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ON MIGRATIONS OF *HEMIANAX EPHIPPIGER* (BURMEISTER) AND *TRAMEA BASILARIS* (P. DE BEAUVOIS) IN WEST AND NORTH-WEST AFRICA IN THE WINTER OF 1975/1976 (ANISOPTERA: *AESHNIDAE, LIBELLULIDAE*)*

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H. ephippiger migrated along the Atlantic coast of Senegal and Mauretania in January 1976. An analysis of the movement is made, and its causes and consequences are discussed. It is suggested that specimens found in Iceland and the British Isles are more likely to have come from West Africa, moving with the air current between the Açores and Iceland, than from the Mediterranean. Swarms seen in Italy, because of the period of their appearance, must, conversely, have come from the steppes of North Africa. *T. basilaris* was seen in high numbers in Dakar, Senegal in January 1976, and a dense migratory swarm was observed in March 1976 along the River Niger near Ségou, Mali. Possible relations with the migratory behaviour of *Libellula quadrimaculata* L. are discussed.

INTRODUCTION

Following a notorious series of dry years, the summer of 1975 was a good wet season in the Sahel zone of West Africa and in the South-Western Sahara, as far as the Adrar of Mauretania. During my first visit to these areas, April-June 1975, I found few dragonflies in Senegal and Mauretania (DUMONT, 1976). My second visit (January-March 1976) showed an entirely different picture: not only were there numerous dragonflies on the wing, but in at least two species migratory activity was observed.

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OBSERVATIONS AND DISCUSSION

HEMIANAX EPHIPPIGER (BURMEISTER)

Migratory movement was seen in the vicinity of the Atlantic coast only, and especially along the sea-shore. On January 24, 1976, along the beach of Dakar, Senegal, a conspicuous accumulation of dragonflies was present. There were at least three species, viz. *H. ephippiger, Tramea basilaris* (de Beauv.) and *T. limbata* (Désj.). The former was the commonest and also the only one to fly over the sea in significant numbers. During the next day, I drove along the highway Dakar-Rosso, which is several tens of kilometers away from the sea over most of its distance, and no dragonflies were seen. However, on January 27, 1976, between some 50 km North of Rosso and Nouakchott, Mauretania, dragonflies were constantly spotted from the car. It was found that they were all *H. ephippiger* (both sexes), all adult and flying North. The asphalt road is here running parallel and close to the coastline. The migratory movement was not very dense, but one could see flocks of four to five specimens passing by all the time. It went on during the whole day. On January 28, 1976, the shore was left again and between Nouakchott and Atar, no migrating *Hemianax* were seen. However, on the guelta's, daya's and in every oasis of the Adrar mountains, great numbers of *Hemianax* (non-migrants) were in evidence. This includes oases such as Tod (North of Atar) where no surface water is available. At Atar, specimens were taken at light during the night.

The migratory activity of *Hemianax ephippiger* is well-known in the literature. WILLIAMS (1925, 1929) gives several examples of concentrated swarms in Egypt and the Sudan and the erratic occurrence of specimens in many places of West and Central Europe is also ascribed to immigration from Africa (HEYMER, 1967). Recently, it has been claimed (DUMONT & HINNEKINT, 1973) that migration is a facet of population dynamics, and that one important condition to migration is overcrowding. Second, it was stressed that migrants tend to follow simple linear "signal" pathways (rivers, shorelines, roads, railroads) and third, the result of migration was considered to be population regulation rather than dispersal. As to the real causes (stimuli) of migration: some hypotheses were made, but it will not be possible to add any new element to these in the present paper. However, the migratory movement in *Hemianax* is illustrative of the first two points, and allows some interesting speculations.

The species breeds in shallow, temporary ponds and pools, and it seems to favour rather saline environments. The latter type of biotopes (gueltas, dayas, sebkhas, etc.) are numerous in the Sahara-Sahel belt (including the Nile, which, in view of its yearly floods, is a special, "regular" source of astatic pools). The wet season, beginning in June, peaks in July-August, and rains may last till end September. To aquatic animals, the difference between a good and a poor rainy season is that, in the former case, more daya's are inundated and keep their

