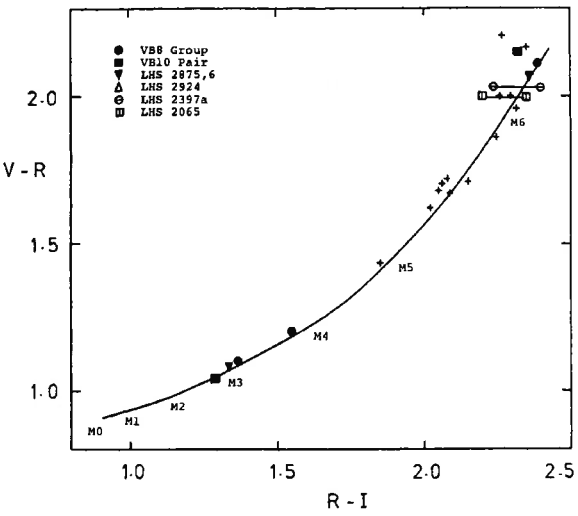

FIG. 1. The $V-R$ vs $R-I$ diagram for M dwarfs in Table 1.

MSO systems. I am grateful to Neill Reid for providing *JHK* photometry for some of the stars prior to publication. Photometry for several other stars were taken from Probst & Liebert (1983) and Persson *et al.* (1977). The IR colors were transformed into the homogeneous *JHKL* system as described by Bessell & Brett (1987).

Spectroscopic observations have been made on the AAO 3.9 m telescope with the red IDS (image-dissector scanner) on the B&C spectrograph (1981–1984), and with a GEC CCD on FORS (a cryogenic transmission grating spectrograph) (1984–1986). The IDS spectra covered 5000 to 8000 Å at a resolution of 5 Å, the CCD spectra covered 5300 to 10 200 Å at 15 Å resolution. The absorption features from the atmosphere were removed by division with a smooth spectrum star, such as an extreme halo K giant. The spectra were flux calibrated using standards described by Taylor (1986) or Oke & Gunn (1983). Some reticon spectra of northern stars were kindly provided by Liebert (private communication), and some CCD spectra of standard M dwarfs were kindly obtained by Peter Wood.

3. DISCUSSION

3.1 Colors

Figure 1 shows the relation between the $V-R$ and $R-I$ colors; some specific stars are identified in Figs. 1–3. The *VRI* colors were not available for LHS2924. The old-disk loci drawn in this and the following figures were derived from data in the photmetry papers referred to above. In Table 2 the mean colors and other properties of the old disk M dwarfs are tabulated; $(V-I)_{KM}$ refers to colors in the Kron–Mayall system used by observers at the USNO. The $V-R$ and $R-I$ colors of the earlier M dwarfs correlate closely with each other and with the spectral type, but given that the colors and types are both influenced mainly by the TiO bands this is not unexpected. There is some indication that the $V-R$ colors of the high velocity M stars are bluer for a given $R-I$, than the $V-R$ colors of the lower velocity stars.

During the photometric program it was obvious that the colors and magnitudes of some of the late-M stars were varying by amounts larger than could be explained by likely observational imprecision; in particular VB10 (LHS474) was often bluer in $(R-I)$ than VB8 (LHS429), although it was known to have a later spectral type. LHS2397a, and LHS2065 also showed month-to-month changes in $R-I$ color. The $V-R$ and $R-I$ colors of Proxima Cen (LHS49, M5.5) have also appeared to change by a few hundedths of a magnitude over the last seven years, in comparison with the colors of W358 (LHS294, M4), W359 (LHS36, M6), and GL866 (LHS68, M5.5). Weis (private communication) suspects that most M dwarf stars, especially the dMe and late-type dM are intrinsically variable (perhaps 0.02–0.10 mag) on long timescales owing to spotting or other activity, and that if used as photometric standards, several should be used rather on relying on a few. It seems that *VRI* colors are reliable for deriving color temperatures for M dwarfs of earlier spectral type than about M5.5 ($R-I$ and $V-I$ color bluer than 2.1 and 3.8, respectively), but for stars of later spectral type or cooler temperature, the $R-I$ and $V-I$ color can be bluer than anticipated, and longer wavelength observations must be used to infer the correct color temperature.

When the K magnitudes are combined with the V, R, or I magnitudes, the longer baselines result in large color differences for late-M stars, which overwhelm uncertainties in the individual magnitudes and enable one to derive precise color

TABLE 2. Colors, absolute magnitudes, and temperatures of the old disk M dwarfs.

SP	B-V	b-y	V-R	R-I	V-I	$(V-I)_{KM}$	V-K	I-K	J-H	H-K	BC_I	M_I	Teff
K7	1.32	0.80	0.83	0.77	1.60	1.48	3.16	1.60	0.66	0.15	0.62	6.63	4000
M0	1.41	0.87	0.89	0.91	1.80	1.70	3.65	1.84	0.67	0.17	0.59	7.06	3800
M1	1.48	0.94	0.94	1.02	1.96	1.87	3.87	1.90	0.66	0.18	0.57	7.45	3650
M2	1.52	0.99	1.00	1.16	2.16	2.06	4.11	1.98	0.66	0.20	0.55	8.00	3500
M3	1.55	1.05	1.10	1.37	2.47	2.38	4.65	2.18	0.64	0.23	0.44	8.71	3350
M4	1.60	1.14	1.23	1.63	2.86	2.82	5.28	2.41	0.62	0.265	0.30	9.85	3150
M5	1.82	1.25	1.48	1.91	3.39	3.40	6.17	2.78	0.62	0.33	0.05	11.30	3000
M5.5	1.94	1.30	1.69	2.06	3.75	3.81	6.71	2.96	0.64	0.35	-0.08	12.00	2900
M6	2.06	1.35	1.91	2.22	4.13	4.25	7.37	3.24	0.66	0.38	-0.30	12.50	2800
M6.5			2.12	2.38	4.50		8.10	3.60	0.70	0.42	-0.60	13.20	2700
M7			2.18	2.32	4.50		8.55	4.05	0.75	0.47	-1.00	14.10	2600
M7.5			2.1:	2.2:	4.3:		9.0:	4.6:	0.80	0.51	-1.50	15.20	2450