

NOTES ON THE AUTUMNAL NORTHWARD MIGRATION OF THE
CLOUDLESS SULPHUR, *PHOEBIS SENNAE* (PIERIDAE),
ALONG THE SOUTH CAROLINA COAST

On 27 August 1978 large numbers of cloudless sulphurs, *Phoebis sennae* (Linnaeus), were observed moving along the South Carolina coast in a northeasterly direction. The butterflies were flying over a salt marsh just inland from Folly Island, a barrier island south of Charleston, South Carolina. This flight continued for several days with few butterflies stopping at flowers or attempting to oviposit. The flight also was observed over grassy areas and fields a few miles inland from the coast, but the flight seemed to be most intense just inland from the barrier islands. Ten or more miles inland, the cloudless sulphurs seemed to be flying in random directions with no perceptible migration taking place. (On 3 October 1978, however, one of us (Laurie) received an inland report of cloudless sulphurs moving east in large numbers.)

On 1 September a procedure was initiated to quantify the continuing migration on the immediate coast. A 60 m wide grassy area, bounded on the southeast by a row of trees and on the northwest by the offices (located at the South Carolina Marine Resources Research Institute on James Island, two air miles (3.2 km) south of Charleston, S.C.) of the authors, was selected as a study area where daily observations could be made. All northerly-migrating cloudless sulphurs passing between the row of trees and the windows of our offices flew perpendicular to our line of sight and, therefore, could be counted with ease. Five minute counts were conducted at different time periods of each day of the migration. The total number of cloudless sulphurs passing through our observation area in northerly and southerly directions was recorded for each five minute period. Counts were made in the morning, at mid-day, and in the afternoon. General observations on wind direction, wind speed, and cloud cover were also made.

During the 1978 migration an early peak was reached on 5 September with an average of 125 cloudless sulphurs passing through the count area per five minute period, all in a northeasterly direction. The migration continued through 6 October with a second peak on 28 September of 323 butterflies moving northeasterly through the observation area per five minute count period (64.6 cloudless sulphurs per minute or about one per second). The average number of northeasterly-migrating cloudless sulphurs recorded per five minute period in 1978 was 69.5 ($n = 29$).

In 1979 a similar migration occurred, beginning again in late August (23 August). The same five minute count procedure used in 1978 was employed in 1979 and was carried out in the same study area. In 1979 the migration was most intense between 24 August and 31 August and between 10 September and 9 October. One hundred and fifty cloudless sulphurs were recorded during one count period on 31 August, and 160 butterflies were counted during a five minute period on 9 October. Fewer cloudless sulphurs migrated northeasterly during the 1979 migration, the average number of butterflies per five minute count period being 48.9 ($n = 25$).

Again, in 1980 a northeasterly migration of cloudless sulphurs was observed in the study area. The 1980 migration began in late August (28 August) and continued through 22 September; however, fewer butterflies were seen during the 1980 migration than were seen in 1978 or 1979. The average number of cloudless sulphurs observed per count period in 1980 was only 15.6 ($n = 17$) with peak counts of 31 occurring on 11 and 17 September.

A review of our general observations on wind speed, wind direction, and cloud cover reveals that the migrations were most intense on still, clear days; however, considerable flights were recorded on breezy, partly cloudy days. A marked reduction in the number of cloudless sulphurs on the wing was obvious on gusty days, with no butterflies flying on rainy days. In 1979 Hurricane David passed just south of the study area on 4 Sep-

tember, but the northeasterly migration continued on 6 September, after the rains associated with the hurricane had passed through the area.

The northeasterly migration reported herein was limited to late August, September, and early October. The cloudless sulphurs flew over marshes and grassy areas and generally avoided woodlands. Few cloudless sulphurs were observed flying along barrier island beaches, as do monarchs (*Danaus plexippus* (L.)) in their autumnal southward migration. On the other hand, the cloudless sulphurs migrated in large numbers over the salt marshes just inland from the barrier island beaches. In late September and early October of 1978 some cloudless sulphurs flew southwesterly, against the grain of the larger northeasterly migration. During one count period on 19 September 1978, 109 cloudless sulphurs were counted flying northeasterly, while 90 were recorded moving southwesterly. The total number of southwesterly-migrating cloudless sulphurs counted during this period could have been influenced by possible northeasterly head winds from Charleston harbor—just north of the observation area—that may have blown some butterflies back into the study area. During the period of 18 September to 6 October 1978 when the southwesterly-migrating cloudless sulphurs were counted, an average of slightly less than ten butterflies per five minute count period was recorded ($n = 16$).

In his discussion on the cloudless sulphur, Klots (1951, *A Field Guide to the Butterflies of North America, East of the Great Plains*, Houghton Mifflin, Boston, 349 pp.) noted that "there appears to be a considerable northward migration in the autumn." In Virginia, Clark and Clark (1951, *Smithsonian Misc. Collect.* 116(7), 239 pp.) stated that they had "kept a special watch" for migratory flights of the cloudless sulphur; however, only a few directional flights, all recorded from inland counties, have been reported in Virginia. None of these flights were mass migrations; instead, the butterflies were "widely separated and seldom in sight of each other" (Clark and Clark, op. cit.). Harris (1972, *Butterflies of Georgia*, University of Oklahoma Press, Norman, 326 pp.) pointed out that, in Georgia, the "annual fall migration of the cloudless sulphur . . . coincides with that of the monarch, . . . southeast toward Florida." In Florida, Walker (1978, *J. Lepid. Soc.* 32:178–190) caught significantly more cloudless sulphurs moving southward than northward in Malaise traps set in the autumn of 1975 and of 1976.

As mentioned earlier, the northward migration of the cloudless sulphur was only obvious along the immediate coast, which it seemed to follow northeastward. Inland, the butterflies seemed to be moving at random. In light of the fact that there are no reports from Virginia, North Carolina, or Georgia to corroborate our South Carolina migration data, several basic questions must be asked: Is this migration a local phenomenon? Or does the autumnal cloudless sulphur migration continue up the Atlantic coast? And, why, in autumn, would cloudless sulphurs be flying northward along the coast of South Carolina, while in Georgia and Florida the butterflies seem to be moving southward?

Baker (1968, *Phil. Trans. Roy. Soc. London, Ser. B, Biol. Sci.* 253:309–341; 1969, *J. Anim. Ecol.* 38:703–706) has carefully studied the migrations of British butterflies and has developed a theory of the evolution of butterfly migration. He has pointed out that most British butterflies have become migratory in response to one or more of the following factors: 1) the abundance of predators or parasites; 2) the abundance of a preferred food plant; 3) day length; and 4) climate (temperature and/or humidity). The combination of the above factors that has resulted in the cloudless sulphur migrating northward (in autumn) along the South Carolina coast (and possibly farther north) and southward in Georgia and Florida is yet to be explained.

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