water longer than in the latter case. *Hemianax* will be significantly favoured by a good rainy season only if it is physiologically adapted to temporary habitats, i.e. if its eggs can survive drought periods, that may last for several years. Although there is no experimental evidence for this, this property is so adaptive for temporary-pool dwelling groups (e.g. the Crustacea Euphyllopoda) that it is really a conditio sine qua non. Observational evidence was given by GAMBLES (1960) who noted that, following the first appearance of water in a pool in Nigeria, total larval development of Hemianax took 100 days. Thus, depending on an early or a late onset of the rains, emergence in West Africa should begin between end August and end September and, following long droughts, should also be largely synchronous. Importantly, in temporary habitats food (micro- and macroplankton) is abundant and predation is virtually absent (no fish, few birds, etc.). The proportion of larvae developing into adults can thus be expected to be relatively high, crowding is achieved, and the scene for migration is set. The maiden flight probably achieves a partial dispersal of specimens over the desert and, indeed, isolated specimens have been observed hundreds of kilometers remote from the nearest known surface water point (MONOD, 1958). However, and especially if very large numbers of specimens are produced, a regrouping will occur along optical orientation landmarks (an asfalt road, rock escarpments, but also fossil stream beds, which will ultimately drain a fair proportion of the total number of specimens towards the sea).

It is interesting to note that *H. ephippiger* was recorded three times from Iceland, where no native dragonflies exist (September 1941, 11 October 1964, two specimens on October 29 and November 5, 1971) (NORLING, 1967; MIKKOLA, 1968; OLAFSSON, 1975). The last two authors opine that the specimens had been flying in from the Eastern or Western mediterranean basin (cf. also TUXEN, 1976). I consider this hypothesis as highly improbable. In such a case there would have to be more records available from Central and Western Europe, and, more importantly, the autumn dates fit well with specimens imported from an area with monsoon regime (W. Africa) but not with areas with distinct summer and winter seasons (the Mediterranean basin). I therefore suggest that at times specimens belonging to migratory swarms along the coast of NW-Africa may migrate by chance (at night?) as far as the Açores, where they are picked up and carried further by the permanent western winds in the direction of Iceland. Specimens reported from Ireland and England (October 12, 1913 and February 24, 1903) (HEYMER, 1967) may fall into the same category, instead of being imported by boats from the Far East. Some migratory swarms that were seen in Italy, conversely, arrived here in late July or early in August (GHILIANI, 1869, 1874). They can, consequently, not have come from areas South of the Tropic of Cancer but must have developed in the daya's and sebkha's of the steppe zones of N. Africa following a wet spring, or in the lower Nile valley.

In conclusion, it appears that the migratory activity in *Hemianax* can be linked up with the theory developed earlier (DUMONT & HINNEKINT, 1973), but that it differs from the *Libellula quadrimaculata*-scheme in frequency (statistically, migration in *Hemianax*, dependent before all on yearly precipitation, should occur rather frequently) and further in the ability of *Hemianax* to continue flying during the night, permitting the species to disperse over much larger areas.

TRAMEA BASILARIS (P. DE BEAUVOIS)

Mass migrations of this species, either alone or in conjunction with other Anisoptera, have been reported from Nigeria, especially in November and December (GAMBLES, 1960). It was part of compound swarms seen along the rocky corniche as well as the sandy beach of Dakar, Senegal, on 24.I.1976. A mass movement was in evidence on March 16, 1976 near Ségou, Mali, along the swampy shores of the River Niger, and was observed over a stretch of about 20 km, as long as the road continued to run parallel to the river, i.e. roughly between Konidimini and Ségou itself. This migration was strongly reminiscent of what is usually seen in *Libellula quadrimaculata*: a very dense swarm of animals, that was continuously passing by at low altitude. The direction was westward. The width and the height could not be estimated. About 20 specimens were picked up from the grating of the Land-rover cooling system in front. Both sexes were represented and all specimens were very teneral, indicating that the migratory movement had only just begun. I again ascribe this mass-appearance of animals to the good wet season that preceded it, and considerably expanded the number of larval biotopes. Although *T. basilaris* closely resembles the holarctic *L. quadrimaculata* in habitus, and perhaps fills up a similar ecological space in Africa, too little is known about the species to speculate on further parallelisms between both, especially as far as the causes of migration are concerned. Following our 1973 paper, no experimental evidence on the possible influence of a parasite-host relationship on migration has been published; it is rather evident that in *Hemianax ephippiger* such a relationship is irrelevant and not needed to explain the fact of migration. About *T. basilaris*, we do not know. However, it may be useful to attract attention to the fact that the internal delta of the Niger in Mali is an enormous "reservoir" of waterbirds.

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