role in cancer research in East Asia after 2008. The increase was also observed for Italy, Germany and the UK, although not as significant as in Asian countries.

To sum up, Cancer Statistics articles had increased their global influence in cancer research in the last decade. However, their influence on cancer research in the US might be decreasing, as indicated by the much lower percentage and frequency of citations received from the US researchers. One possible reason could be that the content of Cancer Statistics articles were not in accordance with the cancer research agenda in the US, and thus these articles are not cited as often by the US researchers. Another reason could be the decrease in funding for cancer research after 2008. It was possible that the financial crisis of 2008 might have a negative influence in scholarship and funding that supported cancer research in the US. Based on the available data, it was not clear why such a significant drop in the US citations had occurred. Nevertheless, this result did indicate a sign of warning concerning cancer research in the US. Further research is needed to see if such a trend continues.

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Adaptive modifications in lip and barbel of an endangered catfish *Amblyceps arunchalensis* Nath & Dey, 1989

The mountain streams of the Eastern Himalayas are perennial shallow water bodies, characterized by low temperature, highly turbulent current and sandy, rocky substratum[1]. Fishes are unique among vertebrates in that some of them, particularly catfishes exhibit external taste buds especially abundant on their barbels[2]. *Amblyceps arunchalensis* Nath and Dey, 1989 has limited distribution in the torrential water bodies of North East India (Figure 1 *b*). The fish falls in the endangered category[3]. So far only taxonomic data are available and key characters include unequal jaws, reduced rectal fold, tuberculated skin and a number of adaptive modifications suitable for torrential habitat. Taste buds and mucus pores are invariably present in lips and barbels, which serve as chemo and mechano receptors. In the present study we describe the characteristic differences observed in the structure of lips and barbels of *A. arunchalensis*.

Live specimens of *A. arunchalensis* were collected from Ranganadi river (Figure 1 *a*), a northern tributary of the Brahmaputra in Lakhimpur district, Assam, India. Fishes ($N = 5$) were in the range of total length (TL) = 8.28–10.69 cm and body weight (BW) = 4.43–8.55 g. For SEM analysis, barbels and lips of *A. arunchalensis* were removed with the help of a surgical blade and fixed in 3% glutarldehyde solution for 24 h and the prescribed methodology of SEM[4] was followed. Sputtering was done with gold palladium mixture for 6 min using Emitech-SC7620 sputter coater and was viewed in FESEM (ΣIGMA, Zeiss, Germany) at 5 kV. Sizes of the central pores of the taste buds were measured with IMAGE J software.

In catfishes, the sense of taste is principally used to guide them to food, thereby acting as a long-range receptor[5]. Similar studies in case of *Corydoras arcuatus* and *Tinca tinca* have shown that numerous taste buds are present which in turn have several microvilli[5,6]. Presence of microvilli help them in adhering to the substratum and also act as mechano-cum-sensory receptors. The presence of these spine-like microvilli increases the

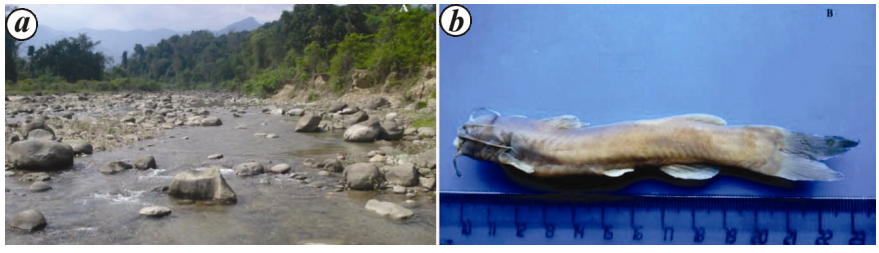

Figure 1. ***a***, Habitat of the fish, Ranganadi, Lakhimpur, Assam, India; ***b***, *Amblyceps arunchalensis*.

