Discussion

BB cells and BL cells may be the same type of cone bipolar cells

The BL cells were showed similar morphology with BB cells, they differ only in S cone connectivity and axon terminal stratification in the IPL (Fig 9A&9B). However, the BL cells were observed for two specific morphological features: 1) The long and branchless dendritic processing of BL cells also showed some kind of cone selectivity but not the same as BB cells. 2) The BL cells contact almost all available S cone pedicles in the dendritic fields (9 S cone pedicles in the dendrite fields of 5 BL cells, but only 1 without dendritic contact). In fact, the little difference of the axon stratification in the IPL between BB and BL cells may be resulted from the rare microinjection which only 2 BB cells have been observed in this study. Give that there is no clear morphological difference between BB and BL cells except the S cone connectivity. And because the lower S cone population and sparse distribution in the dorsal side retina, my findings of the dendritic branches without S cone pedicle contact in the BL cells may be resulted from the lacking S cones in the region. If this is indeed the case, the BL cells should be categorized into BB cells according to the same morphological properties.

Comparison of wide-field bipolar cells

There are two types of wide field bipolar cells had been described in previous reports: wa (Famiglietti, 1981) and wb (Famiglietti, 1981; Jeon and Masland, 1995; MacNeil et al., 2004). In Famiglietti's description, "each wide-field bipolar cell gives rise to 1-4 relatively thick and extensive primary dendrites which rarely branch prior to giving off a small terminal cluster. … The dendrites of wa bipolar cells terminate at these clusters, but the dendrites of wb bipolar cells extend for considerable distance beyond the terminal cluster" (Fig. 11). According to these morphological properties, the BB and BL cells are similar with the wa bipolar cells, and WA and WB cells are clearly different from any bipolar cell described before (Fig 9C&9D). There is no wide-field bipolar cell with similar morphology with Famiglietti's wb bipolar cells found in our research.

Although the BB and BL cells have similar morphology with the wa cell, there are still some differences between them: 1) The wa bipolar cells contact 1-4 cone pedicles in common and a maximum of 6 in peripheral, but the BB and BL cells mostly contact 4-5 cones in the dorsal side retina. 2) The wa bipolar cells only show some kind of cone selectivity but the type of cone cells contacted by the wa bipolar cells is unknown, whereas the BB cells show a clear S cone connectivity. 3) The axon terminal stratification of the wa bipolar cells are in the outer most part in IPL (sublamina 1), whereas the BL cells have more broadly distribution from sublamina 1-2. Therefore, it is still obscure whether the BB or BL cells and the wa bipolar cells are the same population or not.

The blue pathway in the rabbit retina

Because the close relationship between the destination of the BB bipolar cell axon terminals and the presumed polarity of its electrophysiological response, we can assume that the BB cells provide the blue-OFF signal to the underlying ganglion cells. In addition, a small bistratified ganglion cell (G3) has been suggested to be a color encoding ganglion cell in the rabbit (Caldwell and Daw, 1978; Rockhill et al., 2002). Therefore, a blue off pathway from S cones through the BB cell to the ganglion cell can be expected. The color opponency should result in ganglion cells received blue OFF center from the BB cells and green ON surround from the diffused bipolar cells. In contrast, the electrophysiological response measured in the ganglion cells is ON-center and OFF-surround. Therefore, either the BB cell provides center blue-ON signal despite the axonal strata located at sublamin a, or the BB cell makes connection with other type of ganglion cells is uncertain. In Famiglietti's report (1981), he proposed that there are two types of wide-field bipolar cells involved in rabbit color vision. If the BB cell is the same with wa bipolar cell despite their slightly morphological differences, there should be another type of wide-field bipolar cells except the 4 types of wide-field bipolar cells found in this study.

Compare to the Blue cone bipolar cell (also named BB cells) in macaque study (Calkins et al., 1998; Herr et al., 2003), blue cone bipolar cell in primate is a narrow-field bipolar cell with axon stratified in the inner most of the IPL (sublamina 5). Therefore, the blue cone bipolar cell in primate transmits a blue-ON signal to small bistratified ganglion cell which also receives a yellow-OFF

surround from the diffuse bipolar cell (Dacey and Lee, 1994). The opposite circuits between rabbit and primate may compensate in the overall blue-yellow pathways. Alternatively, two species may use different color processing pathways.