The Effect of Sunlight and Temperature on the Posture of Perithemis tenera (Odonata)[1]

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Dragonflies which spend much time in a resting position called a "perch" are commonly referred to as perchers. Jacobs (1955) noted that at times of bright sunshine and temperatures close to 37 C, male perchers skew their wings thus shading the body. Simultaneously they point their abdomens toward or away from the sun, thereby preventing the rays from striking the abdomen perpendicularly. However, when clouds obscure the sun a horizontal position is resumed.

With these observations as background Mr. Lothar Hornuff suggested an investigation of temperature effect on this orientation of the dragonfly's abdomen. He postulated that the degree of elevation of the abdomen might be directly proportional to an increase in temperature. A method was devised whereby the angles formed by the planes of 1) the thorax and abdomen and 2) abdomen and the horizontal could be measured. In addition an attempt was made to determine what effect other weather

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conditions would have on the posture of the dragonfly. The dragonfly chosen for the investigation was *Perithemis tenera* (Libellulidae).

Apparatus included: 1) tripod-mounted telescope, with horizontal and vertical planes (cross-hairs) to which had been attached a calibrated scale; 2) battery-operated tele-thermometer; 3) apparatus built to measure position of the sun above the horizon; 4) photometer for recording light intensity; 5) anemometer for measuring wind velocity; and 6) psychrometer for measuring relative humidity. Time of day and wind direction were also recorded.

This research was conducted at Looney #2 pond located approximately 0.65 miles west of the University of Oklahoma Biological Station at Lake Texoma in Marshall county, Oklahoma, where *Perithemis tenera* is abundant. The pond is almost round, approximately 50 ft in diameter, and 8-10 ft deep in the center. Located about 50 ft from the Willis road, Looney #2 is surrounded by willow trees with large clearings on the east and west. These clearings are populated with tall vegetation, 3-4 ft high, along the edges of the pond and extending about 5 ft into the water. The west side of the pond was chosen as a study site. Observations were made between 7:00 and 11:00 AM or between 12 noon and 4:00 PM 4 days a week during the months of June and July, 1965. To check general behavior all-day observations were made on two occasions.

Measurements of main concern to this study were 1) temperature, 2) position of the sun above the horizon, 3) angle between plane of abdomen and plane of thorax, and 4) angle between plane of abdomen and the horizontal (Fig. 1). Two leads from the tele-thermometer were set up 5-10 ft apart, at the tops of vegetation bordering the pond. Temperature was recorded in direct sunlight from the lead nearest the dragonfly. At the beginning and end of each observation period sun position was noted.

When a perching dragonfly was sighted, the telescope was focused on it and one of the cross-hairs was set parallel to its abdomen (Fig. 2, A & B). The telescope and attached calibrated scale were shifted so the cross-hair parallel to insect's abdomen was allowed to parallel the thorax plane.

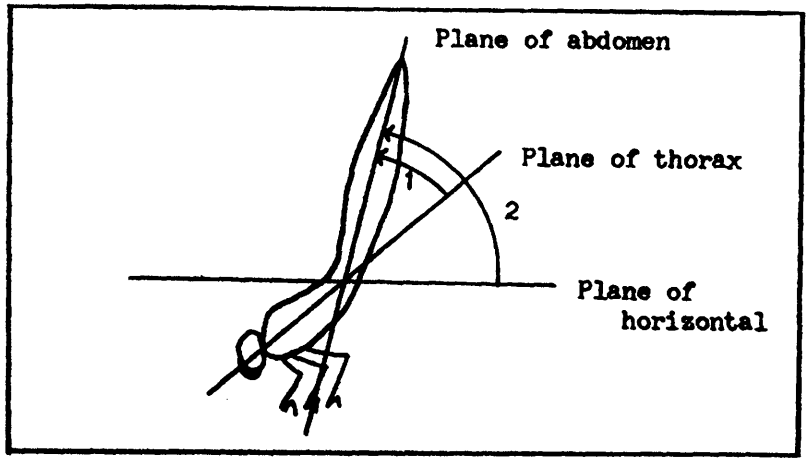

Fig. 1 Posture Angles formed 1) between the plane of the abdomen and the plane of the thorax and 2) between the plane of the abdomen and the plane of the horizontal.

The angle between abdomen and thorax was then recorded (Fig. 2, C). The telescope was again shifted to permit the cross-hair to parallel the horizontal plane of the pond's surface. This reading was then recorded as the angle between abdomen and horizontal (Fig. 2, D).