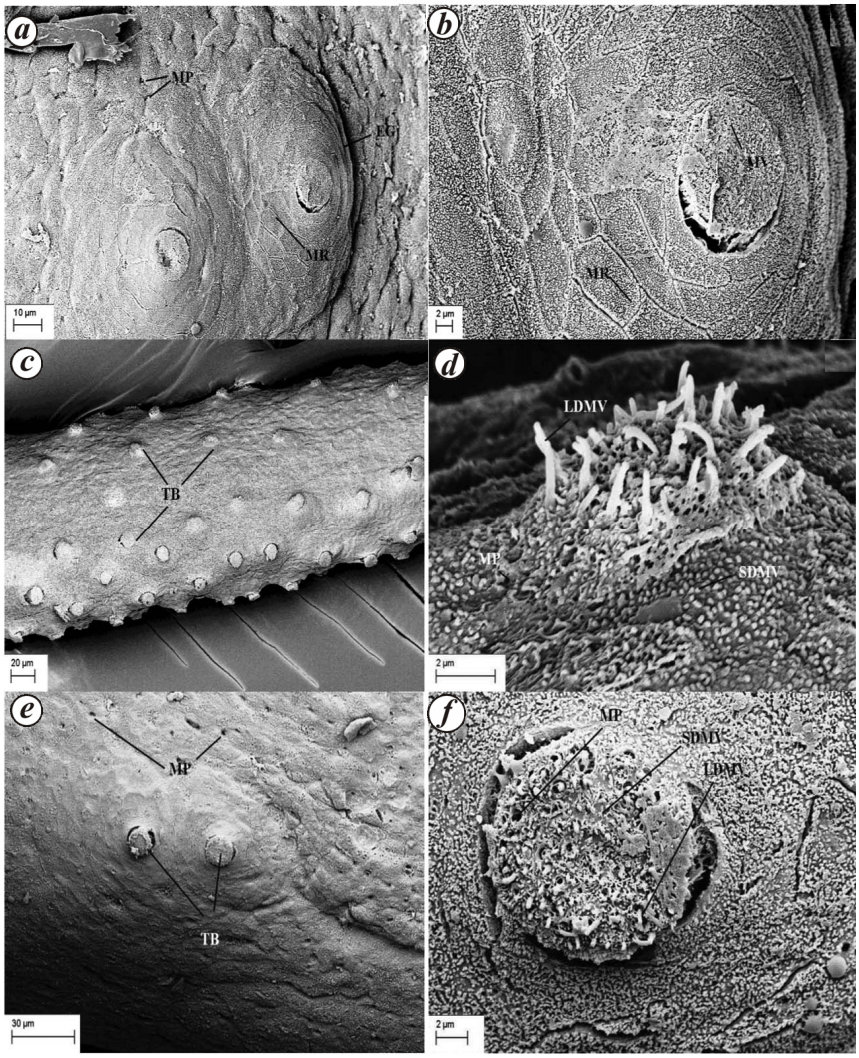

Figure 2. ***a***, Taste buds (TB) of the lip (scale 10 µm) with mucus pores (MP) and microridges (MR); ***b***, Magnified view of a single TB with microvilli (MV) and MR (scale 2 µm). ***c***, TB on mandibular barbel (scale 20 µm). ***d***, Magnified view of a TB, large diameter microvilli (LDMV), small diameter microvilli (STMV) and mucus pores (MP); ***e***, TB and MP on the maxillary barbel (scale 30 µm). ***f***, Magnified view of a single TB with MP, LDMV, LDMV and SDMV (scale 2 µm).

Box 1. Size of the central pore of the taste buds (N = 5)

Size of the central pores (µm; five taste buds from each portion of five individuals)		
Lip	Maxillary barbel	Mandibular barbell
12.85 ± 0.44	12.92 ± 0.54	13.46 ± 0.23

mobility of the mucus[7]. Apart from acting as the organ for chemical sense, taste buds play an important role in fish behaviour like searching for food and assessing its suitability[5].

Lips and barbels of *A. arunchalensis* show the presence of numerous taste buds and mucus pores (Figure 2 *a*, *c* and *e*). Distribution of the taste buds is not uniform in both the structures. Majority of the taste buds are hillock-shaped with a central pore that acts as a sensory zone of the organ, whereas others are roughly circular. Taste buds were identified according to the findings in other cat fishes. Three different types of cells were described in taste buds[6]. The first type, 'basal' cell, does not project to the external surface; several of these can be seen in close association with the extensive nerve terminal network entering the taste bud at its base. The other two cell types are larger than the basal cells and of elongated shape extending to the entire length of the taste bud; they project to the external surface by bearing microvilli at their apex. The size and shape of their

microvilli serve to distinguish these two cell types[6]. These cells are supporting, gustatory and basal cells[5]. For *A. arunchalensis*, the cells protruding above the surface bearing microvilli confirm the characteristics of the second type of taste buds[6] or light cells[8] (Figure 2 *b*, *d* and *f*). Light cells perform the major gustatory functions[8].

Mucus is secreted on receiving the necessary stimuli from the surrounding environment, providing a platform in the form of a feeble adhesion for the secondary adhesion of spines with the rough surface of the substratum[9] (Figure 2 *a* and *e*). Under higher magnification (15.00 kx), the epithelial cells show numerous microridges (Figure 2 *b*) which increase the surface area and also provide mobility to the mucus[9]. The mucus secreted by the numerous pores provides protection from mechanical abrasions, besides its immunological functions[9]. Study of taste buds of lips and barbels of the same individual revealed that central pores of taste buds of mandibular barbels are largest followed by maxillary barbels and lips (Box 1). In barbels of a catfish *Ictalurus punctatus*[10], goatfishes *Mullus barbatus* and *Mullus surmulatus*[11], distribution of taste buds was recorded along the entire length of the barbel, whereas in *A. arunchalensis* taste buds were restricted to middle region only. Two types of taste buds were described in *Clarias batrachus* and *Serrasalmus nattereri*[12], but only a single type of taste bud was recorded in *A. arunchalensis*.

The present study on ultra-surface structure of lips and barbels of the endangered cat fish, *A. arunchalensis* shows that except distribution of the taste buds, the structures of microvilli and mucus pores are similar to those in other cat fishes.

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