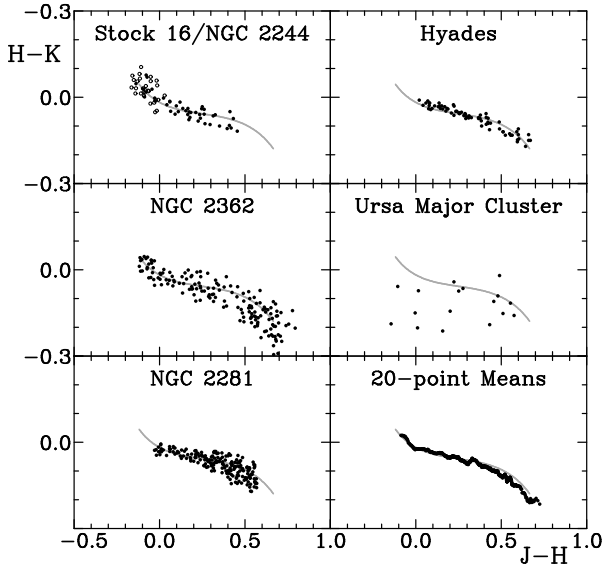

Fig. 2. Unreddened JHK_s colors (left) for stars in Stock 16 and NGC 2244 (top), NGC 2362 (middle), and NGC 2281 (bottom), and (right) for stars in the Hyades (top), and the Ursa Major cluster (middle) relative to the intrinsic relation for ZAMS stars (gray curves). The lower right diagram shows the data for stars in all clusters, except for saturated UMa stars, combined using running 20-point means.

four reddened clusters the *UBV* colors display *no* differential reddening, so it is unlikely to appear in the JHK_s colors unless there is some unforeseen component, such as circumstellar emission, affecting the observations. A pronounced "extra" scatter for B-type stars may have such an origin, given the evidence for circumstellar dust associated with some rapidly-rotating late B-type stars (Turner 1993), but it is unlikely that similar effects extend to the remaining cluster stars. It is more reasonable to attribute the scatter to intrinsic uncertainties in the precision of the JHK_s magnitude estimates, which appear to be larger than the cited values and also larger than what is attainable from iris photometry of photographic plates (Turner & Welch 1989). The tendency toward larger scatter for the coolest stars of NGC 2362 and NGC 2281 may be a problem with membership selection.

An earlier calibration similar to that of Table 1 was derived using stars in Stock 16, NGC 2362, and NGC 2251, with polynomial and linear fits made to combined running 20-point means for the data. Some of the features of the earlier calibration (see Turner et al. 2008, 2009) can be seen in the lower right portion of Figure 2, namely the pronounced "kink" near spectral type A0 in the mean data. But the data also match the new curved relationship very well.

For Hyades stars the JHK_s observations represent a combination of both 2MASS data and data from Carney (1982), as noted. The colors from both data sets display a scatter similar to that for Stock 16 and NGC 2244 members, but it is much reduced when the data are averaged together. There remains a sizeable residual scatter that is slightly larger than the cited uncertainties in the observations. Perhaps it represents an observational limitation for ground-based observations in the infrared imposed by variable atmospheric water vapour content (e.g., Milone & Young 2005, 2008). The scatter is greatly reduced in the 20-point running means, which is consistent with a problem that is tied to the precision of the observations. Otherwise, the intrinsic relation of Table 1 appears to be confirmed.

The colors for cluster stars in Figure 2 agree closely with the derived intrinsic relation, in most cases displaying only random scatter about it. If there were an extra reddening component of, say, 0.01 to 0.02 in *E(J–H)* for the stars, the centroids for the data would display a noticeable offset from the intrinsic relation. Thus, despite large scatter in the colors for stars in many open clusters, it is possible to derive an observational reddening for the stars from a color-color diagram by eye, with uncertainties of no more than ±0.01 to ±0.02 in *E(J–H)*, provided that the scatter in such cases is random in nature. Likewise, distance moduli derived from observational *J* versus *J–H* color-magnitude diagrams can be derived by eye with uncertainties typically no larger than ±0.1 to ±0.2. Such conclusions are confirmed by tests on the many open clusters studied to date (see, for example, Turner et al. 2008, 2009).

3. OTHER OPEN CLUSTERS

As noted above, the intrinsic relations of Table 1 have been tested successfully previously (Turner et al. 2008, 2009), but three clusters of uncertain properties were selected for further testing here: Berkeley 44, Turner 1, and Collinder 419. All three clusters possess limited published optical observations, and provide good examples of where 2MASS observations may help to clarify previous conclusions about cluster properties.

3.1. *Berkeley 44*

The sparse northern hemisphere cluster Berkeley 44 (Figure 3) has been identified as an old group by Carraro, Subramaniam, & Janes (2006), although