will luminesce when they are warmed. Some animals had only one organ removed and these showed luminescence in the remaining organ but none on the operated side. They died before pupation. The animal with both organs removed was taken from the refrigerator on March 10, 1928, and pupated in April. During the latter half of the pupation period this animal glowed diffusely in all parts of its body, just as does a normal firefly pupa. The adult emerged on May 11, 1928, was perfect in every way, even to histological structure, and flashed normally.

On May 6, 1928, eight more larvae had their luminous organs completely removed. Four of these pupated in the latter part of May and showed no luminescence until the diffuse luminescence appeared throughout the pupa, characteristic also of the normal controls. Only one operated animal emerged as an adult firefly, but it was normal in every respect, with a complete luminescent luminous organ.

We therefore conclude that the luminous granules described in the firefly organ are not luminous bacteria but luminous substance. The only alternative interpretation is that supposed symbiotic bacteria might have developed a non-luminous stage in their cycle of existence, which does not seem probable. The above conclusion applies only to the firefly, for there is no doubt that in several luminous fishes[3] symbiotic luminous bacteria are always present in the organ.

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PLASMOPARA MILDEW OF SUNFLOWER[1]

FURTHER observations and review of literature have revealed information not given by Young and Morris.[2] Melhus[3] illustrated *Plasmopara halstedii* in sunflower stems. Nishimura[4] illustrated this fungus in sunflower roots, stems and cotyledons. Gardner[5] illustrated Peronspora in turnip roots. Salmon and Ware[6] and Ware[7] described hibernating and root mycelium of Pseudoperonospora in hops.

Plasmopara halstedii (Farl.) Berl. and de Toni was abundant in a six-acre field of Mammoth Russian sunflowers at Bozeman, Montana, in 1927. This field had been planted in sunflowers in 1925 and 1926. There was a large increase in downy mildew in 1927, when 6 per cent. of the stems had this disease. In one row, from 5 to 26 per cent. of the sunflowers had downy mildew. Many cotyledons and leaves were mottled by this disease. Although this mottling is prominent and suggests mosaic, the disease is not called mosaic because this would confuse it with the mosaic viroses.

Sections showed Plasmopara hyphae in cotyledons, roots, stems and leaves. Many seedlings showed clear symptoms of downy mildew in their cotyledons and leaves within a week after they came up. Severely diseased sunflowers lived only a few weeks, but a dozen of the most mildly affected plants became 0.6 to 1.3 m tall. Six of them were placed in the greenhouse after the first mild frost. Although many diseased plants bloomed, none produced any viable seed.

To secure evidence concerning soil transmission of downy mildew, soil was secured in March, 1928, from the part of the sunflower field that was most abundantly infested with Plasmopara in 1927. In the greenhouse, 633 White Beauty sunflowers were grown in this soil for forty days. Downy mildew appeared in nine of these plants within eighteen to forty days after planting. No disease appeared in 218 check plants of White Beauty sunflowers grown simultaneously in greenhouse potting soil. In autoclaved soil were planted 858 White Beauty and Mammoth Russian sunflower seeds. The resulting plants were observed for forty-six days, but none of them showed disease. Since downy mildew appeared only in sunflowers grown in soil from the infested field, probably they were infected by zoospores produced by oospores in the soil. This evidence supports the statement of Nishimura[4] that *Plasmopara halstedii* overwinters as oospores in sunflower refuse in the soil.

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[3] E. N. Harvey, Pub. 312 Carnegie Inst. Wash., p. 43, 1922; and H. Yasaki, *Jour. Exp. Zool.*, 50: 495. 1928.

[1] Published with the approval of Director F. B. Linfield, of the Montana Agricultural Experiment Station.

[2] P. A. Young and H. E. Morris, "Plasmopara Downy Mildew of Cultivated Sunflowers," *Amer. Jour. Bot.*, 14: 551–552. 1927.

[3] I. E. Melhus, "Perennial Mycelium in Species of Peronosporaceae Related to *Phytophthora infestans*," *Jour. Agr. Res.*, 5: 59–69. 1915.

[4] Makato Nishimura, "Studies in *Plasmopara halstedii*," *Jour. Coll. Agr. Hokkaido, Imp. Univ. Japan*, 11(3): 185–210, 1922; and 17(1): 1–61, 1926.

[5] M. W. Gardner, "Peronospora in Turnip Roots," *Phytopath.*, 10: 321–322. 1920.

[6] E. S. Salmon and W. M. Ware, "On the Presence of a Perennial Mycelium in *Pseudoperonospora humuli* (Miyabe and Tak.) Wils.," *Nature*, 116: 134–135. 1925.

[7] W. M. Ware, "*Pseudoperonospora humuli* and its Mycelial Invasion of the Host Plant," *Trans. Brit. Myc. Soc.*, 11: 91–107. 1926.