Figure 1 Neighbour-joining tree of the four species of *Cyclothone*. Tree topology is congruent with one of the two maximum parsimony trees (186 steps; consistency index = 0.742; retention index = 0.924). Pairwise distances were calculated using the Kimura two-parameter method, and neighbour joining analyses used MEGA[10]. Maximum parsimony analyses used the heuristic algorithm in PAUP[11], with no transition or transversion weightings. Phylogenetically uninformative sites were excluded. Haplotypes are designated by the first three letters of specific names and two digits. Number of individuals (if any) with identical sequences follows in parentheses. Numbers beside internal branches indicate bootstrap probabilities[12] (>50% only) for 1,000 replicates. Wedge-shapes denote possible population subdivision events. Shaded portions of maps show distribution ranges[5]. Specimens were taken from two stations in the Sargasso Sea (western North Atlantic, WNA), two in Hawaiian waters (central North Pacific, CNP), two in the equatorial eastern Indian Ocean (EEI), one in the Coral Sea (western South Pacific, WSP) and three off southern Japan (western North Pacific, WNP).

ern South Pacific population, and the western North Pacific and eastern equatorial Indian Ocean populations, which required three within-ocean fragmentations of the ancestral population in the Pacific (Fig. 1). It is evident that these three lineages have not been ephemeral, as there has been a lack of within-ocean coalescence between populations during the past few million years, which probably extends back beyond the closure of the Panamanian seaway.

Our results show that there are genetically structured, isolated populations in open oceans. Given the long periods where there were no physical barriers, such as continents, it seems surprising that the three populations in the Pacific have not coalesced. Numerous questions remain unanswered, such as what factors might structure genetic diversity in such a homogeneous environment. As stated by Gibbs[9], we are a long way from knowing what species really exist in the oceanic pelagic realm.

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Extraterrestrial handedness

M. H. Engel and S. A. Macko[1] tentatively ascribe the enantiomeric excess of L-amino acids in extraterrestrial sources to the circular polarization of synchrotron radiation, from a neutron star, incident on the interstellar molecular cloud from which the Solar System formed (see also the accompanying News and Views article by C. F. Chyba[2]). But the Kuhn–Condon zero-sum rule[3,4] for the rotational strengths of a chiral molecule requires that broadband circularly polarized radiation cannot discriminate between the enantiomers of a racemic substance in photochemical reactions.

Kuhn first demonstrated photochemical optical resolution by showing that monochromatic circularly polarized light of a given handedness, tuned to the frequency of a specific circular dichroism absorption of an enantiomer, preferentially photolysed that enantiomer in a racemic mixture[3]. The mirror-image enantiomer was favoured if the radiation was tuned to a circular dichroism absorption of opposite sign, under the same conditions. Kuhn used coupled-oscillator theory to account for the observation that the circular dichroism bands of an enantiomer alternate in sign along the wavelength ordinate, and so cancel out over its electronic spectrum. Therefore the optical rotatory power of a given enantiomer, and its susceptibility to differential photochemical change with circular radiation, sum to zero over the electromagnetic spectrum as a whole[3]. Kuhn's classical result was confirmed by Condon[4], who demonstrated quantum-mechanically that an enantiomer's rotational strengths (measured by the circular dichroism band areas) sum to zero over the spectrum.

The zero-sum rule does not exclude a photochemical origin for biomolecular homochirality under severely restrictive initial conditions, covering time, place, radiation filters, and so on, for example by a prebiotic pool of racemic amino acids on an east-facing slope exposed to solar radiation only at dawn on the early Earth[5]. But such suggestions are essentially *ad hoc*.

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