross section of testis of parasitized nymph. ×60. c. Cross section of testis of a parasitized adult, showing spermatozoa ×230. d–g. Sagittal section of ovaries of parasitized adults ×60. Ovaries sectioned with the liver of rat.

The ovaries of hosts are found to be more exceedingly damaged than the testes ; they cannot produce grown ova. In the normal females the oviducts are tapering towards the apex and give rise to about 11 ovarioles on the inner edge. The ovarioles are regularly arranged and slender in the nymph stage, but gradually enlarged at their base to contain grown ova in the adult (Fig. 3). The effects of the parasite upon the host are indicated in abnormal growth of the oviducts and decrease in number of the ovarioles. In Fig. 3, f illustrating an ovary of a nymph parasitized by the dipteran, the ovarioles, though regularly arranged, were found to be more or less reduced in number. In Fig 3 g, h and i the oviducts of the adults are deformed and the ovarioles are much fewer and irregularly arranged. In the ovaries of the parasitized nymph there are mostly observable young germ-cells from the oogonia to oocytes, and also a few young ova at the basal portion. In the adult hosts the ovaries contain numerous oocytes and young ova, but no well-grown ova were observed. Inferring from the above facts the parasitized female appears to be unable to reproduce offspring. The spermathecal glands were found always normal.

Remarks

Clausen (1940) who reviewed the entomophagous insects, makes the following statement : "Pantel (1898) has shown that the degeneration of the reproductive system of female Phasmidae as a result of parasitism by *Thrixion* is only temporary and that in some instances these females are again able to produce and deposit eggs after the parasite larvae have left their bodies". In the orthopteran here treated, however, the female can not possibly deposit eggs any more, because there is not time enough for the ovaries to be regenerated. The male grasshopper parasitized by the dipteran comes at least to have morphologically developed spermatozoa, but it is questionable whether they are fertile, because there are reported several insect hosts which have seemingly normal gonads but are sterile.

So far as the writers have observed, the parasitism is not fatal to the host, there having been found some hosts still active, bearing the respiratory funnel of the parasite. In these hosts the parasite must have emerged sometime previously.

Regarding the effect of parasites on insect hosts, there have been published rather many reports from the viewpoint of ecological values, but very few about histological changes of the gonads. There are recorded the following remarkable cases of parasitic castration in insects : *Thelia bimaculata* parasitized by *Aphelopus theliae* (Kornhauser, 1919), several hymenopterans by stylopids (Salt, 1927 & 1931) and *Chironomus hyperboreus* by nematodes (Rempel, 1940). In these cases some sexual characters were changed into the opposite sex in accordance with the histological changes of gonads. Esaki and Hashimoto (1931) reported that both sexes of the leaf-hopper, *Pelphacodes furcifera*, parasitized by the stylopid,

Elenchinus japonicus, came to have neutral copulatory organs. In the orthopteran considered in this investigation parasitic castration was effected to some degree but no external changes were caused. The parasitic castration of this insect seems to be slightly more advanced than that of the amphipod, *Hyalella azteca* parasitized by the acanthocephalan, *Latrohynchoides thecatus.*

Literature

Clausen, C. P. 1940. Entomophagous insects. New York and London.

Esaki, T. et S. Hashimoto. 1931. Report on the leaf-hoppers injurious to the rice plant and their natural enemies (In Japanese). Publ. No. 2, Entom. Lab., Dept. Agric. Kyushu Imp. Univ.

Kornhauser, S. I. 1919. The sexual characteristics of the membracid, *Thelia bimaculata* (Fabr.) I. External changes induced by *Aphelopus theliae* (Gahan). Jour. Morph., vol. 32, p. 531-636.

Rempel, J. G. 1940. Intersexuality in Chironomidae induced by nematode parasitism. Jour. Exp. Zool., vol. 84, 261-289.

Salt, G. 1927. The effects of stylopization on aculeate Hymenoptera. Jour. Exp. Zool., vol. 48, p. 223-331.

——— 1931. A further study of the effects of stylopization on wasps. The same, vol. 59, p. 133-163.

Spaeth, F. W. 1951. The influence of Acanthocephalan parasites and radium emanations on the sexual characters of *Hyalella* (Crustacea, Amphipoda). Jour. Morph., vol. 88, p. 361-383.