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Remarkable cases of diurnal mass aggregations of Oriental species of *Orectochilus* subg. *Patrus* AUBÉ (Coleoptera: Gyrinidae)

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Abstract

Remarkable cases of gregarious behavior of several Oriental species of *Orectochilus* DEJEAN, 1833 subgen. *Patrus* AUBÉ (Coleoptera: Gyrinidae) are reported from India, Thailand and Indonesia. Terminology and possible causes of gyrinid mass aggregations are briefly discussed. Three types of diurnal aggregations of *O*. (*Patrus*) *haemorrhous* Régimbart, 1902 are described: 1) "terrestrial clusters" (numerous individuals resting motionless and densely packed immediately above the water line), 2) "body rafts" (numerous more or less motionless individuals floating densely packed side by side on the water surface), 3) "surface swarms" (numerous individuals gyrating close together on the water surface). Gyrinid body rafts are here described for the first time.

Key words: Coleoptera, Gyrinidae, *Orectochilus*, *Patrus*, mass aggregations, Oriental Region, India, Thailand, Borneo.

Introduction

Among aquatic insects, the behavior of gyrinids is unique in various aspects. For instance, they are able to swim on the water surface at an enormous speed (*Gyrinus natator* L. has been estimated to swim at one meter per second in short bursts, NACHTIGALL 1965), they produce waves to enable echolocation (TUCKER 1969). Due to their complex chemical secretions gyrinids were used in the past as an aphrodisiac for cows and mares (NETOLIZKY 1916, 1919, OCHS 1966), and – among other curiosities – at least some genera are supposed to use their genitalia for steering while swimming and diving (OCHS 1969: 389–390).

Another noteworthy behavioral peculiarity of Whirligig Beetles is their inclination to form mono- or plurispecific congregations, which sometimes comprise thousands of individuals of both sexes.

The earliest reports of gyrinid mass aggregations (apart from mass flight to light sources) were probably published by OHAUS (1909) and by DAVIS (1914). The former described a cluster of more than 100 specimens (Gyrinidae sp.) clinging to an aerial root found near Petrópolis (southeastern Brasil). DAVIS (1914) noted that "a very great number" of *Gyrinus dichrous* LECONTE were sunbathing on a branch on the banks of the River Wallhill (New York, USA).

Since then, mass aggregations have repeatedly been recorded by various authors (e.g., OCHS 1935, 1969, YOUNG 1954, HEINRICH & VOGT 1980, WATT & CHAPMAN 1998). OCHS (1935, 1969) reported about enormous amounts of *Gyretes strandi* OCHS clinging to stones like beehives, just above the water line in the River Paraná near Hohenau (southern Paraguay). A single sweep with the net yielded at least one kilogram of beetles. This is obviously one of the largest aggregations that had been recorded so far. YOUNG (1954: 147) estimated that the

incredible amount of 50 000 specimens of *Dineutus carolinus* LECONTE were living in a small pond in Georgia (USA).

Members of the Palearctic/Oriental genus *Orectochilus* DEJEAN are generally rheophilous. They can be collected singly, in pairs or – quite often – in large or very large numbers. According to our knowledge, accounts of mass aggregations of *Orectochilus* have been recorded hitherto only from *O.* (*Patrus*) *marginepennis* AUBÉ and *O.* (*Patrus*) *nigricans* RÉGIMBART (see OCHS 1927, 1940, 1969). However, detailed descriptions of these congregations were not provided.

Fig. 1: River Denva (Narmada River System), ca. 400 m a.s.l., 22°34'29"N/78°29'43"E, Hoshangabad District, southern Madhya Pradesh, Central India. Very large number of *Orectochilus* (*Patrus*) *limbatus* RÉGIMBART, hiding under partly submerged riparian vegetation (arrow).

In tropical Asia, *Orectochilus* species are usually nocturnal, hiding during daytime below undercut river banks, under semisubmersed logs, or under partly submerged riparian vegetation (see Fig. 1). In case of disturbance, specimens can be often seen swirling in large numbers on the water surface, from where they are collected easily with an insect net (see Fig. 2).

During the daytime some nocturnal gyrinids do not hide, but aggregate on the water surface in smaller or larger groups, that are usually found day after day in the same locations. According to HEINRICH & VOGT (1980) the average distance between aggregations of *Dineutus horni* ROBERTS and *Gyrinus* spp. along the shoreline of Lake Itasca (Minnesota, USA) is 800 m. Mark-recapture studies by the same authors revealed that most beetles did not return to the same aggregations, which they had left the night before, but in fact joined other aggregations in the following days, moving as far as four km per night!

Fig. 2: A net full of *Orectochilus* (*Patrus*) *limbatus*, which were collected from Denva River, after they had been roused from their hideaway (see Fig. 1).

