flavors form during storage at −17.5° C. (0° F.) in vegetables exposed to air. Definite changes in flavor occur in two months, and the off-flavors increase in intensity during storage. Joslyn and Cruess[1] and Joslyn[2] have reported that heating for 1 or 2 minutes in steam or boiling water at 100° C., followed by cooling, was sufficient to prevent the appearance of these hay-like flavors during storage at −17.5° C. for over 8 months. Subsequent tests by us and others have confirmed these findings. Blanching of the vegetables also resulted in a greener color, stable to heat during cooking.

In the course of investigations on the nature of these changes, very striking results were obtained on blanching peas, string-beans and spinach at various temperatures for 2 minutes in water. We found that there was a critical temperature range, somewhat different for each vegetable, at which the color, flavor and texture was most benefited by heating. These temperature ranges were 71 to 76.5° C. (160° to 170° F.) for peas, 82.2 to 90.6° C. (180° to 195° F.) for string-beans and 73.9 to 82.2° C. (165° to 180° F.) for spinach. Blanching below the temperatures given did not entirely inhibit formation of off flavor, and blanching at higher temperatures resulted in loss of fresh flavor and, especially for peas and spinach, the formation of other objectionable flavors, *e.g.*, "cooked" flavors. The texture of the cooked vegetables was also best in approximately the same temperature range, becoming very soft when blanched at the higher temperatures. Vegetables blanched below these temprarures, in general, did not retain the bright green color during cooking, becoming a dull green.

It was found that peas were most susceptible to the formation of hay-like flavors and string-beans least. The hay-like flavor in string-beans after four months' storage was least objectionable and that in spinach most. Unblanched spinach had a fish-like "keroseney" flavor rather than hay-like flavor.

In view of the fact that this change in the favor of vegetables was more intense in the presence of air and was reported to be absent in vegetables stored in cans closed under vacuum, it was thought that vegetable oxidases were in part responsible for these changes. These vegetables were found to turn benzidine blue in the presence but not in the absence of H_2O. Thus a complete oxidase system was not present. The temperatures at which the peroxidases present were inactivated after heating for five minutes so far as the benzidine test is concerned were found to be at about 90° C. However, the rate of color formation in presence of benzidine and H_2O was markedly reduced at temperatures of 70° C. and above and the color formed at higher temperatures was not a true blue color, being a brownish blue.

A very marked difference between the unblanched samples and those blanched at temperatures below the ranges given was found. Although blanching at 70° C. (140° F.) did not inhibit the formation of some hay-like flavor in peas, the intensity of off flavor was markedly less than in the unblanched sample. Similar results were found for other vegetables.

The fact that the vegetable peroxidases were inactivated at temperatures above the desirable range and that peroxidase was present in the tissues of vegetables which retained their flavor during freezing storage lead us to believe that it may not be the chief causative agent involved in the deterioration. Neither tyrosinase nor active proteases were found in these vegetables. It is possible that other oxidizing systems may be involved in these changes. These investigations are being continued and more complete results will be published in the not too far distant future.

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[1] M. A. Joslyn and W. V. Cruess, *Fruit Products Journal*, 8 (7): 9–12, 8 (8): 9–12. 1929.

[2] M. A. Joslyn, California Agr. Expt. Sta. Cir. 320. 1930.

DEVELOPMENT OF CERCARIA MACROSTOMA FAUST INTO PROTEROMETRA (NOV. GEN.) MACROSTOMA[1, 2]

The life history of *Cercaria macrostoma,* a cystocercous (mirabilis) cercaria, has been experimentally determined. The adult is *Proterometra macrostoma* nov. gen., a member of the family Azygiidae Odhner.[2, 3]

The author has found *Cercaria macrostoma* in *Goniobasis livescens* from the Salt Fork branch of the Vermilion River at Homer Park, Illinois, and in *Pleurocerca acuta* from the Oconomowoc River, Wisconsin. Pratt[4] reported immature specimens under the name *Cercaria fusca* in *Goniobasis livescens* from Oneida River, New York, and Smith[5] described the mature form under the name *Cercaria melanophora* from *Goniobasis* sp. in Alabama. Cahn[6] reported

[1] Contributions from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, No. 441.

[2] E. C. Faust, "Two New Cystocercous Cercariae from North America," *Jour. Parasit.*, 4: 148–153, 1918.

[3] T. Odhner, "Zum natürlichen System der Digenen Trematoden," II *Zool. Anz.*, 37: 237–253, 1911.

[4] H. S. Pratt, "A New Cystocercous Cercaria," *Jour. Parasit.*, 5: 128–131, 1919.

