ZONAL DEFINITIONS

This section contains a description of the limits of 32 presently recognized low-latitude zones and 11 presently recognized middle-latitude zones.

Low Latitude Zonation

The low-latitude zonation presented herein for the Quaternary is that of Nigrini (1971). The rest of the low-latitude zonation is primarily that of Riedel and Sanfilippo (1978a), with some subsequent modifications by Sanfilippo et al. (1985) and Sanfilippo and Riedel in Saunders et al. (1985). The oldest zone recognized is the *Bekoma campechensis* Zone in the Late Paleocene (Nishimura, 1987). The reader is, however, directed to a more recent review and modification of the low-latitude zonation in Sanfilippo and Nigrini (1998; see **Addendum**).

Other zonal schemes have been presented for parts of the Cenozoic or for specific regions, but are not widely applicable. Goll (1980) described a zonal scheme for the Pliocene–Pleistocene based on DSDP Leg 54 material from the Eastern Pacific (**Fig. 1**). Johnson et al. (1989) proposed a zonal scheme for the Pliocene–Pleistocene of the tropical Indian Ocean (**Fig. 2**). Moore (1971) suggested that the *Dorcadospyris ateuchus* Zone be divided into the *Dorcadospyris papilio* and *Theocyrtis annosa* Zones, based on the first appearance of *Dorcadospyris papilio*. Additional zonal modifications can be found throughout the DSDP/ODP (Deep Sea Drilling Project/Ocean Drilling Program) volumes.

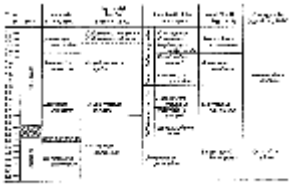

Figure 1.

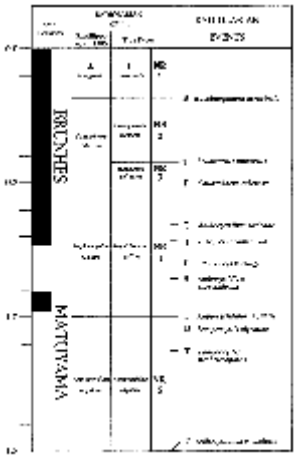

Figure 2.

Middle Latitude Zonation

The middle-latitude zonation is that of Hays (1970) and Foreman (1975). This zonal scheme is satisfactory from the Holocene to the upper

Pliocene (*Lamprocyrtis heteroporos* Zone). However, we have found that it is difficult to recognize the *Sphaeropyle langii* Zone and feel that this part of the zonation needs to be revised. Below the *Sphaeropyle langii* Zone researchers have tried, with varying success, to apply the tropical zonation of Riedel and Sanfilippo (1978a), but the fauna is sufficiently different to make this both difficult and ultimately unsatisfactory. However, because we do not presently have any better scheme, we have chosen to include the commonly used zonation but with the original (1978a) zonal definitions.

Reynolds (1980), working on Miocene to Holocene material from DSDP Leg 57 in the North Pacific, attempted to integrate the tropical zonation of Riedel and Sanfilippo (1978a) with several new zones (**Fig. 3**), but his zonation has not been applied by other workers. The reader should also note the more recent papers by Morley and Nigrini (1995; see Addendum) and Shilov (1995; see **Addendum**).

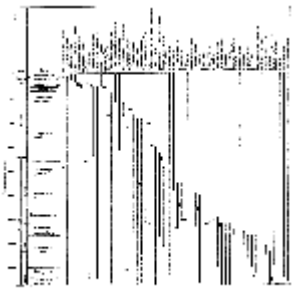

Figure 3.

Radiolarian Events

Within each zone there is a list of radiolarian "events," which are based on morphotypic first and last appearances or evolutionary transitions. A dash in front of the event (or group of events) separates it in time from the event(s) above and below. Events separated by semicolons are approximately synchronous. The first and last appearance of a taxon is indicated as "Bm" (earliest morphotypic appearance) and "Tm" (latest morphotypic appearance), and an evolutionary transition (Ev) with an arrow. "Morphotypic" and "evolutionary" limits, as applied in the zonal definitions, are explained in Riedel and Sanfilippo (1971, p. 1530).

