Table 1. Measurements of six specimens of *Mayomyzon pieckoensis*. Abbreviations: *, complete fish; s-df, snout to start of dorsal fin; s-ml, snout to middle of eye.

Specimen	Character			
	Body length (cm)	Body depth (cm)	Length s-df (cm)	Length s-ml (cm)
	FMNH PF			
5687	4.8	0.6	3.2	0.6
5688	4.5	0.5	3.0	—
5539	6.1	0.7	3.5	0.6
	HTP			
1640	5.1*	0.6	3.3	0.7
5015	4.1*	0.5	2.5	0.5
980	3.3	0.5	—	—

plate and just in front of the anterior end of the piston.

The seven gill pouches appear as ellipsoids which begin below the otic capsule (*O.c*) and extend with a ventroposterior slope to the pericardial cartilage. In *Lampetra*, the first gill pouch lies posterior to the otic capsule. Each pouch (*G.p*) consists of a dorsal and ventral, dark, cup-shaped stain. The clear central region of each pouch probably represents the opening between pouch and pharyngobranchial duct. The gill basket skeleton is not preserved except for a pair of V-shaped ventral elements below the last gill pouch.

The position of the posterior part of the pericardial cartilage is indicated by the concave outline of the anterior end of the liver (*L*). A pair of vertically arranged fenestrae in the cartilage (*F.p.c*) are in line with the gill pouches, but lack their dark markings. In recent lampreys these fenestrae are more horizontally oriented.

Two organs within the coelomic cavity are seen. A dark triangular mass, twice as long as high, located behind the pericardial cartilage represents the liver. If the entire liver is preserved, it is shorter than in recent lampreys. The digestive tract (*D.t*) is a slender dark band extending from the posterodorsal end of the gill basket to the area below the dorsal fin. The connection between the digestive tract and the pharynx is not apparent. The expanded gill pouches probably forced collapse of the digestive tract in this area. We have found that this part of the tract does not appear in X-rays of recent lampreys.

Stensiö (*5*) has demonstrated that the lampreys are related to the Paleozoic ostracoderms (Osteostraci and Anaspida), but the question of which particular ostracoderm group is ancestral to them has been much debated by paleontologists. *Mayomyzon pieckoensis* indicates the following possibilities about lamprey evolution: (i) A basically modern lamprey had evolved by mid-Pennsylvanian time. (ii) The close similarity between the Pennsylvanian and recent lampreys implies a pre-Pennsylvanian origin and evolution of the group that may have extended to the middle or even early Paleozoic. If lampreys have always been as conservative in their evolution as *Mayomyzon pieckoensis* would indicate, support is given to Stensiö's view (*6*) that known cephalaspidomorph ostracoderms (Osteostraci, Anaspida, and petromyzontids) represent three lineages independently derived from a common ancestor. (iii) On the other hand, the lamprey ancestry may not have been too remote. Recent study of *Jaymoytius* from the Silurian of Scotland led Ritchie (*7*) to suggest that this vertebrate is derived from an anaspid stock which might have given rise to petromyzontids. *Jaymoytius* has cyclostome characters such as a subterminal, circular mouth and a branchial basket that begins behind the orbit; but *Jaymoytius* retains lateral fin folds, body scales, lacks a piston, and has 15 or more gill slits. The morphology of *Mayomyzon* provides no evidence for or against Ritchie's suggestion. (iv) As can be judged from the mosaic resemblance of *Mayomyzon* to late metamorphosing and adult lampreys, modern lampreys may have evolved neotenically from larval ostracoderms or preostracoderm fishes. (v) Specialized features of the lampreys, such as the hood and the piston (the latter already present in *Mayomyzon*), probably evolved with the development of their specific mode of feeding. (vi) *Mayomyzon* shows no evidence of hagfish characters. Thus lampreys and hagfishes apparently had a separate pre-Pennsylvanian ancestry, supporting Stensiö's opinion that the two types of living cyclostomes are independently derived from two distinct groups. This is in contrast to the view that the cyclostomes represent a single phyletic line (*6*). (vii) The presence of a well-developed piston implies the presence of a rasping tongue. Thus *Mayomyzon* may have been wholly or partially parasitic. We have, however, seen no evidence of suctorial damage to the bodies of vertebrates in the Francis Creek Shale fauna.

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Light Scattering in Central Arctic Ocean: Some Winter Profiles

Abstract. *Measurements for light scattering in an Arctic water column reveal strong gradients and variability of the order of 15 percent in depths of less than 500 meters. The region of variability appears to persist from day to day and is roughly associated with the typical hydrographic features of the region. No definite nephelocline was observed.*

Use of optical properties of seawater in tracing oceanic currents and differentiation of water mass, and in detecting biological and geological variations

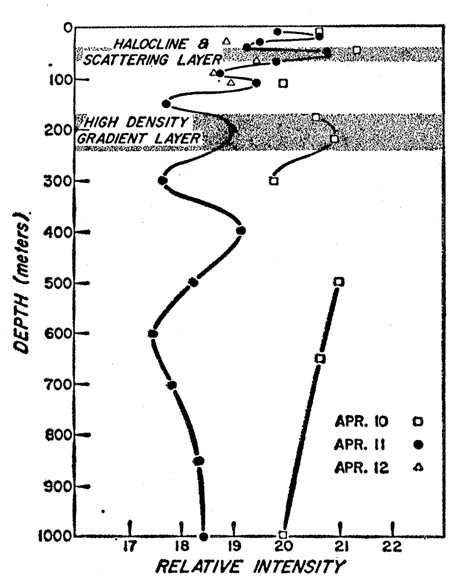

Fig. 1. Relative forward light scattering as a function of depth at the Arctic Ice Island T-3.

in the water column has been described by Jerlov (*1*). We explored the possibility of applying one optical technique, measurements of light scattering, to the study of variations in the water column in the Arctic Ocean.

