Short Communication

The beard of the Bearded Vulture (*Gypaetus barbatus*): citizen science suggests an adjustable airflow sensor

Tiziano Londei

Abstract - The beard of the Bearded Vulture is part of a facial mask of prominent bristles that extends under the bill with two tufts between the mandibular rami. The function of this unique beard is still unclear. The facial bristles of birds are simple feathers, probably similar to the feathers that may have served a tactile function since the origin of all birds. Although their present-day functions are generally poorly understood, facial bristles have mechanoreceptors near their follicles, as in the case of filoplumes located at the base of flight feathers, an apparatus with proven sensitivity to airflow. Citizen science is increasingly providing a great number of Bearded Vulture images, some of which already allow us to suppose that these birds adjust the projection of the beard, relative to the bill line, depending on flying conditions. This viewpoint might produce further hypotheses, e.g., that the longer beards of the adult birds might serve their visibly more agile flight and that the likely ornamental function in sexual/social displays might be an added function to the primary, sensory role of the facial bristles, both of which would be enhanced by the length of the beard.

Keyword: bird facial bristles, sensory feathers, ornamental feathers.

Riassunto - La barba del Gipeto (*Gypaetus barbatus*): la scienza partecipata suggerisce sia un sensore regolabile del flusso dell'aria.

Questa barba è parte di una maschera facciale di vistose setole che si prolunga sotto il becco con due ciuffi tra i rami mandibolari. La funzione di questa peculiare barba non è ancora chiara. Le setole facciali degli uccelli sono piume semplici, probabilmente simili a quelle che possono aver avuto funzione tattile fin dall'origine di tutti gli uccelli. Sebbene le loro attuali funzioni siano generalmente poco conosciute, le setole facciali hanno meccanorecettori vicino ai loro follicoli similmente alle filopiume situate alla base di remiganti, un apparato scoperto sensibile al flusso dell'aria. La scienza partecipata sta offrendo un gran numero di immagini del Gipeto, alcune delle quali già permettono di ipotizzare che questi uccelli regolino la proiezione della barba, rispetto alla linea del becco, secondo le condizioni del volo. Questo punto di vista potrebbe produrre ulteriori ipotesi, per esempio che la barba più lunga negli adulti sia funzionale al loro volo, visibilmente più agile che nei giovani, e che la probabile funzione ornamentale nelle esibizioni sessuali/sociali sia una funzione aggiunta al ruolo primario, sensoriale, delle setole facciali, entrambe le funzioni potenziate dalla lunghezza della barba.

Parole chiave: setole facciali degli uccelli, piume sensoriali, piume ornamentali.

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All bird feathers may have originated with a tactile function, with a simple hair-like structure similar to the facial bristles of modern birds (Persons & Currie, 2015). Variously located around the bill, facial bristles have likely been gained, retained, or lost, in several bird lineages, although these feathers are generally poorly investigated for their present-day functions (Delaunay *et al.*, 2022). Located above the line (rictus) of the upper mandible, the upper rictal bristles are the best-studied ones, especially for their possible function in the foraging of nocturnal species (Strigiformes, Caprimulgiformes, and Apterygiformes). Their follicles are surrounded by mechanoreceptors that are highly sensitive to pressure and rapid mechanical deformations. In addition, their follicles are connected by several muscles that counteract horizontal movements of the feather, lift the feather up or pull the feather down, and counteract the vertical rotation of the feather induced by the airflow (Ostmann *et al*., 1963). After an early suggestion that these feathers might serve for orientation in the environment (Küster, 1905), this possible function has only been evaluated at short distances, e.g., for obstacle avoidance in complex/dark environments (Seneviratne & Jones, 2010), analogous to mammalian tactile hairs (vibrissae).