Diurnal mass aggregations observed recently in the Oriental Region

During a faunistic survey carried out in the Satpura National Park (Hoshangabad District, southern Madhya Pradesh, Central India), three authors of this article (M.A. Jäch, S. Sharma, and P. Sharma) witnessed a remarkable monospecific assemblage of thousands of specimens of *Orectochilus* (*Patrus*) *haemorrhous* RÉGIMBART, which were assembled in the River Denva Reservoir (Narmada River System, ca. 350 m above sea level, 22°34'1"N/78°08'38"E) on February 29, 2008. Three different types of aggregations could be discerned (Figs. 4–5): More than thousand specimens were found on the lower part of the hull of a red outboard motorboat tied to the pier of the national park headquarters (Fig. 3). This group of beetles (here termed as "terrestrial cluster", Fig. 4) was very densely packed, reaching from the water line (the lowermost specimens were at least partly submerged) to about 7 cm above the water line, covering an area of approximately 200 cm². The mass of bodies was partly 1–2 cm thick because the specimens were piggybacking in several layers. All specimens were totally motionless, as far as could be seen from a distance; however, as soon as the first author approached the site to take pictures, several hundred specimens quickly slipped from the hull into the water, where they hectically drew their circles and eventually joined another large concentration of the same species, that swam at the water surface between the boat and the boat bridge, roughly covering an area of about 1 m² (Fig. 5). Specimens in the outer parts of this area rapidly gyrated close to

each other on the water surface. This second type of aggregation is here termed “surface swarm”. Towards the center of this aggregation at least hundreds of individuals were not gyrating, but floating very densely packed side by side in almost gapless crowds resembling timber rafts, being swayed back and forth by the swirling swarms of the freely moving individuals that surrounded them. This third type of aggregation is here termed “body raft”.

Fig. 3: River Denva Reservoir, pier of the Satpura National Park headquarters, ca. 350 m a.s.l., 22°34'1"N/78°08'38"E, Hoshangabad District, southern Madhya Pradesh, Central India.

A remarkable surface swarm of *Orectochilus* spp. was observed by the second author in Thailand near Kaeng Lambduan waterfalls (Ubon Ratchathani Province) on January 2, 2000. The Kaeng Lambduan waterfalls are located in a lowland river, which diverts into a rather narrow branch (about 20–30 m long and 3–4 m wide), separated from the main course by a small island, shaded

by riparian trees. In its central section, the water surface was covered by many thousands of specimens covering roughly an area of about 50 m^2. A couple of sweeps with the insect net yielded 366 specimens (a tiny fraction of the total), belonging to six species: *Orectochilus* (*Patrus*) *klynstrai* OCHS (203 exs.), *O.* (*P.*) *corniger* ZAITZEV (65 exs.), *O.* (*P.*) sp.n. (prope *pescheti* OCHS) (52 exs.), *O.* (*P.*) *pescheti* (40 exs.), *O.* (*P.*) sp.n. (prope *striolifer* RÉGIMBART) (3 exs.), and *O.* (*P.*) *scalaris* RÉGIMBART (3 exs.). The beetles were swimming actively and very quickly in a very dense crowd. The observation was made at noontime, thus the specimens were swimming in bright daylight, although in the shade of trees. As already pointed out above, *Orectochilus* species are usually nocturnal, hiding during the day unless disturbed. However, in this case there obviously seemed to be no particular disturbance, except for the presence of the second author. This particular surface swarm is indeed most remarkable because of: 1) the large extension (50 m²), 2) the high number of species involved (at least six), and 3) the high number of specimens, which can hardly be estimated, but probably comprised tens of thousands.

Another very large amount of *Orectochilus* specimens was observed by the second author in July 1998, along the River Kayan and its tributaries (Apokayan, Kalimantan, Borneo, Indonesia), in particular on July 25 in the River Kayan itself near the village of Lidung Payau and on July 31 in the River Danum near the village of Sungai Barang, at an altitude of ca. 800 m. In the first case eight species were involved: *Orectochilus* (*Patrus*) *mjobergianus* FALKENSTRÖM, *O.* (*P.*) *brevitarsis* FALKENSTRÖM, *O.* (*P.*) *pusillus* RÉGIMBART and five undescribed species. Most of these species are comparatively small; only one (an undescribed species of 7.3–7.8 mm length, which was represented by only 11 specimens) is comparatively large. In the second case seven species were involved: *O.* (*P.*) *mjobergianus*, *O.* (*P.*) *brevitarsis*, *O.* (*P.*) *pusillus* and four undescribed species. In both cases about 300 specimens were collected, but thousands were present, and in both cases the bulk of the specimens (more than 80 %) consisted of only two species: *O.* (*P.*) *mjobergianus* and *O.* (*P.*) *brevitarsis*. The congregations were not particularly densely packed and they were not forming discernible groups; instead, the congregation continued unchanged for a very long distance (probably for kilometers), with the beetles swarming along a rather narrow belt under the cover of the riparian vegetation, which allows the conclusion that this population was, and "hopefully still is" enormously huge.

