# EXPERIMENTAL REPAIR OF COMMON DUCT DEFECTS UTILIZING A FREE VEIN GRAFT OVER BLAKEMORE-LORD TUBES *

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THE REPAIR OF COMMON DUCT DEFECTS and the treatment of stenosis of the common bile duct is an imposing surgical problem. Witness to this is the multitude of operative procedures which are employed today. Treatment of common duct stenosis is difficult in itself, becoming increasingly so when a defect of the duct must be bridged. Proportionally, the longer the defect which is present, the greater the difficulty in repair.

Eliot[1] in 1936 reviewed the various basic methods of repair of cicatrical strictures of the bile ducts which were in use from 1900 on. Many of the methods he discussed are still widely in use today. Two recent developments have contributed a substantial share of success in the treatment of these lesions. Pearse[2, 3] developed a vitallium tube for insertion in duct strictures to maintain patency. This method has been quite commonly used since his original publication in 1942. Cole et al[4] favor the modified hepaticojejunostomy with employment of the Roux loop and baffling of the intestinal wall, especially when a defect is present in the common duct. Pearse[3, ,5 6] in a report of 106 collected cases in which the vitallium tubes were used, makes note of the fact that each case in which the tube was used to bridge a gap in the duct resulted in failure. There were seven patients in the series in which this occurred. Pearse also states that the most desirable result is obtained only when and end-to-end anastomosis of the duct stumps can be carried out over a vitallium tube and the tube is left in situ indefinitely. Bettman,[7] Neibling and Walters,[11] and Cattell[12] have shown that biliary obstruction occasionally recurred with the use of the vitallium tube when it became plugged with deposit (bile encrustation), similar to that which occurred in rubber tubes which have been used for the same purpose.

Horsley, in discussing papers by Eliot[1] and Allen,[8] states that one of the earliest attempts in this country to reconstruct the common bile duct was performed by Sullivan in 1900 when he inserted a rubber tube into the hepatic duct and carried it into the duodenum. The indwelling tube was then surrounded with fat and neighboring tissue. Horsley, in 1918, inverted a segment of vein and sutured it into a defect which was made by resecting a portion of the common duct in dogs. He pointed out that the operation was successful from a technical standpoint, but after a few months the vein, being unaccustomed to irritation by bile, contracted and became completely obstructed.

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Dean Lewis, cited by Eliot,[1] related that experimental substitution of the wall of a vein, or other fascial structure, for the excised segment of duct invariably terminated in failure, and furthermore, that all plastic operations in which portions of adjacent hollow viscera were utilized for a similar purpose were unsuccessful and had been discontinued.