[5] S. Smith, "Two New Cystocercous Cercariae from Alabama," *Jour. Parasit.*, 19: 173–174, 1932.

[6] A. R. Cahn, "Life History of a New Fork-Tailed Cercaria," *Jour. Parasit.*, 13: 222, 1927.

experimental infection of Centrarchidae with a giant yellow cercaria, but identified neither larva nor adult. The author has examined living or preserved specimens of all the preceding and they are all identical with *Cercaria macrostoma.*

The rediae found in the liver and mantle cavity of the snails are yellow sausage-shaped sacks varying from 1 to 8 mm in length. No intestine is present, but at the more pointed end is a stunted pharynx surrounded by a few muscle fibers. The cercariae develop directly from germ balls in the redial cavity by elongation and differentiation. Upon emergence the distome which previously lay in front of the tail is drawn back into a roomy expansion in the anterior part of the tail, where it remains during the free-swimming period.

Cercaria macrostoma is about 6 mm long and bright yellow; the anterior part of the tail is covered with large rounded papillae. The unforked part of the tail is about 5 by 1 mm, the furcae about 1 by 1 mm and the distome about 1.3 by 0.8 mm. The distome is well developed and possesses all adult structures, including the genital organs which are functional; the cirrus pouch and the uterus contain active spermatozoa and the uterus from none to 50 eggs. The distomes break out of their tails when immersed in 0.1 per cent. solution of hydrochloric acid.

Cercaria macrostoma emerges from the snail between 7 and 11 P. M., swimming with a retrograde sculling motion typical of cystocercous cercariae. The color, size and motion of the cercaria make it the kind of an object which attracts fish. Cercariae were fed to members of different families of fish, but they infected only the Centrarchidae. In about 30 days, nearly 100 per cent. of the adult distomes which contained the maximum number of eggs (100 to 150) could be recovered from the gills, esophagus and stomach of infected fish.

Proterometra macrostoma is a small very contractile worm with a large powerful oral sucker opening ventrally and an acetabulum about one half as large, posterior to the middle of the body. Following are the average length and width of structures in living specimens: distome expanded 3.11 by 0.87, contracted 2.28 by 1.38; oral sucker 0.59 by 0.62; acetabulum 0.29 by 0.3; pharynx 0.11 by 0.12; ovary 0.22 by 0.23; testes 0.41 by 0.22 mm. Measurements vary a great deal, due to muscular contraction and expansion which the worm may undergo.

The extremely heavy cuticula is frequently raised in folds, due to contraction of the three strong muscle layers. Numerous very heavy parenchyma muscles lie among and median to the vitellaria. The digestive system is typical of the family Azygiidae. The excretory system consists of a bladder reaching only to the testes, and a pair of lateral tubes extending to the oral sucker, then branching into several tubules, one pair of which meets anterior to this sucker. The round ovary lies behind the acetabulum in the median dorsal line and the two oval testes lateral and ventral to the ovary. The double row of follicular vitellaria extends from the oral sucker to the posterior end of the body. The vitelline ducts empty through a vitelline reservoir into a typical Azygiid shell gland complex. The uterus runs along the dorsal surface from the ovary to the oral sucker in loose irregular loops, then back to the genital pore which lies immediately in front of the acetabulum. The eggs increase from 65 to 95 μ in length and 34 to 75 μ in width during passage through the uterus. The cirrus pouch is a typical Azygiid structure in which the coiled seminal vesicle opens through a sphincter (Verschlussapparat Looss) into a globular cavity at one end of the prostate gland. The ductus ejaculatorius and metraterm open by a common pore into the genital sinus, in which as many as 25 eggs may be held. When the eggs leave the body, the shell is covered by long transparent filaments and contains a well-developed miracidium with 4 anterior bristle plates.

Proterometra macrostoma has been found in the following fish: *Pomoxis annularis, Pomoxis sparoides, Ambloplites rupestris, Chaenobryttus gulosus, Lepomis cyanellus, Lepomis humilis, Lepomis pallidus, Micropterus salmoides* and *Micropterus dolomieu.*

Protometra nov. gen. is separated from the 4 genera of the Azygiidae, Otodistomum Stafford, Azygia Looss, Leuceruthrus Marshall and Gilbert and Ptychogonimus Lühe by the location of the uterine folds and vitellaria which in it extend anteriad beyond the cirrus pouch. *Proterometra macrostoma* is a small compressed Azygiid in which the posterior end has not elongated. Consequently, all the organs are crowded together and the uterus and vitellaria are pushed forward from their more typical location.

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