sufficient to meet their metabolic demand. Although it is not possible to determine whether the swarming behaviour is more than an expression of optimal spacing of grazing individuals in an advective three-dimensional space, it is clear that the swarming amphipods must play a significant part in the bentho-pelagic coupling of chemosynthetic production.

Cindy Lee Van Dover
Stein Kaartvedt
Stephen M. Bollens
Peter H. Wiebe
Biology Department,
Woods Hole Oceanographic Institution,
Woods Hole, Massachusetts 02543, USA
Joel W. Martin
Natural History Museum of Los Angeles County,
900 Exposition Boulevard,
Los Angeles, California 90007, USA
Scott C. France
Scripps Institution of Oceanography,
La Jolla, California 92093, USA

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Tweaking the magnetosphere

SIR — Kurth's News and Views article[1] captures much of the excitement of the phenomenon of solar coronal mass ejections (CMEs) and their role in triggering terrestrial magnetic storms. But we wish to correct the impression that we do not yet know why some CMEs cause storms and others do not.

The necessary feature for the creation of major magnetic storms is the presence of an intense, long-duration (hours), southward, interplanetary magnetic field[2–4] somewhere within the high-speed (CME-related) stream structure. These southward fields efficiently interconnect with the Earth's magnetic field and allow energy transfer to the magnetosphere[5,6]. In a study of 55 (CME-related) shock-led high-speed solar wind-stream events occurring in 1978–79, 9 had such intense long-duration southward fields, 8 had predominantly northward fields and 38 had fields that were primarily in the ecliptic plane or had sufficiently out-of-ecliptic components, but were highly fluctuating in time[7]. Thus, only 9 of 55 shock-led, high-speed (CME-related) streams caused major magnetic storms.

For magnetic storms of lesser intensity, the requirements for the intensity of the southward field component and/or its duration are less[8]. These events are not necessarily associated with high-speed streams or shocks. At the lowest increment of magnetospheric energy, a substorm (thought to be an incremental part of a storm) is caused by even weaker and/or shorter-duration southward fields. Substorms are almost never associated with shocks and/or CMEs but with Alfvén waves[9] and discontinuities.

The level of the intensity of geomagnetic activity is ordered by the intensity and duration of the southward magnetic field. Velocity plays an important but not dominant role. Thus, CMEs are not a necessary and sufficient condition to cause intense magnetic storms, but long-duration, intense, southward interplanetary magnetic fields are.

Bruce T. Tsurutani
Jet Propulsion Laboratory,
Pasadena, California 91109,
USA
Walter D. Gonzalez
Instituto National de Pesquisas Espaciais,
Sao Jose dos Campos,
Sao Paulo, Brazil

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Emerging cytokine family

SIR — Our colleagues recently reported the cloning of a murine ligand (CD40L) to the CD40 antigen[1]. CD40 is a member of a family of at least nine transmembrane proteins[2], including the low-affinity nerve growth factor (NGF) receptor and two distinct tumour necrosis factor (TNF) receptors that each bind both TNF-α and TNF-β. Although Armitage *et al.* reported that screening of the CD40L sequence against the nucleotide sequence databases revealed no significant similarities[1], we have now found that CD40L is similar to TNF-α and TNF-β (see ref. 3 for a review), suggesting an emerging ligand family parallel to the TNF/NGF receptor family.

CD40L and pro-TNF-α are both type-II membrane proteins and sequence similarity is limited to the carboxy-terminal (receptor-binding) portion of the extracellular domains; in mature TNF-α (and in TNF-β, a secreted protein) the homologous region forms a β-sandwich which trimerizes[4,5]. CD40L thus presumably shares a similar tertiary structure and may be oligomeric, consistent with ligand-induced receptor cross-linking as a common activation mechanism[2].

The only other known ligands to members of the TNF/NGF receptor family are the neurotrophins (such as NGF), a set of homologous cytokines which bind low-affinity NGF receptor (and several *trk* proto-oncogenes)[6]. Although NGF is a homodimer whose protomer, like TNF-α and TNF-β, has an all-β structure[7], its topology differs from the TNF topology and no sequence similarity is apparent. The known ligands of the TGF/NGF receptor family thus fall into two structural classes. Because the remaining members of this receptor family (4-1BB, OX40, CD30, CD27 and FaS) reside chiefly on cells of the haematopoietic system, it seems their putative ligands are more likely to resemble TNF than the neurotrophins.

Terry Farrah
Craig A. Smith
Immunex Research and Development Corporation,
51 University St,
Seattle, Washington 98101, USA

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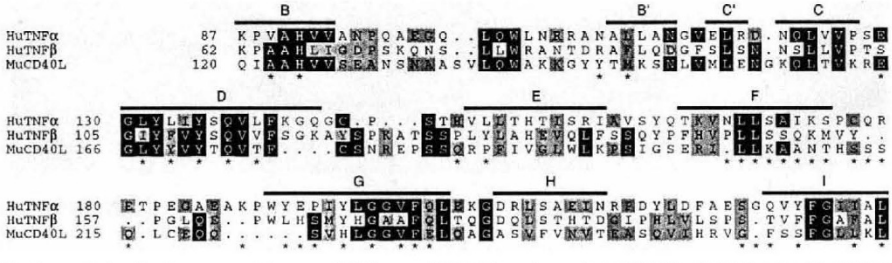

Region of similarity among human TNF-α and TNF-β and murine CD40L sequences. Identities and similarities between CD40L and each of the TNF sequences are highlighted. Asterisks, residues involved in the trimeric interface of TNF-α; B–I, β-strands of TNF-α (ref. 4).