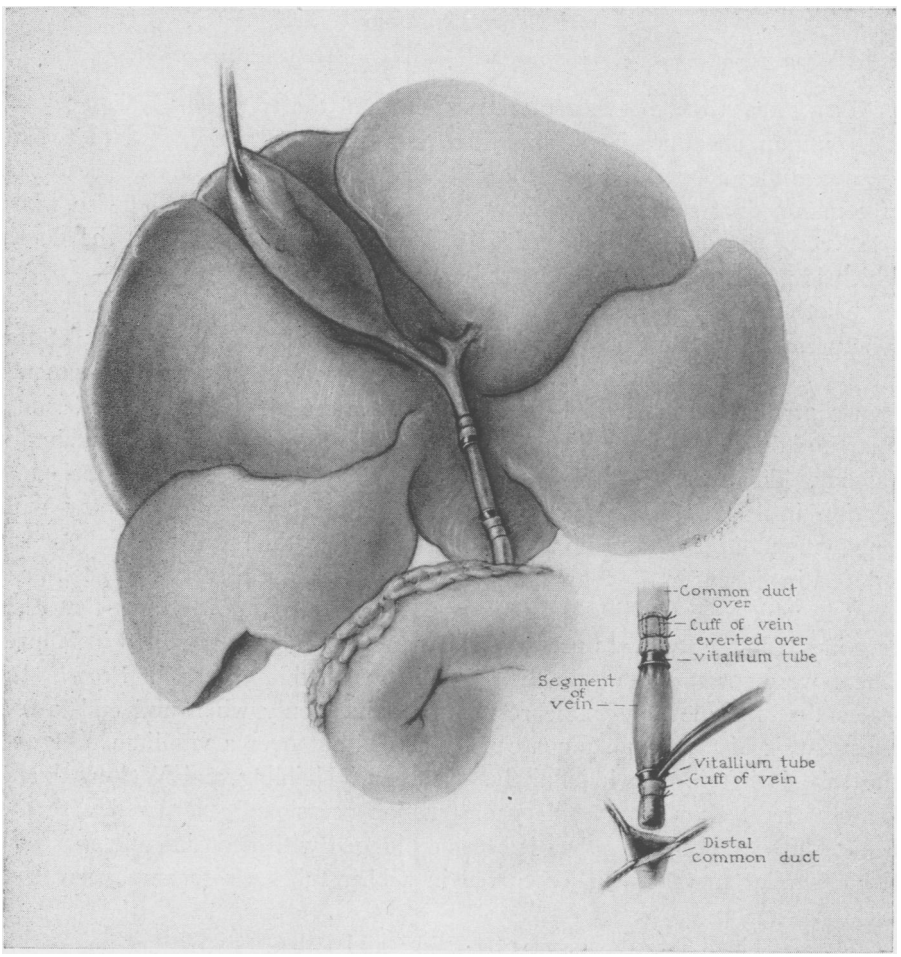


FIG. 1.—Experimental repair of defect of common duct in dogs, utilizing free vein graft and Vitallium tubes. Insert shows technic of implantation of vein graft in common duct.

Despite such adverse reports, however, Lord and Chenoweth[9] reported moderate success with the use of fascial and venous grafts over rigid vitallium tubes in the repair of common duct defects. In their experiments the fascial grafts proved most successful. They observed that the venous grafts developed a lining of biliary epithelium over the intima. Marked shrinkage in the length of their grafts occurred, however, and when the animals were sacrificed it was observed that none of the grafts was more than 3 mm. in length.

In the present experiments we are concerned with the repair of an artificially produced defect of the common duct in the dog. It would be ideal to use a pliable, non-irritant material or tissue which would be available in any length, and which would not be susceptible to necrosis or bile encrustation, and, preferably, one which necessitated the use of no suture material. It has been frequently shown that the presence of any of these factors is a definite detriment to the successful repair of a stenotic common duct or one in which a defect is present.

A non-suture method for anastomosis of blood vessels was described by Crile[13] in 1909. Hitchings, working in Crile's laboratory, devised a brass

