with ease and the details of their morphology and topography can be distinguished rather better than in fixed and stained preparations, particularly if a binocular microscope giving perspective is employed. It is readily seen by focusing up and down through entire nuclei that clumps of particles which in thin sections appear to be isolated, are, in reality, often in contact with one another. Frequently there is a central mass, from which clumps of particles stretch out like arms. As yet we have been unsuccessful in our attempts with fresh, unstained cells to ascertain how the particles are formed. Whether this takes place in single or multiple foci within the nucleus remains to be determined. No indications have been observed of independent motility or of multiplication by division, nor have we detected any increase in size of the particles through accretion or condensation of further materials on their surfaces. The uniformity in size of the particles is noteworthy. They do not grade down past the border line of visibility, nor are there any specially large ones. It should be possible to follow their behavior by implanting groups of affected cells, or even single cells, in pure line tissue cultures of rhesus liver.

For a detailed comparison of these yellow fever inclusions with those produced by other viruses we must await the results of further experimentation. It is evident, however, that they resemble somewhat the inclusions of herpes, as we have studied them in the brain, and as Goodpasture and Teague[4] have very briefly reported them in the rabbit's liver. If it proves possible to maneuver the herpetic virus into the monkey's liver, a direct comparison can be made, which will be helpful, for it is our ambition to learn to know the viruses by their deeds. The inclusions produced by virus III in the testicles of rabbits are, in our preparations, much more dense and compact, but what they would look like in the liver, if virus III were capable of attacking liver cells, we have no means of knowing without experimentation. Caution is necessary, for we have found that the inclusions caused by the submaxillary virus in the brain are rather different morphologically from those which it provokes in salivary glands. The large, spherical inclusions, already referred to as occurring in association with the typical clumps of fine particles, are not unlike the acidophilic inclusions of Borna disease, as the latter exist in nerve cells.

Through the kindness of Dr. Oscar Klotz, we have been able to examine tissues from human cases of yellow fever contracted in widely separate localities as follows: 4 cases from New Orleans, 4 from Brazil, 2 from Ecuador, 3 from San Salvador, 7 from Lagos, 2 from Accra, 3 from Dakar and 2 from Senegal. Most of the tissues had been preserved in formalin and for this reason it was difficult to color them with acid dyes. Nevertheless, intranuclear inclusions like those seen in the monkey tissues were found in 22 of the total of 25 cases. In some of the cases, the large forms previously referred to were very abundant, sometimes several in a single nucleus. It was impossible to distinguish between the intranuclear inclusions in the African and American cases. One of those negative for inclusions seemed to be without doubt a case of true yellow fever; another was recorded as questionable; while the third was said to be some form of poisoning, not yellow fever.

[4] *J. Med. Res.*, 1923, 44: 121.

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WILL THE ADULT FIREFLY LUMINESCE IF ITS LARVAL ORGANS ARE ENTIRELY REMOVED?

IT is well known that the adult luminous organ of the firefly is entirely formed anew during the pupal stage and that the larval organ persists and glows in the pupa and is only absorbed at the time the adult emerges. Therefore, we should expect an adult light organ to form even if the larval organ is removed, but the interesting point concerns the luminescence of the reconstituted adult organ. If luminescence is a fundamental characteristic of the photogenic cells due to the chemical production of a luminescent material, there is no doubt but that the reconstituted adult organ would luminesce even if the larval organs had been removed. On the other hand, if the luminescence is due to symbiotic luminous bacteria, as Pierantoni,[1] Büchner[2] and some others believe, removal of the larval organ should remove completely the bacteria, as no other region of the larva is luminescent, and we should expect no luminescence of the adult.

Experiments carried out by one of us (R. T. H.) have demonstrated that the adult luminous organ of the firefly will develop perfectly from larvae both of whose light organs have been removed. The statement is based on two surviving animals of many operated on. One had its light organs removed with iridectomy scissors as a full-grown larva on October 24, 1927. It was kept in moist earth and leaves in a refrigerator at 3° C. during the winter, and when examined from time to time at room temperature showed no trace of luminescence, although the controls

[1] U. Pierantoni, *Rend. Ac. Sc. Napoli*, 20: 15. 1914.

[2] P. Büchner, "Tier und Pflanze in introzellularer Symbiose," Berlin, 1921. p. 344.

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.