of the vertex. In *confusus* the width of the vertex is slightly less than half the width of head.

APHELONOTUS FRATERCULUS Harris, Bull. Brooklyn Ent. Soc., 26: 18. 1931.

Several specimens of this form from Bahia and Para, Brazil, are at hand. The species has previously been known from Panama and Ecuador.

Eye-Color Changes in Mayflies of the Genus Stenonema (Ephemeridae).[1]

F. EARLE LYMAN, Tennessee Valley Authority, Norris, Tennessee.

While pursuing ecological studies on lake-inhabiting species of mayflies, the observation was made that the eyes of individuals of certain species of *Stenonema* were of one color during the day and of a different color at dusk or after dark. To the writer's knowledge this phenomenon has not as yet been recorded for mayflies and, as will be pointed out, the fact has a definite taxonomic significance. These eye-color changes were observed only among species of *Stenonema* (Heptageniidae); the extent and degree to which this phenomenon may occur throughout the mayfly group as a whole has not been ascertained.

Each of the large compound eyes in mayflies is divided transversely into an upper portion having large facets and a lower portion consisting of smaller facets. The upper portion of the eye is usually the larger and very often the dividing line between the two is distinct. The eyes of the male are usually much larger than those of the female.

Male or female specimens of *Stenonema femoratum* (Say) collected during the day resting on vegetation had very pale, bluish-grey eyes both dorsally and ventrally. The eyes of *S. interpunctatum* (Say), under similar conditions, have pale,

[1] A contribution from the Biological Station and Department of Zoology, University of Michigan.

yellowish-green eyes. However, specimens taken in the evening while swarming, possessed very dark, bluish-black eyes in both species. Individuals collected in the early part of the evening resting on vegetation just before swarming had eyes in part light-colored and in part dark, i.e., in color the eyes presented the appearance of being halfway between those individuals whose eyes were entirely pale-colored and those whose eyes were completely dark. This same condition was observed on dark, cloudy days among specimens found in shady places where the intensity of light was even further subdued.

The taxonomic import of these facts is emphasized by reference to the descriptions given for species of *Stenonema* by Traver in Needham, Traver, and Hsu.[2] Here, mention is often made of the fact that eye color in living specimens is generally either pale, bluish-grey or pale, yellowish-green, depending upon the species. In several species eye color is not described. In on species only (*Stenonema birdi* Traver) is there any indication that dark eyes are ever present among the members of this genus. According to Traver's statement, the eyes are "bluish black in holotype, greyish blue in some of paratypes (in alcohol)." No further statement or explanation appears. It should be noted that the color of eyes has been used extensively in the past by several mayfly workers as a distinguishing specific character in several different genera of mayflies in both dried and alcoholic material. Until a more extensive survey has been made as to the possibilities of eye-color changes in other groups of mayflies, it would seem best to use this character with caution.

Since it seemed obvious that light was the causal factor that produced the color change in the eyes and with a view to discovering the relationship of light to this phenomenon, a series of simple experiments was performed with living material.

Adult specimens of males and females of both *S. femoratum* and *S. interpunctatum* were collected during a bright day and each was placed in an individual vial. All possessed light-colored eyes. Some were placed in complete darkness, while

[2] The Biology of Mayflies. Ithaca, N. Y. 1935.

others were allowed to remain exposed to strong daylight. Within an hour the eyes of those specimens of both species kept in the dark had changed to a deep, bluish-black regardless of sex. When again exposed to daylight, the eyes turn pale-colored. Those specimens of both species which had remained continuously exposed to light did not show a color change during the remainder of the day. This procedure was repeated a number of times using different specimens with the same results. A differential change between the dorsal and ventral portions of the eye was not noted, both the upper and lower portions changed simultaneously.

Experiments were also performed using artificial electric light at night. Individuals with light eyes were collected during the day. The eyes of all specimens turned to the dark color at the approach of night. When these same individuals were then subjected to the stimulus of artificial light, the eyes again became pale-colored but changed to dark again when the artificial light source was removed. Repetition of similar circumstances produced the same results.

The eyes of the subimagoes of both the species under discussion are normally pale in color, either being a bluish-grey or yellowish-green, respectively. When subimago specimens were subjected to the conditions of either of the experiments described above, an eye-color change was not produced. It was further noticed that those imagoes recently emerged from the subimaginal stage did not change eye color as rapidly as those which were older. These facts seem to indicate that the ability to change the color of the eye is purely an adult adaptation and may be correlated with swarming and mating activities, which take place under conditions of very low light intensities. Small swarms of these species have been seen on dark, cloudy days.

Further experiments were conducted to determine the effects of variable light conditions upon eye-color changes under different types of preservation. When killed and preserved in alcohol, specimens retained that color of eye present at the time of killing, viz., light eyes remained light and dark eyes remained dark. The eyes of such specimens have maintained their orig-

inal color, whether dark or light when killed, even after several years of preservation. However, if the conditions of light were reversed immediately or shortly after the specimens were placed in the alcohol, the eyes were likely to change their color, unless the killing and fixing process was very rapid. The change from dark to light eyes in freshly killed individuals was first observed when specimens with dark eyes were placed in 80 percent alcohol and then allowed to stand under a bright electric light. Pinned specimens invariably turned dark upon drying. However, pale-eyed individuals did not usually become a deep black but rather a dark brown, whereas, dark-eyed individuals retained their original deep-black color when dried. A very marked shrivelling of the eyes occurred in most dried specimens which was not the case when alcohol was used as a preservative. If dark-eyed individuals were placed in the light immediately after killing with cyanide and mounting on the pin, the eyes usually turned pale again; contrariwise, light-eyed specimens usually turned dark if placed in the dark immediately upon killing.

According to the figure of the longitudinal sections of mayfly ommatidia given by Hsu in Needham, Traver, and Hsu (1935, Pl. IX), the eye of a mayfly is evidently of the type that forms an apposition image. Strangely enough the apposition eye is most characteristic of diurnal insects, although not limited to them, while most mayflies are considered as nocturnal. The eye-color changes that have been noted above are probably due to the migration of pigment contained in the iris cells and the movement of this pigment is in response to differences in light intensity.

A Correction: The millipede inadvertently described as *Fontaria kentuckiana* new species (ENTOMOLOGICAL NEWS, liii, p. 167) should have been **Cleptoria kentuckiana** new species. —Nell Bevel Causey.