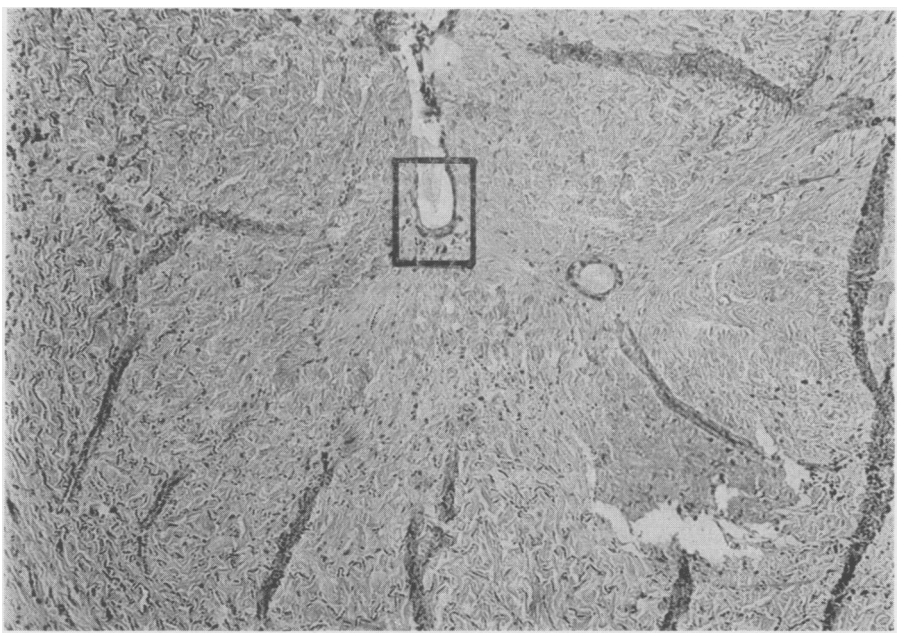

FIG. 2.—Photomicrograph (H & E stain). Free vein graft 88 days after implantation in common duct. There has been partial autolysis of biliary tract epithelium, but low columnar cells are evident in the outlined portion. Van Gieson stain shows the presence of normal elastic fibers. Trichrome stain reveals a normal amount of connective tissue. Cellular infiltration is absent.

cannula over which a vein was cuffed for insertion into an artery for direct transfusion of blood. Shortly after Blakemore and Lord[10] described in detail a non-suture technic for bridging arterial defects, employing special vitallium tubes of their own design, along with a free vein segment, it occurred to us that a defect in the common duct could be similarly bridged.

In contemplation of the problem we were well aware that difficulties such as Horsley encountered might occur. It was noted, however, that in employing this type of graft, no injury to duct epithelium or vein intima from the use of suture material would result, and therefore there would be less predilection to stenosis. Rather than invert the vein, we felt that the endothelium of the

intima would withstand the irritation of bile far better than the adventitia, whose fibroblasts react more quickly to irritation. At the onset, it was also appreciated that several events might occur: first and most important, immediate necrosis and rupture of the vein graft might occur as a result of inadequate blood supply and irritation by bile; second, obstruction might result from edema of the vein wall or encrustation with bile salts; and third, fibrosis and ultimate stenosis might occur from irritation over a long period.

In its favor, however, the employment of the free vein graft over Blakemore-Lord tubes theoretically gave us an agent for bridging a gap in the common

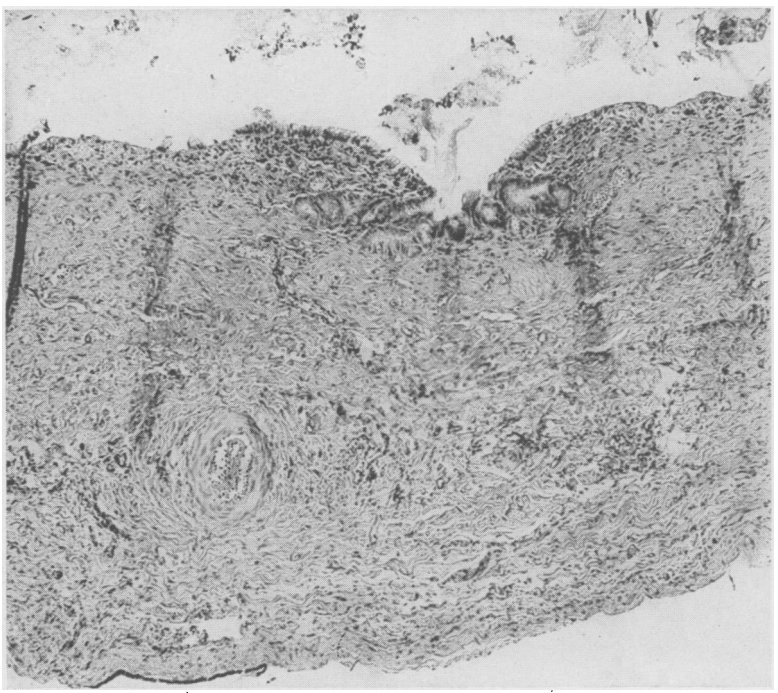

FIG. 3.—Photomicrograph (H & E stain). Bridging channel after free vein graft implantation of 114 days duration. H & E and PTAH stains show biliary tract epithelium lining the lumen. Van Gieson stain reveals the presence of elastic fibers and trichrome stain shows normal connective tissue. Cellular infiltration is absent.

duct which would obviate the use of suture material in the epithelial lining and which presented a medium of adequate length. Also, for all intents and purposes, it is a non-rigid system and one in which a common duct defect can be bridged and still retain the physiologic usefulness of the sphincter of Oddi. This is exceedingly important since ascending cholangitis is such a frequent complication of other types of repair.