Humidity, wind velocity and direction were recorded each hour while at the pond. The light intensity and the direction the dragonfly was facing were also recorded. All measurements were taken at approximately the height at which the dragonflies were seen perching.

Observations during the two all-day periods showed that *Perithemis tenera* followed the general behavioral pattern mentioned by Corbet (1963) in his chapter on adult life. The following account of the general behavior is based on personal observations.

Perithemis tenera spends the night in the tops of trees. As the sun appears in the morning they follow its rays down to the pond. While males pearch near the pond females perch at distances as much as 50 ft from the pond. As the temperature increases, the males begin setting up territories. This activity lasts throughout the morning. The females may fly over the pond but mating does not occur until the hotter part of the day, between 12 noon and 4:00 PM. Females fly over the male territories. The males pursue, intercept and bring the females to the territories previously established by the males; mating then takes place at this site.

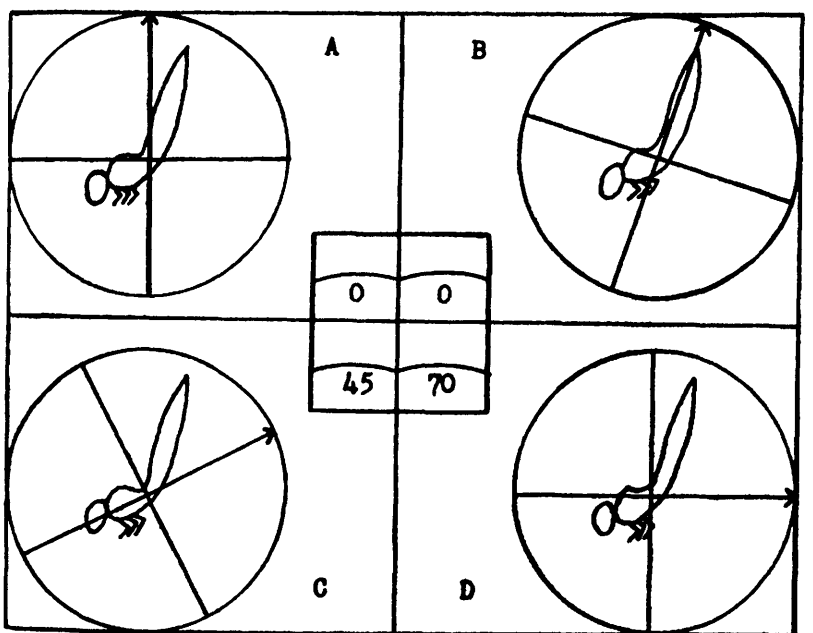

Fig. 2 Angle Measurements — A. Telescope is focused on dragonfly. B. Telescope with cross-hairs is shifted until one of the cross-hairs is parallel to the dragonfly's abdomen (calibrated scale is not moved). C. Telescope and calibrated scale are both shifted so the cross hair parallel to the abdomen now parallels the thorax plane; calibrated scale now reads 45 degrees (angle between abdomen and thorax). D. Telescope and calibrated scale are again shifted so the cross-hair parallel to the thorax plane now parallels the horizontal plane of the pond's surface; calibrated scale now reads 75 degrees (angle between abdomen and horizontal).

As temperature falls and day draws to a close the males continue to perch at the pond and the females perch away from the pond. With the setting of the sun dragonflies return to the tree tops.

It is believed that dragonflies must reach certain temperatures to carry on some activities. It is also believed that the posture assumed by the dragonflies could function to regulate their body temperature (Corbet, 1963). This work is concerned primarily with the relationship between posture assumed and body temperature regulation with regard to air temperature and sun position.

This study can be divided into two parts according to temperature: the first part deals with postures assumed at temperatures below 36 C. Those dragonflies observed facing toward the sun at these lower temperatures were observed to perch with their abdomens above the horizontal approximately perpendicular to the sun's rays (Fig. 3, A). Those dragonflies observed facing away from the sun at these lower temperatures were observed to perch with the abdomen dropped below the horizontal, again approximately perpendicular to the sun's rays (Fig. 3, B). These two postures could function to increase the temperature of the dragonfly owing to the amount of body surface area exposed perpendicularly to the sun's rays. A third posture was observed at this lower temperature level in which those dragonflies perching with the sun's rays hitting them from the side would perch with the abdomen dropped below the horizontal (Fig. 3, C). No relationship could be found between this drop below the horizontal and the position of the sun.