The Bearded Vulture *Gypaetus barbatus* takes its scientific name, as well as common names in various languages, from having a prominent "beard", in fact, two tufts of interramal bristles (bristles from between the rami of the lower mandible). The structure of these bristles is rather unusual (see the bristle collection "quebrantahuesos - 77 - feathers of the beard" at https://plumarium.es/en/bearded-vulture/); according to Delaunay *et al.* (2022), they are semibristles with barbs at the base of the rachis (rather than along the rachis), but some of the barbs are almost equal in length to the rachis, as if they have evolved from a simple structure to "add volume" to the beard. The beard reaches its full length in adult birds, forming a con-

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tinuous black mask with equally long rictal bristles and shorter eyebrow bristles (Delibes *et al*., 1984). The current opinion holds that the purpose of the beard is not yet clear (https://www.beardedvulture.ch/beardedvulture/biology). Brown (1989) proposed that the beard and rictal bristles might function as tactile organs to prevent the vulture from inserting its head too deeply into a fresh carcass and thereby matting its feathers with blood. However, a link to efficient foraging could hardly explain why it takes several years for the beard to reach its maximal length. Delibes *et al.* (1984) found denser bristles on the heads of Eurasian Bearded Vultures than of African conspecifics. This would be in line with the generally denser plumage of the former and might be explained as a better protection, in colder climates, of the most sensitive parts of the head by bristles: the nostrils and the mouth opening by extended rictal bristles, the eyes by eyebrow bristles and the ears by ear-tuft bristles. However, again, this would leave the lengthy development of the beard bristles unexplained. As the black facial mask makes a strong contrast with the prevailing light colour of the head and neck in adults, a longer beard might contribute better to displays during intra- or interspecific interactions. Most of the photographs of living Bearded Vultures show eyes with a swollen red scleral ring, a recognized sign of arousal (e.g., Terrasse, 2017) and thus likely an effect of the photographer having been close to the subject. Considering that the erection of the interramal bristles might make the beard point forward, such a state of arousal might have created the opinion that the Bearded Vulture has a forward-pointing beard as a trait of the species, as in the description provided in Terrasse (2017). However, other photographs show a different projection of the beard relative to the line of the bill, about at a right angle, or backward. At this point, the beard might be seen as an adjustable ornament that is fully developed in adult birds. On the other hand, experimental evidence in *Aethia* auklets suggests that "exaggerated" facial feathers have evolved secondarily in ornaments while maintaining their primary mechanosensory function (Seneviratne & Jones, 2010).

The facial bristles may be compared to the filoplumes that surround the base of secondary flight feathers. The mechanoreceptors near the follicles of these filoplumes were found to be sensitive to the deformation caused by airflow to the flight feathers, but the removal of the filoplumes did not change this sensitivity, suggesting that filoplumes may be evolutionary relics, i.e., degenerate feathers that are retained only for the mechanoreceptors associated with their follicles (Brown & Fedde, 1993). Let us now suppose that facial bristles work on their own with airflow. Close-range photographs, or videos, of Bearded Vultures in flight would allow this possibility to be investigated by considering how the beard projects from the bill line under different flight conditions. Thanks to citizen science, thousands of images of Bearded Vultures are available. However, given that much individual variation exists in the shape of the beard, which might also change in the same bird because of transient states of the bristles, only images of the same bird obtained at short intervals might reveal that the subject has adjusted its beard to flight conditions. A combination of plumage traits should be considered to identify the same bird in different images, thus avoiding, e.g., that birds of a pair recorded one at a time would be understood as the same bird. This task would be easier with nonadult Bearded Vultures because of greater variation in their plumage, but their shorter beards would be less useful for understanding beard adjustments. That said, I have obtained some useful suggestions, as follows, from a search in the Global Facility Information gallery, which presently offers more than 3900 freely available photographs of Bearded Vultures.

Fig. 1 provides a comparison between a relaxed subject (Shnayder, 2012), a rare photograph of Bearded Vultures at close distance in the field, and an active subject (Pulido Enrique, 2010), the usual state of these birds in the photographs.In the latter case, erected bristles produce the image

Fig. 1 – Two adult Bearded Vultures: the beard of the resting subject (left, photograph by Shnayder, 2012) is sleeked backwards, while the beard of the subject on the alert (right, photograph by Pulido Enrique, 2010) points forwards due to erection of the bristles. The swelling of the red scleral ring in the eye of the second bird suggests some degree of arousal, which may have contributed to the targeting of the beard. / Due Gipeti adulti: la barba del soggetto in riposo (a sinistra, fotografia di Shnayder, 2012) è lisciata all'indietro, mentre la barba del soggetto in allerta (a destra, fotografia di Pulido Enrique, 2010) punta in avanti per erezione delle setole. Il turgore dell'anello rosso della sclera nell'occhio del secondo uccello suggerisce un certo grado di eccitazione, che può aver contribuito al puntamento della barba.

