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Short report

First records of preorbital gland opening in rare wild barasingha (*Rucervus duvaucelii*) in social contexts may help to explain this phenomenon in cervids

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ABSTRACT

The opening of the preorbital gland in deer serves as a visual communication and has been linked to a wide variety of behavioural situations. As we reported recently, all previous long-term studies on preorbital gland opening were carried out on only one species, whereas case reports on six other rarely studied species have shown associations with different behaviours, thus greatly increasing our overall understanding of the real function of this gland in animal visual communication. Here, we report for the first time preorbital gland opening in the barasingha (*Rucervus duvaucelii*) in social contexts as observed in a wild population in Kanha National Park, India. We observed this behaviour in two different contexts: agonistic and sexual. Moreover, our record of preorbital gland opening during copulation is the first one amongst cervids. Our findings of preorbital gland opening in both contexts in wild barasingha indicate that the gland was opened only when the individual was highly excited. We suggest that preorbital gland opening may be an important behavioural indicator of an individual involved in a serious intraspecific interaction, and thus a useful tool with which to distinguish between playful and serious behaviours, especially in agonistic and sexual situations.

1. Introduction

The preorbital gland is a slit-shaped cavity anterior to the eye that exists in nearly the entire family of Cervidae, with the exceptions of roe deer (*Capreolus* sp.) and Northern pudu (*Pudu mephistophiles*; Groves and Grubb, 1987). Besides scent-marking (Lawson et al., 2000), the opening of this gland clearly also serves as a visual communication (recently discussed in Ceacero et al., 2014), which has been linked to different behavioural situations such as agonistic interactions (Bartoš, 1983; MacNamara and Eldridge, 1987), maternal behaviour (Bartošová et al., 2012; Ceacero et al., 2014), alert behaviour (MacNamara and Eldridge, 1987), and sexual behaviour (Bartoš, 1983 for a review see Ceacero et al., 2015). Most of these reports involved long-term investigations of just the one model species: red deer *Cervus elaphus*. Although these studies have provided some information regarding the purpose of pre-orbital gland opening, observations of other rare species might help to better understand this gland's function as a communication mechanism. Recently, we documented such a case of pre-orbital gland opening in the rarely studied rusa deer (*Rusa timorensis*), which involved a new specific situation (direct aggression between adult females) unreported in other species (Ceacero et al., 2015).

Although only classified as Vulnerable by the IUCN, barasingha or swamp deer (*Rucervus duvaucelii*) is one of the rarest cervid species in the world (Duckworth et al., 2013). The total population comprises less than 5000 individuals and is split between two wildlife reserves in Nepal and three national parks (NP) in Northern (Dudhwa NP), central (Kanha NP) and North-Eastern (Kaziranga NP) India. Of the 3 subspecies of barasingha, two, *R. d. branderi* and *R. d. ranjitsinhi*, have less than 600 individuals each (Qureshi et al., 2004; Duckworth et al., 2013). In the wild, barasinga exclusively inhabit wetlands and meadows (Martin 1977; Duckworth et al., 2013). Despite the fact that this species receives high conservation attention and lives solely in open habitats (avoiding forests), thus making it easy to observe, published behavioural studies on barasingha remain extremely rare (Schaller, 1967; Ullrich, 1972; Martin, 1972, 1977, 1987; Ahmed and Khan, 2014). The barasingha are polygynous, forming separate uni-sex herds with linear hierarchies

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in each sex; the sexes mix only during the rutting season (Schaller, 1967; Martin, 1977; Qureshi et al., 2004) when they move to traditional rutting grounds. General rut behaviour involves bugling, wallowing and foreplay (Schaller, 1967; Martin, 1977). During the rutting season, stags in a herd tolerate each other but the largest stags lay claim to the females, either forming small short-term harems within the herd or tending them singly. As far as we are aware stags of this species do not maintain territoriality or invest in large long-term harem holding (Schaller, 1967; Ullrich, 1972). Compared to some other cervids (e.g. *Rusa* sp. and Eld's deer *Panolia eldii*), the preorbital gland in barasingha is not well pronounced (Prater, 1971; Groves and Grubb, 1987; Meijaard and Groves, 2004). Only one report has described the opening of this gland in a barasingha, a stag that wiped his preorbital gland on dry grass or saplings, thus for scent marking but not visual purposes (Schaller, 1967).

In this study, we report for the first time preorbital gland opening in social contexts in wild hard-ground barasingha (*C. d. branderi*). Our observation also includes the first documentation of preorbital gland opening during copulation in any cervid. In addition, we recorded this phenomenon during a number of agonistic interactions, which further expands our understanding of the behaviour of the preorbital gland opening as well as of agonistic behaviour.