In referring to the list of radiolarian events, the worker should realize that the list is based primarily on Pacific Ocean material. It should NOT be assumed that these events are synchronous from one latitude to another or even within a given latitudinal belt (Johnson and Nigrini, 1985).

Figure 1. Comparison of the Pliocene-Pleistocene radiolarian biozonation for DSDP Leg 54 (East Pacific Rise) sediments and other radiolarian biozonations. After Goll (1980).

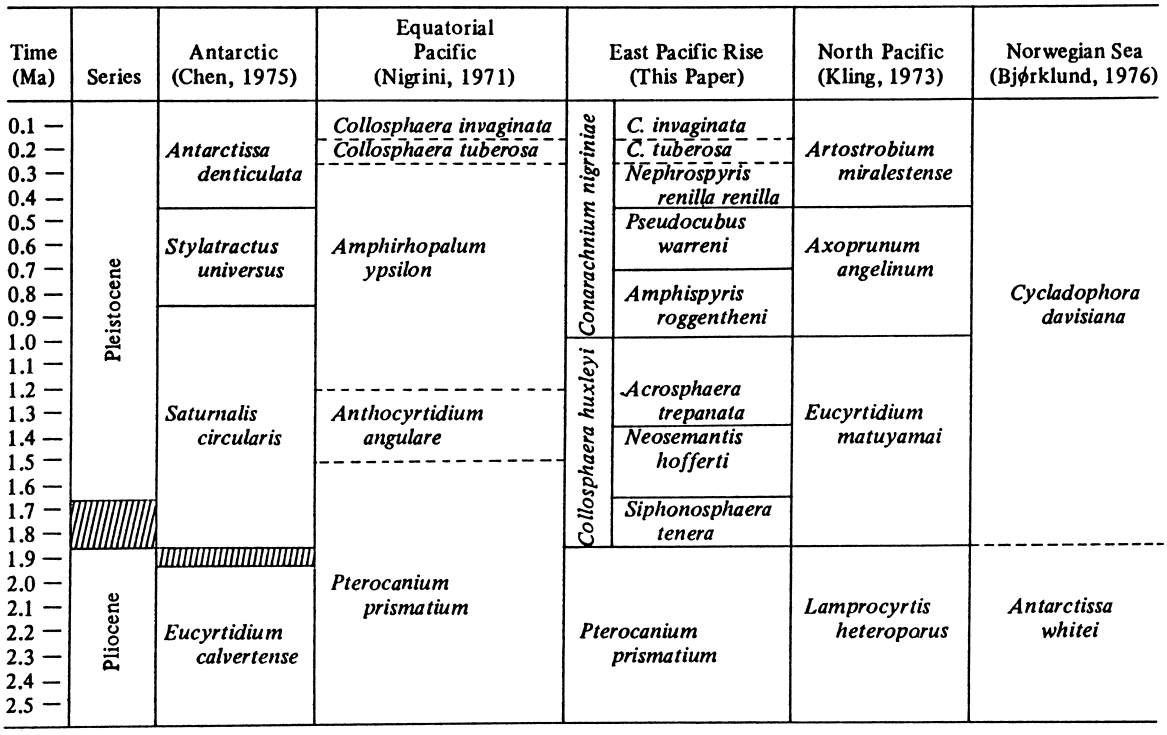

Figure 2. Summary of proposed radiolarian zonation, radiolarian events and paleomagnetic stratigraphy for the Pliocene-Pleistocene of the tropical Indian Ocean. Geomagnetic polarity time scale from Berggren et al. (1985). After Johnson et al. (1989). See also Sanfilippo and Nigrini (1998; in **Addendum**).

