that, after 3 hr., nearly all the radioactivity induced in bone originates from sodium-24. R. Loos, of the Department of Physics, confirmed this fact for our material by γ-spectrography.

After this delay, the sections were sandwiched between two 'Maximum Resolution' plates (Kodak Ltd.). When exposed for about 40 hr., the plates were developed in *D*-178.

Microradiograms of the sections were then obtained in 10 min. by exposure at a distance of 25 mm. from the tube of a Philips apparatus set at 5 kV. and 1·8 m.amp.

Fig. 1 shows an autoradiogram (*A*) and a microradiogram (*B*) of the same region of a human rib in transverse section. The darkening of the autoradiogram is not uniform. On the left, a large area which is not radioactive corresponds to an absorption cavity. Smaller white spots on the autoradiogram indicate Haversian canals as seen on the microradiogram. Besides these empty spaces which could be expected to be devoid of sodium, one may observe that the osseous substance itself is not uniformly radioactive. More precisely, the osteons not yet fully calcified, and thus appearing gray on the microradiogram, have given a weaker imprint on the autoradiogram. No doubt they are poorer in sodium than the completely calcified tissue.

Some sections were decalcified in ethylenediaminetetracetic acid; others were thus treated[4] before neutron activation. The former produce much paler images on the autoradiographic emulsion; the latter give the same pictures as untreated bone. It is thus confirmed that most of the sodium is linked in the mineral portion of bone tissue[5].

These observations show that the load of sodium, at least of sodium remaining in ground sections of bone fixed in alcohol, parallels the load of calcium as indicated by X-rays. The concentration of sodium is lower in young osteons than in old ones, just as it is lower in the skeleton of young rats than in that of old rats[6]. It seems that an osteon reaches saturation nearly at the same time for both calcium and for sodium.

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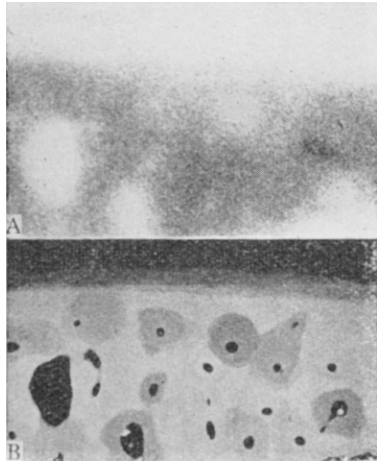

Fig. 1. Transverse section of a human rib. Correlation between autoradiogram after neutron activation (*A*), where darkening is related to sodium concentration, and microradiogram (*B*), where white areas indicate the greatest amounts of calcium. The absorption cavity (on the left) and the Haversian canals are not radioactive. The less calcified osteons contain less sodium than the others. (×*c.* 25)

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Dimorphism and Size Distribution in *Velella* and *Physalia*

WOODCOCK[1] attributed right- and left-handedness in *Physalia*, the Portuguese man-of-war, to a selective advantage in avoiding entrapment in windrows of *Sargassum* weed and floating debris. This selective advantage was presumed to be due to differences in sailing patterns through convection cells in the surface water of the northern and southern hemispheres. The absence of *Sargassum* from the South Atlantic and the paucity of debris in the barren, blue waters in which *Physalia* is characteristically found would seem to invalidate this hypothesis. On the other hand Woodcock's arguments concerning food concentration by the convection cells and sailing patterns are more convincing. Woodcock[2] continued to favour the hypothesis that there are significant differences in abundance of the two forms between the northern and southern hemispheres. Other authors[3,4] have commented on this problem; however, none has pointed out that the more extensive literature on *Velella*, long known to be dimorphic[5], shows no statistically reliable difference between the abundance of the two forms in the northern and southern hemispheres.

The fact that Agassiz[6] found only left-handed specimens present in more than two thousand *Velella* collected along the shores of the north-west Atlantic while Chun[7] found 71 left-handed and 6 right-handed *Velella* off Africa in the north-east Atlantic would indicate an east-west or zonal difference. Chun's[7] findings are confirmed by the results of Moser[8]. In a recent paper, Savilov[9] reported left and right-handed specimens of *Velella* from the north-west and south-west Pacific. Of more than 250 specimens examined by the author from the north-east Pacific all were left-handed. Thus, if there is an east-west difference in relative abundance of the two forms, the results available to date indicate that the situation in the Pacific is the reverse of that in the Atlantic.

Savilov advances a hypothesis that appears to solve this problem. In the northern hemisphere, left-handed specimens of *Velella* move to the left of the wind direction due to the anticyclonic wind circulation over the ocean. The left-handed specimens are therefore concentrated along the outer edges of the distribution. The right-handed *Velella* move to the right of the wind direction and are concentrated in the centre of the distribution. Thus one should find the left-handed specimens near shore. In the anticyclonic wind circulation of the southern hemisphere the left-handed *Velella* are concentrated in the centre of the distribution with the right-handed specimens more abundant along the borders of the distribution. The only results which weaken this argument are the exclusively left-handed specimens taken by me off California. Many of these were collected more than 300 miles off shore.

