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MALES OF *ENALLAGMA VANSOMERENI* PINHEY SETTLING ON WATER SURFACE (ZYGOPTERA: COENAGRIONIDAE)

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Males of the very small damselfly were observed to settle frequently on the open water of a savanna pond in the Comoé National Park, Ivory Coast (= Côte d'Ivoire). In the order Odonata, prolonged stays on the water surface are unusual.

INTRODUCTION

There are several insect orders with representatives living on the water surface: Collembola, Heteroptera, Coleoptera and Diptera (WESENBERG-LUND, 1943). Various adaptions, such as small body size, large contact surfaces, as well as hydrophobic hairs and cuticles, contribute to make such a life possible (GUTHRIE, 1989). Until now, prolonged activity on the water surface was not known for any odonate species. For dragonflies and damselflies the water surface is a rather dangerous place, particularly so for the latter, when surfacing after submerged oviposition (FINCKE, 1986; MILLER, 1990).

During investigations of the dragonfly colonization of savanna water pools in the Comoé National Park, Ivory Coast, we were struck by very small damselflies which repeatedly settled on the water surface, from where they again took off to the air. Since such behaviour in an odonate species was unknown to us, during our stay we paid particular attention to this interesting phenomenon. This paper describes and discusses the unusual behaviour we observed.

LOCALITY AND METHODS

The Comoé National Park is located in the northeastern Ivory Coast and encompasses an area of 11.500 km^2. In a wet depression of the Guinea Savanna Woodland in the South of the park there is a water pool directly at the track, 13 km NE of Gansé (8°32'N, 3°56'W; alt. 250 m). In 1993, the pool was filled up after the first strong rainfall in March, covered by April an area of 45 x 15 m, with a maximum depth of 1.2 m. During our observations, *Ludwigia abyssinica* was the dominant water plant, growing all along the water verge and dividing the open water into two parts, each of 4 x 5 m. The first fish was noticed on 20 April, after strong rainfall of the previous night had caused a small rivulet to flow from the Comoé River into the pool. On the open water some Gerridae and Gyrinidae occurred and between water plants there were young larvae of Notonectidae. In April 1993, 25 odonate species were evidenced at the pool, *Palpopleura deceptor* (Calv.), *Crocothemis erythraea* (Brullé), *Trithemis arteriosa* (Burm.) and *Diplacodes lefebvrei* (Ramb.) having been particularly well represented.

After having noticed damselflies settling frequently on the water surface, on 17 April regular observations were made and recorded. These were carried out usually between 10:00 and 13:00 h local time. Because of unfavourable light and reflections, it was not possible to make an accurate assessment of the numbers perched on water plants. The residence time of individuals on the water surface was determined from direct observations and video recordings. To collect data of more than one individual simultaneously, on 18 April areas of open water were filmed for about one hour with a camera on a tripod.

OBSERVATIONS

Numerous individuals of a conspicuously small zygopteran species (abdomen length 17.1 ± 0.7 mm s.d.; n=8) were observed at the pond. All those collected and photographed were males of *Enallagma vansomereni* Pinhey. They were sitting in large numbers, motionless and evenly distributed on the surface of the water with folded wings. The tarsi of the middle and rear legs, as well as the apex of the abdomen, were in contact with the water surface, while the front legs were held free from the water. The thorax was well above the water (Fig. 1). Individuals remained settled on the water surface for a mean period of 19 s (± 17 s s.d.; maximum = 62 s; n = 41) before taking off, flying at a height of less than 1 cm above the surface, often in a curved zig-zag course, and then settling again on the water. Wind caused the damselflies to drift on the water surface, and their bodies and heads always faced towards the wind. If an individual came within one body length of a water plant it took to the air and, compensating for the distance it had drifted, settled back on the water. Airborne individuals regularly caused the settled ones to take off. Aside of brief approaches, no interactions between

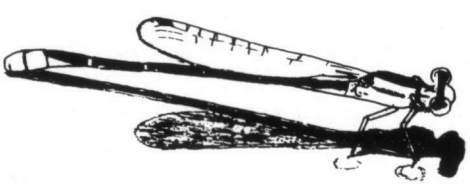

Fig. 1. Male of *Enallagma vansomereni* settling on the water surface. Redrawn from slides.

individuals were observed. Up to 40 individuals were counted on a 4 x 5 m area of open water on 18 April. On the morning of 20 April, under an overcast sky, no more than 2 males were present. Settled males were observed in one of the open water areas only, while in the other open area, which was covered with a bacterial film, no individuals were present.