of a forward-pointing beard, although it is the fanning out of the bristles that makes the main difference from the beard of the resting bird. Some degree of arousal is evident in the active bird, but no other part of its plumage might suggest a display for intra/interspecific communication; hence, a sensory adjustment seems rather likely in its beard. Fig. 2 suggests that when a Bearded Vulture changes flight direction or carries a heavy load (the skull and spinal column of an ibex, in this case), the bristles not only of the beard but also of the eyebrow are erected (Diana, 2024a, 2024b, 2024c, 2024d). The inconspicuous scleral rings in Fig. 2 suggest that the presence of the photographer did not arouse the subjects; hence, bristle erection was more likely caused by flight conditions.

A greater number of suitable images, ideally from close-range videos of some length, and some experiments would be needed to ascertain the function of the beard and possibly also of other facial bristles in aiding the flight of the Bearded Vulture. The following three considerations might make further study of this topic more intriguing. Firstly, the Bearded Vulture is an acrobatic flyer in adulthood, but younger birds are visibly clumsy in comparison. They counterbalance their lack of flying experience with lower wing-and-tail loading (broader, though shorter, wings and longer tails) (Brown, 1989). The shorter beards of the young birds would match well with this difference rather than with less efficient foraging. A less efficient air flow sensor would be sufficient for their flight mode. Secondly, accepting that bristles are protective means and considering that the perceived temperature of the air depends on the airflow, a general increase in the length and density of head bristles during the Bearded Vulture's evolution in mountain climates may have produced a double advantage: a general protection from bad weather and, especially in the beard, an increased perception of the airflow. Lastly, regarding the origin of the beard, the retained sensory function of facial bristles (Delaunay *et al.*, 2022) would match well with the ancient origin of *Gypaetus*, a genus that may date back to the late Miocene, as well as *Neophron* (Sánchez Marco, 2022). The Egyptian Vulture (*Neophron percnopterus*), the closest extant relative of the Bearded Vulture (e.g., Seibold & Helbig, 1995), shows no trace of beard during its development, but

Fig. 2 – An immature and an almost adult Bearded Vulture, each under two different flight conditions on the same day: compared to the photographs on the left (photograph by Diana, 2024a and 2024c), both the photographs on the right (photograph by Diana, 2024b and 2024d) show a more prominent beard due to erection of the bristles, which is evident at the bristle base, although the airflow bends the beard backwards. On the right, both subjects also show some erection of the bristles over the eye, which widens the black supercilium. Unlike in Fig. 1, no scleral swelling joins the bristle erection, here. / Un Gipeto immaturo e uno quasi adulto, ciascuno in differenti condizioni di volo nello stesso giorno: a confronto delle fotografie a sinistra (fotografia di Diana, 2024a e 2024c), entrambe le fotografie a destra (fotografia di Diana, 2024b e 2024d) mostrano una barba più vistosa a causa dell'erezione delle setole, evidente alla loro base anche se il flusso dell'aria piega la barba indietro. A destra, entrambi i soggetti mostrano una erezione delle setole sopra l'occhio, il che rende più largo il sopracciglio nero. Diversamente da Fig. 1, qui l'erezione delle setole non è accompagnata da turgore della sclera.

young birds have rather conspicuous facial bristles, which are retained with the same arrangement, although in a reduced form, on the bare faces of adult birds. If any function is retained in these bristles, it is very likely a sensory function. The Egyptian Vulture is a less agile flyer than the Bearded Vulture despite its smaller size, lives in warm to hot climates, and the adult face is brilliantly coloured on the skin. Thus, during its evolution, *Neophron* might not have had an equal need to enhance the original sensitivity of facial bristles to airflow or otherwise enhance protection from cold, and the retained bristles could hardly become an ornament on a face that took advantage of the lack of feathers. In contrast, *Gypaetus* may have added an ornamental function to the enhanced primary sensory function of its interramal bristles, thus producing a multitask beard.

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