2. Material and methods

We observed barasinghas in two NP in India (Kanha and Kaziranga). During all behavioural observations of the males, the appearance of the preorbital glands was noted and photographed when possible using *ad libitum* sampling (Altmann, 1974). Two groups of *R.d branderi* were watched in the Kisli region of Kanha NP, Madhya Pradesh, India: one at 9 AM on 23 November and the 2nd at 4 PM on 24 November in another part of the same meadow. The first group consisted of 3 adults males (one large adult stag with 5 tines in each antler and two smaller stags with 3 and 4 tines per antler) and around 30 hinds with fawns. The second group was initially made up of 6 adult males consisting of one large stag (dark brown coat and 6 tines per antler) and 5 smaller stags (bright rufous-yellow coats; 4–5 tines per antler) before another large stag (dark brown coat and 6 tines per antler) joined them. A third group, a large mixed group of eastern barasingha (*R.d. ranjitsinhi*) was observed at 7AM on 20 November near the Kohora village in the Kaziranga NP, Assam, India.

The observations in Kanha was made during the rutting season (which peaks from November to December in Kanha: Schaller, 1967; Prater, 1971; Qureshi et al., 2004), while that in Kaziranga was made shortly before the rut commenced. Although it has been reported that the rutting season occurs there from April to May (Schaller, 1967 the same source was quoted in all later reviews: Prater, 1971; Qureshi et al., 2004), all of the stags which we observed were in hard antlers suggesting that the rutting season was soon to start, therefore much earlier than previously stated.

3. Results and discussion

In Kanha NP, for the group encountered at 9AM we observed a copulation with the large stag at 10AM. Shortly after our arrival, the large stag opened his preorbital gland and performed flehmen for 15 s. Then, he started to follow one of the females, smelled her frequently and performed another flehmen for 5 s with the gland closed at that time. He opened the gland again after 22 min and 8 s when he attempted to mount the female without penile erection. This mounting attempt lasted no longer than 2 s. Nevertheless, following this observation, the gland remained half-opened for another 73 s, when he then fully opened it again. After another

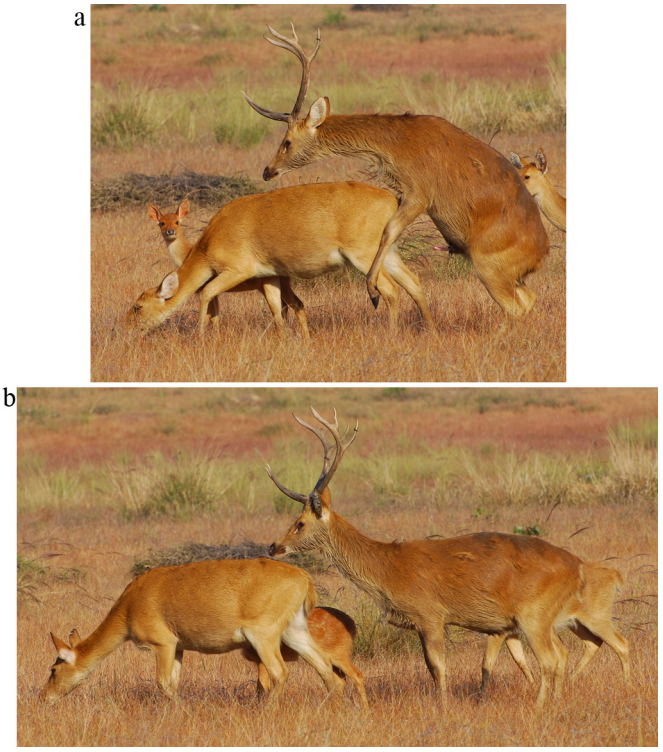

Fig. 1. Hard-ground barasingha (*Rucervus duvaucelii branderi*) displaying an open preorbital gland before (a) and after (b) copulation in Kanha National Park, India. Picture: Jan Pluháček.

15 s he mated successfully with the female with visible penile erection, and with the preorbital gland staying fully opened (Fig. 1). For 6 s after mating, the stag remained close to the hind, touching his head on her rump and licking her with the preorbital gland still open. After another 7 s the gland closed and he followed the hind, as the two walked away with the rest of the group. Two minutes later both younger stags performed flehmen, but without the preorbital glands opening in both cases.

Our study provides the first reported observation of preorbital gland opening during copulation in any cervid species. Preorbital gland opening in other mating contexts has previously been reported in 4 other species, being used for marking or display during the precopulatory stage in Eld's deer (Blakeslee et al., 1979) and in Indian sambar (*Rusa unicolor*; Schaller, 1967; Leslie, 2011; Lydekker, 1898). For Southern pudu (*Pudu puda*), MacNamara and Eldridge (1987) reported preorbital gland opening during courtship, though without further details. Most observations, however, have been recorded for red deer stags: while roaring (Butzler, 1974; Bartoš, 1983), performing flehmen, searching for and pursuing oestrus hinds, or licking the hind's vulva (Bartoš, 1983). Observations have also been recorded for oestrus red deer hinds during soliciting behaviour to the stag, although preorbital gland opening by females in a sexual context appears to be much more rare (Bartoš, 1983). However, even in this well studied species, preorbital gland opening during and after mating has never previously been observed.

In only one of the four cases of flehmen in barasingha, did we observe the preorbital gland open, and in this case it was the stag that copulated shortly after. Therefore, we suggest that preorbital gland opening may be an important behavioural indicator of real excitation of the individual in the sexual context. Our findings are also in line with the suggestion of Bartoš (1983) that olfactory signals emanating from the preorbital gland may have some role in the sexual behaviour of cervids.