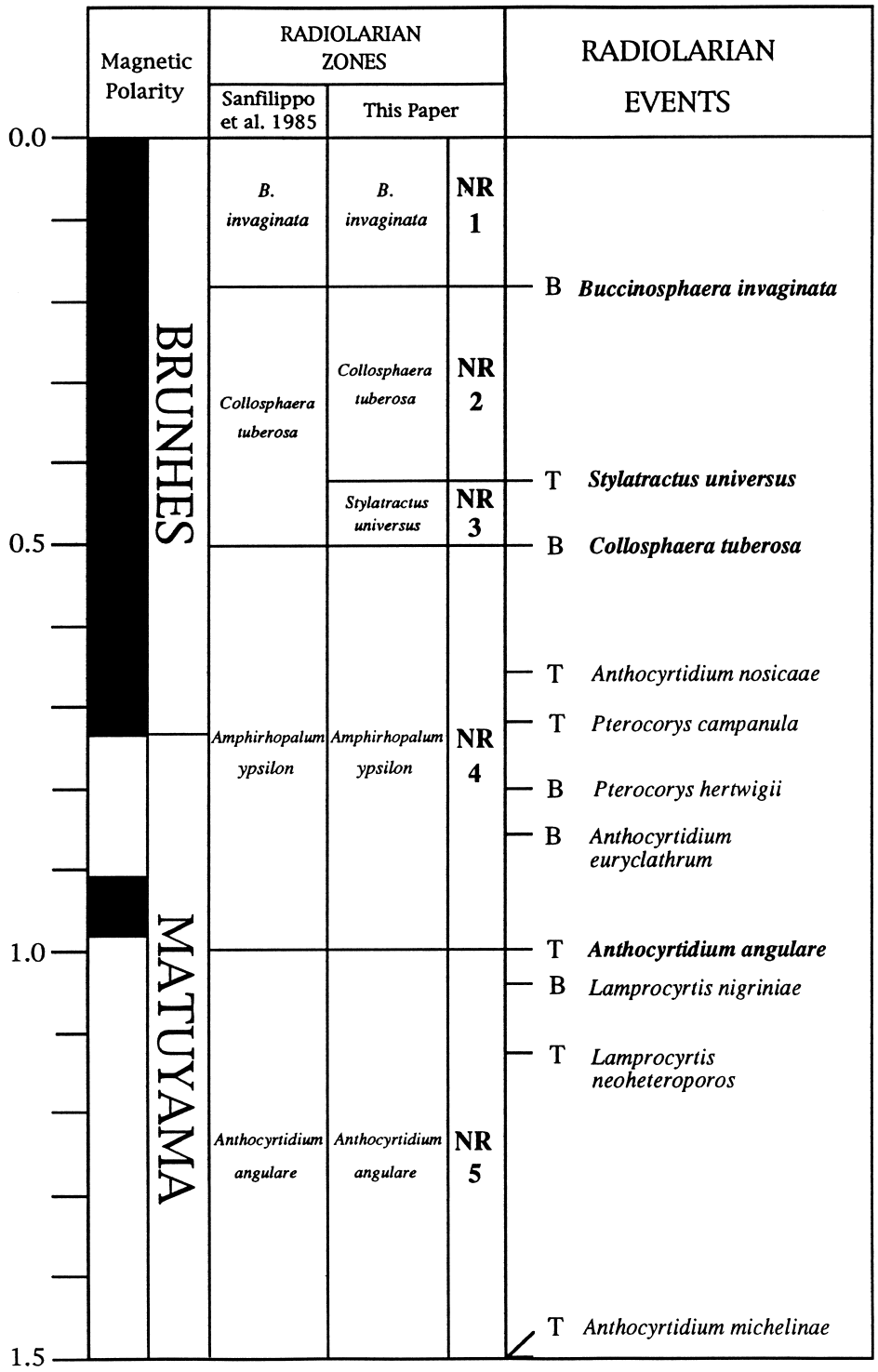

Figure 2 (continued).