Discussion

OCHS (1969: 394) listed three cases of mass aggregations (two terrestrial clusters and one mass flight) in South America, which he believed to be a reaction to meteorological influences, because each of these three aggregations was observed shortly before the outbreak of a thunderstorm. However, we cannot infer any relation between the weather and gyrinid mass aggregations without more detailed data. In any case, the Madhya Pradesh terrestrial cluster was observed during the dry season with no clouds in the sky for weeks.

The habit of "sunbathing" had been reported for the first time by DAVIS (1899), who watched *Dineutus discolor* AUBÉ "enjoying a sun-bath, in the same manner that turtles do under similar circumstances". A photograph of a large number of obviously sunbathing specimens of *Gyrinus sayi* AUBÉ was published by CIEGLER (2003: back cover). Conversely, many other gyrinids, especially nocturnal species, often congregate during daytime at shady places (WILSON 1923: Fig. 4, OCHS 1969: 394). The Madhya Pradesh terrestrial cluster was for instance found on the eastern side of the boat hull, which, at the time of the observation (about 5 p.m.), was shaded. According to GRAW et al. (2005) habitat cover (shade) plays an important role in niche differentiation in the three different African gyrinid species, which they have examined.

Fig. 4: Terrestrial cluster of *Orectochilus* (*Patrus*) *haemorrhous* on the hull of a motorboat. Seconds before the picture was taken, several hundred specimens had slipped from the hull into the water.

Fig. 5: "Surface swarm" and "body rafts" of *Orectochilus* (*Patrus*) *haemorrhous*.

VULINEC & KOLMES (1987) hypothesized that in stream-dwelling beetles the aggregations might be simply caused by the limited amount of good microhabitats available, and that such congregations offer protection from predation. VULINEC & MILLER (1989) found that beetles in aggregations respond more quickly to the approach of stimuli than isolated beetles; they either sight the stimuli themselves or respond to waves generated by fleeing conspecifics. This in turn could be explained either by the fact that the high contact rate between members of the aggregations makes them aroused from a physiological viewpoint, allowing a quicker reaction, or that the addition of more eyes to the group makes scanning of the environment for possible dangers easier. Furthermore, aggregations benefit from multiple release of defensive secretions (BENFIELD 1972).

Our own observations have shown that aggregations of *Orectochilus* indeed seem to be restricted to favorable parts of their environment. The Thai aggregation was confined to a small lateral river branch, which was shaded and had weaker current. The aggregation in the River Denva Reservoir in India was located right at a pier with several boats tied to it, which provided an excellent shelter at an otherwise very unsuitable insolated shoreline. In case of the Borneo populations, the pristine environment obviously provided exceptionally favourable environmental conditions, enabling the presence of an enormously large number of specimens, which do not need to congregate in separate swarms.

The phenomenon here termed "body raft" has obviously never been described in gyrinids before. Unfortunately, our observations lasted only for a short period of time on a single day. Thus we could not find out whether this type of behaviour occurs regularly or whether it was only due to a spontaneous thigmotactic reaction of the roused boat hull specimens that were drowsily seeking body contacts.

Diurnal gyrinid surface swarms have been generally termed as "rafts" by various authors, especially in the 1980s (HEINRICH & VOGT 1980, KOLMES 1983b, FREILICH 1986, 1987, 1989, FITZGERALD 1987, VULINEC & MILLER 1989). However, WILKINSON et al. (1995) noted that according to their observations gyrinid beetles "swam not only on the surface, but also in clusters within the water column" concluding that "the term 'raft' used by other workers thus seems inappropriate". Furthermore, a raft is generally supposed to be something solid, not a mass of swirling individuals. Floating body rafts are also known in other insects; colonies of the fire ant, *Solenopsis invicta*, are for instance known to form body rafts in order to keep together during floods (HAIGHT 2006). To our knowledge, the term "raft" has not been used for diurnal gyrinid swarms in recent publications. ROMEY & WALLACE (2007) used the word "group" in the limited sense of the word "congregation" as defined in PARRISH & HAMNER (1997). The term "swarm" has been already used in several publications in the past: e.g., by BROWN & HATCH (1929), KOLMES (1983a, 1985), VULINEC & KOLMES (1987), OYGUR & WOLFE (1991).

Video sequences of all three types of aggregations observed in Madhya Pradesh are archived at the Vienna Natural History Museum.

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