through their narrow apertures to their 'cells'. The spines are used in feeding, to elevate the zooids above the slow-moving boundary layer of water close to the shells on which they live (Fig. 2).

Other living pterobranchs grow small spines in a similar way, but the discovery of such long processes is unique. It elegantly and unequivocally removes the difficulty in explaining how pterobranch-like zooids could have secreted the nema. To all intents and purposes, graptolites and living pterobranchs can be regarded as a single phylogenetic group. Whether *Cephalodiscus* is a living genus of graptolite, as Dilly suggests, or whether graptolites are an extinct group of pterobranchs, remains to be decided; on balance, many characteristics of extant pterobranchs seem primitive compared with the highly specialized morphologies seen in graptoloids[5]. These taxonomic differences are, however, largely a matter of terminology. What is important is the undoubted closeness of relationship between the two groups.

Palaeontologists can now reconsider the functional morphology of graptolites afresh, no longer plagued by doubts about their affinity. Study of living pterobranchs can be extended in the knowledge that their comparison with graptolites will yield new insights about the extinct forms. It becomes possible, for instance, to use coenecium growth rates of extant pterobranchs to calculate a minimum lifespan for graptolites because we are now sure that they built their colonies in much the same way. Population studies will be possible for the many bedding planes where graptolites are preserved abundantly and as the victims of mass mortality.

Another area open to investigation is the relationship of the individual zooid to the colony. Fewer spines are secreted by *C. graptolitoides* than there are zooids in the colony and there is clearly a degree of cooperation between zooids. There is no rigid colony architecture but the zooids work together to build functional units. It should be possible to determine the controls on this interaction. In contrast, the planktonic graptolites were built with a high degree of regularity and symmetry. The number of thecae, the stipe width, the degree of overlap between thecae and the design of thecal ornamentation all show consistent variation along the length of the colony. The observation of loosely organized cooperation in living, benthic pterobranchs implies that the unusually tight organization of graptoloids was determined largely by their planktonic mode of life, as this is the main remaining difference between the two groups.

FIG. 2 *Cephalodiscus gracilis* feeding on a transparent spine.

A simple but valuable lesson emerges from the discovery and analysis of *C. graptolitoides*. The biology of most fossil organisms is best studied with reference to the living world, yet collaboration between zoologists and palaeontologists remains patchy at best. The advantages of such mutual awareness are amply demonstrated by Dilly's study; he was sufficiently familiar with a major fossil group to realize the importance of a new zoological find. The alternative can be years of fruitless wrangling and the stagnation of whole fields of study. □

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DAEDALUS

Sun and shadow

AMONG the underpigmented peoples of the world, the craze for a chic sun-tan is still alive. A sun-tan, of course, is the body's defence against the ultraviolet component of direct sunlight. These days, with the thinning of the ozone layer, solar ultraviolet is beginning to overwhelm this defence. The Sun lover now risks getting skin cancer. But while this cancer can take many years to develop, the perceived benefits of a tan are immediate and powerful. They include enhanced social popularity and sexual desirability, leading to a wider choice of mates and therefore a greater likelihood of high-quality offspring. Those who go for the tan and risk the cancer are probably acting in their own best evolutionary interests.

Tanning, says Daedalus, also has another biological benefit. It is not a mere uniform coloration. It preferentially darkens the sunlit areas of the skin. It thus acts as a self-optimizing camouflage, reducing the body's optical contrast. (Many animals are darker on the top and lighter on the underside for just this reason.) Our primitive ancestors, anxious not to attract the attention either of fierce predators or alert prey, would have valued a sun-tan for added obscurity rather than conspicuous chic.

So Daedalus wants to make tanning safer. He remarks that the first silver-halide photographic emulsions were sensitive only to ultraviolet and blue light. Early photographers used ultraviolet-rich light sources, such as direct sunlight or the rather fearsome explosion of carbon disulphide vapour in nitric oxide. But then photographic sensitizers came along: dyes that absorb visible light and hand its energy to the silver halide. The resulting panchromatic film was sensitive to the whole visible spectrum.

The same trick might work on human skin. Daedalus is coating DREADCO volunteers with a variety of dyes, from photographic sensitizers to traditional war-paints, and is then exposing them to light of different wavelengths. He hopes to discover a skin pigment that will activate a tan even in overcast British daylight, perhaps even under translucent clothing. When in due course the user washes off the dye, a chic, safe, becoming tan will be revealed.

Daedalus has particularly high hopes for that ancient blue skin dye, woad. He suspects that the ancient Britons (who had quite as much trouble getting sun-tanned as their modern counterparts) used it not merely as a terrifying war-paint, but as an activator for a camouflaging tan. It served a double duty, attracting attention and fear when worn, and deflecting them when washed off.

David Jones