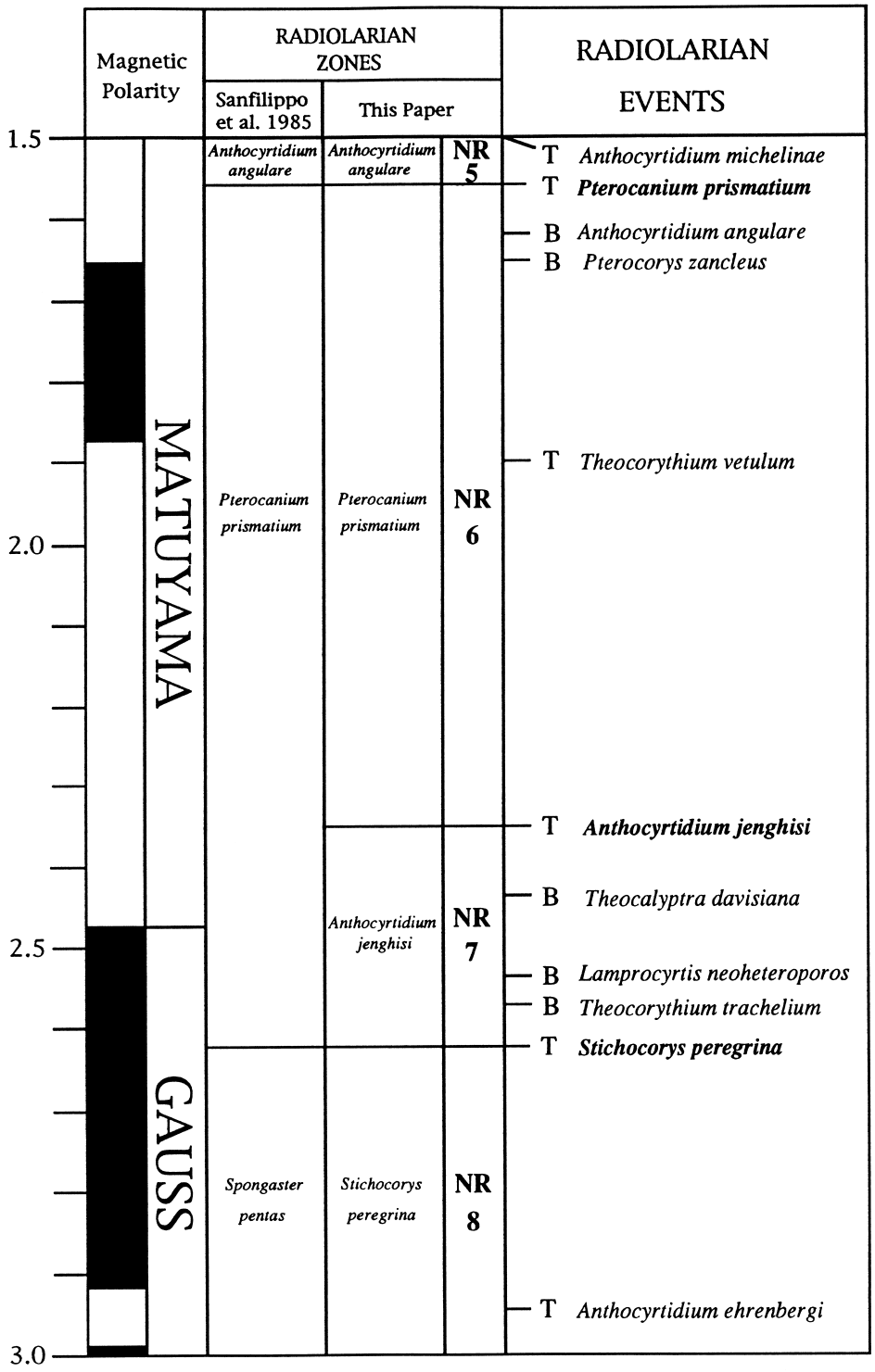

Figure 2 (continued).