The absence of significant air-sea interface makes the central Arctic region optically unique. The ice cover both delays the transfer of wind-blown terrigenous particles into the surface layers and prevents the mixing of these layers by wind wave generated turbulence. The general climatic conditions during the period of study (late winter) preclude recent river runoff as an effective source of scatterers, although it may be an important source over longer periods of time. The extent of the spring phytoplankton crop is also unknown. Since the intensity of optical scattering depends on the totality of particles present, its variation as a function of depth should then be related to the light level preferred by the phytoplankton, the type of terrigenous particles, the nature of the detritus, the density structure, and mixing caused by shear flow and nonlinear effects of internal waves.

The measurements of light scattering were made on the Ice Island T-3 (82°N 156°W) between 10 April and 12 April 1968, by the use of samples obtained with a plastic-lined sampling bottle. A small-angle scattering meter with a helium-neon laser as a source was used to obtain relative values with overall precision of about 1 percent, taking into account variations in output of the laser, fluctuations of the detector, and sampling error. Figure 1 shows the light scattered through 0.83° (in relative units) plotted against the depth in meters, with the general structure of the water column indicated schematically (*2*).

Most noticeable is the strong variability near the surface. Each day the curves repeat strong fluctuations near the surface. Less evidence of variability is seen below the thermocline. Neal observed similar fluctuations in temperature profiles, suggesting that the stratification in the nepheloid layers may be caused by density gradients rather than by preferential growth of the phytoplankton at depths associated with optimum levels of light.

A more thorough study of the hydrographic and optical properties of this region should provide useful data on the structure of the water column in the absence of wind waves. The stability of the platform (T-3) makes it ideally suited for the study of mixing caused by internal-wave and shear-generated turbulence.

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Mössbauer Investigation of Shocked and Unshocked Iron Meteorites and Fayalite

Abstract. *Mössbauer spectra of several iron meteorites have been measured by a resonant scattering technique rather than by the conventional transmission method, thereby eliminating the necessity for the preparation of thin samples. No significant differences were observed in the spectra of specimens of mechanically deformed, shocked, and unshocked iron meteorites, nor in the absorption spectra of artificially shocked and unshocked fayalite.*

The 14-kev gamma decay of the excited Fe^{57} nucleus exhibits a strong Mössbauer effect (*1*). The natural abundance of Fe^{57} (2.2 percent) makes many naturally occurring minerals that contain iron possible candidates for Mössbauer study. We here describe a nondestructive method for studying the Mössbauer spectra of iron meteorites or other iron-bearing metallic samples and the results of a Mössbauer investigation of single crystals of shocked and unshocked fayalite.

Meteorites may be divided into two general groups (*2*): (i) stony meteorites, which have about 25 percent elemental abundance of iron in various iron phases, and (ii) iron meteorites, which have about 90 percent iron, chiefly in iron-nickel alloys. Previous Mössbauer studies have been made on stony meteorites (*3, 4*). Sprenkel-Segel and Hanna (*3*) have shown that Mössbauer absorption spectra obtained from samples of powdered stony meteorites can be used to identify the iron-bearing phases present. However, there are no previous studies of the Mössbauer spectra from iron meteorites.

Table 1. Internal magnetic fields in meteorite samples and iron-nickel alloys.

Substance	Major elemental content (%) Fe	Ni	Internal field (ratio to pure Fe)
Bartlett meteorite	90.4	8.9*	1.03
Odessa meteorite	90.7	7.2*	1.03
Fe-Ni alloy	90	10	1.029†
Fe-Ni alloy	95	5	1.017†

* Determined by chemical analysis (*8*). † Determined from graph (*7*).

In the usual Mössbauer experiment, gamma-ray intensity transmitted through an absorber is measured as a function of the velocity of the gamma-ray source (*5*). Use of transmission geometry, however, requires that the absorber sample be rather thin (about 1 mil for metallic iron). Two advantages can be gained if the samples of iron meteorites do not have to be powdered or ground to thin dimensions: (i) there is a minimum consumption of the samples, and (ii) more can be learned about the natural properties of the meteorites, such as inherent magnetization, which may be changed by sample deformation during grinding or polishing.

In scattering geometry, the intensity of the radiation scattered by the sample is measured as a function of source velocity. At resonance, the Fe^{57} nuclei in the scatterer absorb the incident photons and are excited. They then decay, emitting radiation isotropically. Thus, at resonance, the detector shows a maximum intensity, in contrast to the transmission method, where resonance is indicated by a minimum. Scattering geometry does not place limitations on the thickness of the sample to be studied.

Spectra were obtained using a Mössbauer spectrometer with constant acceleration (Austin Science Associates, model K3 transducer, model S3 drive electronics) (*5*). The source was mounted on the armature of the velocity transducer, and its radiation was collimated by a graded shield. The radiation, scattered through an angle of about 90° by the sample, was detected by a proportional counter filled with krypton-methane gas. The source used for all spectra was a 2.5-mc (30 January 1968) source of Co^{57} diffused into a palladium foil. This source emitted Mössbauer radiation at a single resonant energy.

In the 14-kev decay of Fe^{57}, internal conversion occurs about nine times