At the same time when some males were settled on the water surface, some others were seen perched on vegetation, often on the floating rosettes of *Ludwigia abyssinica*. Individuals were also observed perched on other pieces of vegetation, emerging vertically just above the water table. With a mean duration of 72.6 s (± 74.2 s s.d.; n=18), the time the insects stayed on vegetation was appreciably longer than of those on the water ($U=154.5$; $z=3.53$; $p<0.001$). Usually the perches were directly adjacent to the area of open water, although some individuals were observed perching within the *Ludwigia* covered area.

Copulation was not observed. However, isolated tandems were sometimes seen flying over the water. On two occasions oviposition was observed, in which the male was also seen to submerge completely. One pair was observed on a grass stem, directly under the surface of the water, while the other pair was ovipositing into *Eichhornia natans*. The female led her partner backwards into the water, reaching a depth of 15 cm below the surface. After 10 minutes, the pair departed the oviposition substrate, floated to the surface and flew off in tandem.

DISCUSSION

Enallagma vansomereni is a very small representative of the Coenagrionidae. Little is known about its distribution on the African continent. With more than 20 known species, the genus is particularly well represented in Africa (PINHEY, 1962), although from many regions reports of its occurrence are restricted to single records (e.g. PINHEY, 1961; BALINSKY, 1967). From the Ivory Coast, so far only two species have been reported, viz. *E. nigridorsum* Sel. and *E. vansomereni* (FRASER, 1941; LINDLEY, 1974). Virtually nothing is known on the biology of these usually inconspicuous and difficult-to-catch damselflies.

It is highly unusual for the male damselflies to settle regularly on the water surface. The following four hypotheses are put forward as tentative explanations for this behaviour:

(1) Open water is a favoured place for finding a mate.
(2) Under conditions of high population density, i.e. the shortage of suitable perches in the vegetation, males resort to perching on the water surface.
(3) A high predatory pressure is exerted by vegetation-bound predators, while aquatic predators are relatively ineffective or lacking.
(4) The males are feeding on prey, trapped on the water table.

The reproductive behaviour of American *Enallagma* species has been well investigated, therefore some comparisons are possible. Females which approach

the pond are grasped by males and forced to mate as soon as they reach the bank, which would argue against the first hypothesis. Waiting on the water surface might at best be considered as an alternative strategy. In this way a male might have a better chance of copulating with a female as she resurfaces after submerged oviposition, as reported for *E. hageni* (Walsh) and *E. cyathigerum* (Charp.) (FINCKE, 1985; MILLER, 1990). However, unaccompanied, submerged ovipositing females have so far not been observed in *E. vansomereni*. In addition, the males were seen to settle only on the open water, where there is no submerged vegetation. The observation that the male continues contact-guarding underwater has been reported also in *E. exsulans* (Hag.), but in this species the pairs have often been observed to lose contact when the female submerges (BICK & HORNUFF, 1966). Thus, for *E. vansomereni* one might reasonably assume that here, too, the female often deposits eggs alone. Remarkably similar behaviour on the water surface occurs in Diptera. Males of the mosquito, *Opifex fuscus* Hutton, in New Zealand form a two-dimensional swarm on the water surface waiting on the appearance of female pupae that are about ready to emerge (KIRK, 1923; MARKS, 1958).

Testing the 2nd hypothesis is problematical, since the population density of *E. vansomereni* can not be determined under the given conditions. Because of their smallness and the difficulty of counting them among the vegetation without disturbing them, a sufficiently accurate assessment of their numbers is not possible. A mark-recapture procedure would be ineffective with this difficult-to-catch species, not to mention that handling and marking would affect their reproduction behaviour on and below the water surface (Dr P.L. Miller, unpubl.). A general shortage of solid perches at the pool is not apparent. However, one cannot rule out the possibility that an even distribution is achieved by the system of scramble competition. The following questions seem to be of particular interest: Do the same males alternate between solid perches and the water surface, and if so, when and how frequently? If they are not the same individual males, are there any differences between those that settle on the water and those that use solid perches (age, body size, weight)? Which solid perches are particularly favoured?