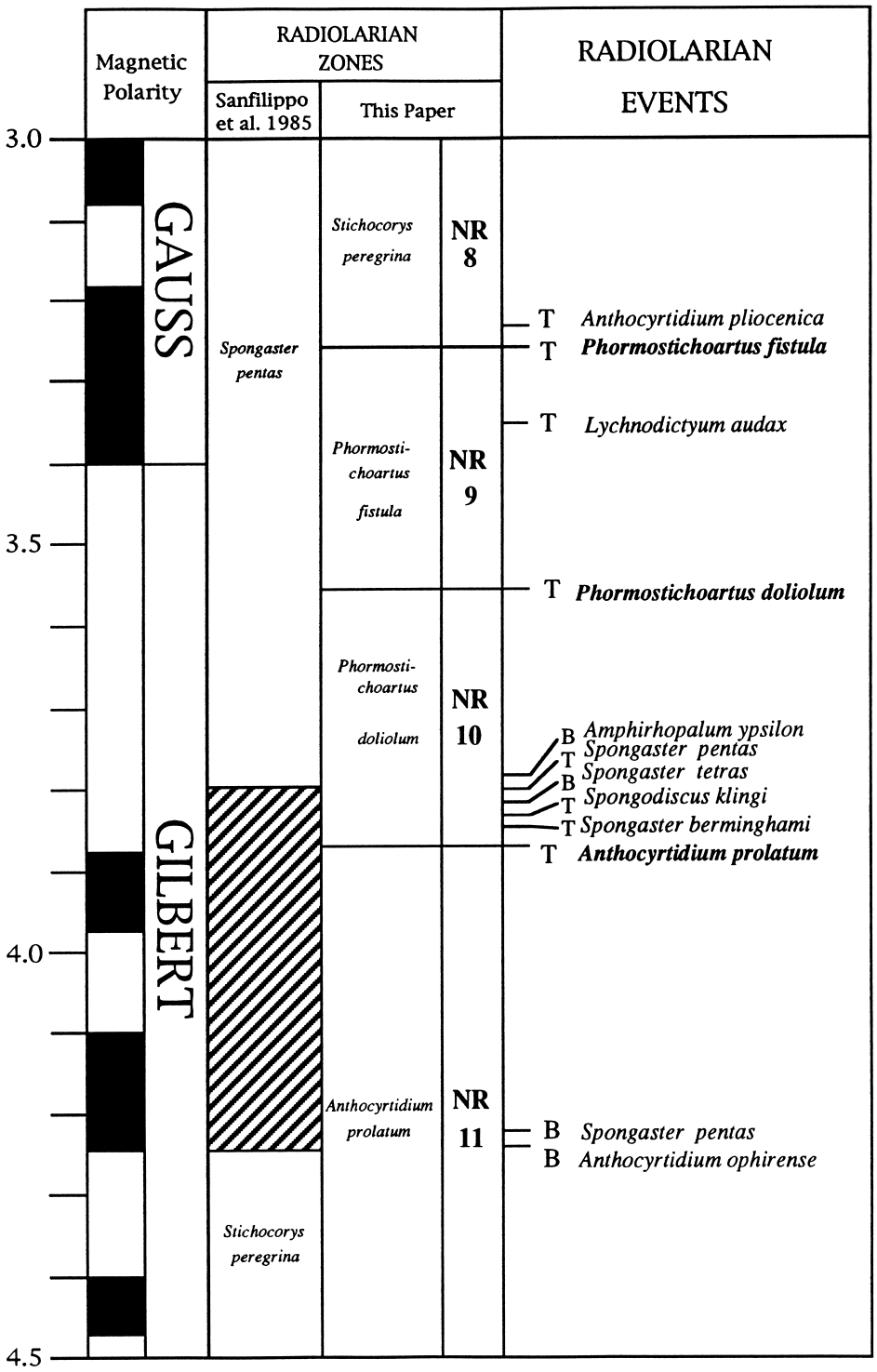

Figure 3. Range chart of DSDP Hole 438 (Leg 57, North Pacific) showing zonal scheme proposed by Reynolds (1980) for the Miocene to Holocene of the North Pacific. After Reynolds (1980).