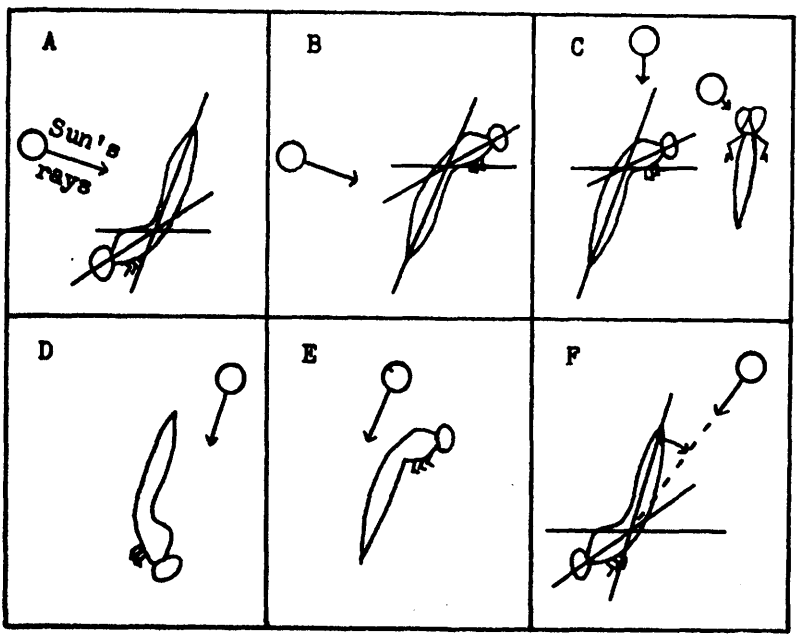

Fig. 3 Dragonfly Postures. (A,B,&C) Postures assumed at temperatures below 36 C. (C,D,E,&F) Postures assumed at temperatures above 36 C.

The second part of this study deals with postures assumed by the dragonflies at temperatures above 36 C. The above posture in which

dragonflies perched with the sun's rays hitting them from the side was also observed in this higher temperature level. Here again they were observed to perch with the abdomen dropped below the horizontal and again no relationship could be found between this drop below the horizontal and the sun's position. Those dragonflies observed facing toward the sun at the higher temperature level assumed two postures: one involved raising the abdomen above the horizontal and pointing it toward the sun (Fig. 3, D) and the other involved dropping the abdomen below the horizontal and pointing it away from the sun (Fig. 3, E). These two postures were observed only a few times and no measurements were taken either time. From observations, however, it could be seen that these postures were approximately parallel to the sun's rays. Those dragonflies observed facing away from the sun at this high temperature level perched with the abdomen above the horizontal and pointed toward the sun (Fig. 3, F). These last three postures could function to decrease the body temperature due to the lesser amount of surface area exposed directly to the sun's rays.

Most measurements on the above posture (Fig. 3, F) show that the angle between the abdomen and horizontal was greater than the angle between the sun and the horizontal. This could function to cast a shadow by the abdomen on the thorax and head. Measurements on individual dragonflies with this posture showed that the angle between the abdomen and thorax changed with changes in temperature, but the change in this angle was not proportional to changes in temperature. Upon plotting total group measurements it was found that this angle increased with rise in temperature until about 41 C where it then tended to decrease with continual rise in temperature. A coefficient of correlation of 0.909 was found between increase in temperature and increase in this angle. This coefficient of correlation exceeds the 0.590 value necessary for significance at the 1% level.

Dragonflies assumed a horizontal posture when clouds obscured the sun or when they perched in the shade.

In conclusion, these data on *Perithemis tenera* show a relationship between the regulation of body temperature and the posture assumed by the insects with regard to temperature and position of the sun. This relationship was shown by a careful study of the postures assumed. It was found that postures assumed at temperatures below 36 C could function to raise body temperature. Those postures assumed at temperatures above 36 C could function to lower body temperature. It could be that the temperature needed to carry on a specific activity is near 36 C. This activity could be mating since it is their greatest activity and does take place at these high temperatures. Those postures assumed by the dragonflies with the sun's rays hitting them from the side could be intermediate postures assumed once they have reached a certain temperature and could use this posture to maintain it. This relationship is also shown when clouds obscure the sun as the horizontal posture is assumed. No relationship was found between these postures and other weather conditions.

Some of the above data verify the findings of Corbet, Jacobs and others and elaborate upon their work. Although a correlation was found between posture assumed, with respect to the sun, and changes in air temperature, more investigation must precede the complete elucidation of the relationship between the postures assumed and their body temperature regulation.

Literature Cited

Corbet, Philip S. 1963. *A Biology of Dragonflies.* Chicago, Quadrangle Books.

Jacobs, M. E. 1955. Studies on territorialism and sexual selection in dragonflies. Ecology 36: 576.