The bank vegetation was often densely populated by predators dependent on that kind of habitat. In the vicinity of the pool, cases of predation were often observed in which odonates fell prey to bush-crickets, mantids, spiders and asilids (K. Grabow, pers. observ.). The possibility that *E. vansomereni* was subject to predation pressure from other dragonflies in the forenoon, can more or less be ruled out. In particular small libellulids, such as *Diplacodes lefebvrei*, occurred in large numbers just above the stands of *Ludwigia*. Males of this species often use the floating rosettes of this plant as perches and fly over them at very low altitude. Contests, copulation and oviposition were frequently observed, but no predatory behaviour. Whether or not dwelling on the water surface puts *E. vansomereni* at risk of falling prey to fish is not clear. Since they remain passive

and motionless while settled on the water surface and since no creatures of similar body shape occur there, it may well be that they simply do not correspond to the pattern of suitable prey of any aquatic predators. Also, because they are supported by just a few points of contact on the layer of surface tension and make little impression on the water, their bodies being above the water surface, they are probably difficult to trigger predators not specialized in feeding on surface prey.

Odonata do not catch only the airborne prey, but some also take spiders or their prey out of the webs (RÜPPELL & FINCKE, 1989). It seems feasible, therefore, that they may also take food from the water surface. That *E. vansomereni* holds its front legs free of the water may be compared with the Gerridae behaviour and could be interpreted as an early stage of convergence, the free fore legs serving to catch and hold prey (ANDERSEN, 1982).

The last two hypotheses are particularly difficult to test because of *E. vansomereni*'s small size. However, it should be emphasized that it is the characteristics of many *Enallagma* species that the males are often found at the boundary to open water and spend much time overflying the open water (DUNKLE, 1990). The case at hand could represent, therefore, the extreme of this trend, with the males no longer relying on emergent vegetation to provide perches.

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REFERENCES

ANDERSEN, N.M., 1982. *The semiaquatic bugs (Hemiptera, Gerromorpha)*. Scand. Sci. Press, Klampenborg.

BALINSKY, B.I., 1967. On some intrinsic and environmental factors controlling the distribution of dragonflies (Odonata), with redescription and a new name for a little known species. *J. ent. Soc. sth. Afr.* 29: 3-22.

BICK, G.H. & L.E. HORNUFF, 1966. Reproductive behavior in the damselflies Enallagma aspersum (Hagen) and Enallagma exsulans (Hagen) (Odonata: Coenagriidae). *Proc. ent. Soc. Wash.* 68: 78-85.

DUNKLE, S.W., 1990. *Damselflies of Florida, Bermudas and the Bahamas*. Scientific Publishers, Gainesville.

FINCKE, O.M., 1985. Alternative mate-finding tactics in a non-territorial damselfly (Odonata: Coenagrionidae). *Anim. Behav.* 33: 1124-1137.

FINCKE, O.M., 1986. Underwater oviposition in a damselfly (Odonata: Coenagrionidae) favors male vigilance, and multiple mating by females. *Behav. Ecol. Sociobiol.* 18: 405-412.

FRASER, F.C., 1941. Results of the mission of P. Lepesmee, R. Paulian and A. Villiers in the

Cameroons. Order Odonata. *Proc. R. ent. Soc. Lond.* (B) 10: 35-42.

GUTHRIE, M., 1989. *Animals of the surface film.* Richmond Publishing, Slough.

KIRK, H.B., 1923. Notes on the mating-habits and early life-history of the culicid Opifex fuscus Hutton. *Trans. Proc. N.Z. Inst.* 54: 400-406.

LINDLEY, R.P., 1974. The dragonflies of Korhogo, Ivory Coast. *Bull. Inst. fr. Afr. noire* (A) 36(3): 682-698.

MARKS, E.N., 1958. Notes on Opifex fuscus Hutton (Diptera: Culicidae) and the scope for further research on it. *N.Z. Ent.* 2: 20-25.

MILLER, P.L., 1990. The rescue service provided by male Enallagma cyathigerum (Charpentier) for females after oviposition. *J. Br. Dragonfly Soc.* 6: 8-14.

PINHEY, E.C.G., 1961. Dragonflies (Odonata) of Central Africa. *Occ. Pap. Rhodes-Livingstone Mus.* 14: 1-97 + XII.

PINHEY, E.C.G., 1962. A descriptive catalogue of the Odonata of the African continent (up to December 1959). (Part I). *Publ̨ões cult. Co. Diam. Angola* 59: 1-161.

RÜPPELL, G. & O.M. FINCKE, 1989. Mecistogaster ornatus (Pseudostigmatidae) – Flugverhalten und Nahrungserwerb. Foraging flight. *Publ. wiss. Filmen* (Biol.) 20(7): 1-15.

WESENBERG-LUND, C., 1943. *Biologie der Süsswasserinsekten.* Springer, Berlin.