Savilov[9] found large specimens of *Velella* most abundant in the region of 40° N. lat. in the Kuroshio Extension. Young and larval forms were common in the south and far western parts of the Pacific. He attributed this size distribution to the wind and current patterns. An alternative explanation follows:

My studies of *Velella* off California, extending over a period of six years (unpublished results), show a marked seasonal appearance of *Velella* at the surface. This is confirmed by a careful examination of the previously published literature. The post-larval specimens first appear at the surface in very late December or early January and continue to reach the surface through the spring. The largest specimens are found in late autumn and early winter.

Examination of the track of the *Vityaz* shows that the stations in the Kuroshio Extension were occupied from July to November when neither larval nor very young forms would be present. The southern and far-western stations were occupied in December, January, February, July and August when the largest specimens are rare if present at all. Larval and young specimens would be present in December, January and February. Thus the size distribution Savilov describes in general terms can be more easily explained by seasonal differences. The data he presents do not allow a more precise analysis of the problem. One might also expect to find mean length differences between local populations because of different sea surface temperatures. However, these would be much smaller than those due to seasonal appearance and growth.

From the above it is apparent that the origin and occurrence of the different sizes and morphological forms of *Velella* and *Physalia* are not yet satisfactorily explained. Of the several variables that appear to be involved, seasonal appearance and growth have not been properly considered in previous reports.

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Penetration of the Liver-fluke, *Fasciola hepatica* into the Snail, *Limnaea truncatula*

The life-history of *Fasciola hepatica* has been recounted in nearly every text-book of zoology or of parasitology since it was elucidated by R. Leuckart (1881–82) and A. P. Thomas (1881–83). In spite of this and much original work by other investigators our knowledge of (*a*) the form which penetrates the snail host and (*b*) the manner of its penetration is misconceived. For example, in the modern account given by G. Lapage[1] it is stated that once a snail has been found, the miracidium "applies the papilla at its broadest, anterior end to the soft skin of the snail and, spinning by means of its cilia on its long axis, it drives the papilla into the snail and penetrates the snail's body". Other writers have introduced something between this sort of statement and the more correct idea, succinctly expressed by Faust[2], that penetration "is accomplished by the secretion of digestive enzymes elaborated in the so-called 'penetration glands' which discharge the secretion at the anterior end of the miracidium". It is difficult to prove that 'digestive secretions' are produced, or even to demonstrate the cytological effects produced by a penetrating larva which is smaller than some ciliated protozoa. It is here shown, for the first time by means of photomicrographs, that the miracidium creates a perforation in the snail's integument by the loosening, cytolysis and abstraction of epithelial cells, an action which appears to be chemical rather than mechanical and is probably the result of enzyme activity. It will be shown also that, because the miracidium loses its ciliated epithelium and is in other ways transformed before penetration is effected, it is an early sporocyst and not a miracidium which enters the snail.

The miracidia of *Fasciola hepatica* are not as efficient in locating and penetrating snail hosts as some studies of their tropistic behaviour lead us to suppose. In the immediate vicinity of a snail many larvæ swim to and fro without ever attacking, and many more encounter the snail but do not succeed in adhering to it, much less penetrating it. When contact is established, however, the miracidium butts the snail several times, and it is this action which has given the false impression that the rotating larva is boring like an auger into the snail when in fact is is merely trying to attach itself. Early adhesion is so light that no matter how carefully snails are fixed and prepared for sectioning, the larvae fall away. Attempts to adhere often fail and the larvæ swim away to try again elsewhere. After several unsuccessful attempts of this kind miracidia seem to be exhausted; their swimming movements become erratic and eventually they die. Some such moribund larvæ lose their ciliated epithelium, however, and undergo partial metamorphosis into ovoid young sporocysts. According to Mattes[3], the anterior and posterior 'Klebdrüsen' are concerned with adhesion. Careful study has not so far revealed these paired unicellular glands, although their large nuclei and their position beneath the first- and second-tier epithelial cells of the miracidium should make them conspicuous. Early attachment is more probably brought about by suctorial action of the anterior papilla which, by its introversion, presses the first-tier epithelial cells hard against the snail's integument, mucus assisting adhesion. Once attachment is established, retraction of the papilla would create a saucer-like space between the anterior nonciliated pit of the larva and the snail's integument, and this would serve for the reception of secretions of the gut and the unicellular pharyngeal glands. Not until marked cytolytic effects have been produced in the epitheium of the snail does the anterior papilla of the miracidium penetrate into this layer (Fig. 1, *A*1, *A*2).

Complete penetration of the larva into the snail takes only about 30 minutes from the time of adhesion. During this period the larva is a sac-like object which occasionally contracts and relaxes but which certainly does not rotate. At the end of the period, when failure to penetrate seems likely, the larva suddenly disappears into the snail. Sections indicate that about the middle of the period the anterior papilla is only slightly extended and is approaching the sub-epithelial tissues of the snail, amidst the debris of loosened and cytolysed epithelial cells (Fig. 1, *A*2).

As the larva presses into the cytolysing mass, some of these cells are heaped externally at the margin of the opening (Fig. 1, *A*1). At the same time, larval epithelial cells are becoming detached, although