We postulated also that there would be epithelialization of the intima of the vein segment with biliary tract epithelium, as reported by Lord and Chenoweth.[9] It was supposed that blood supply to the graft could only be

supplied by vascularization of connective tissue where the graft was interposed in the common duct and the ligature applied, and also from peritonization of the graft and surrounding area.

## METHOD

Mongrel dogs weighing 14 to 16 kg. were anesthetized with intravenous Nembutal, 1 cc. per 5 pounds of body weight. An intratracheal tube was introduced and intermittent positive pressure controlled respiration was

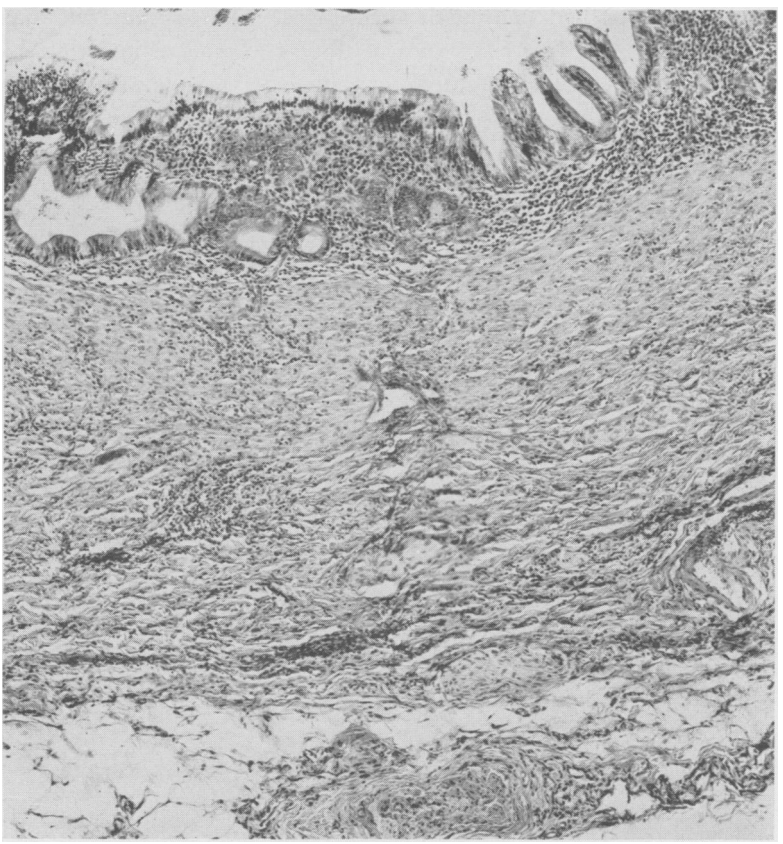

FIG. 4.—Photomicrograph (H & E stain). Bridging channel after free vein graft implantation of 208 days duration. This section, histologically, approaches the appearance of normal common duct seen in Figure 5.

maintained. Using aseptic precautions, a longitudinal incision was made in the left thigh from the knee to the inguinal fold over the femoral vein. The vein was dissected free from the surrounding tissue. All venous tributaries were ligated close to the wall of the vein with 4-0 Deknatel. In each experiment, a segment of vein 5 cm. in length or longer, depending upon the size of the animal, was utilized. Each end was ligated with 3-0 Deknatel and the vein segment excised. The vein segment was then cuffed over 3 mm. vitallium tubes after the method described by Blakemore and Lord[10] in the repair of

arterial injuries. The vein was secured to the tubes with 4-0 Deknatel and the prepared segment was irrigated with physiologic saline to determine its patency and placed in physiologic saline at room temperature. The thigh incision was closed in layers and continuous No. 38 stainless steel wire was used to approximate the skin edges.

A curved transverse incision was utilized to expose the right 9th rib, which was resected along with its cartilage. The thorax was entered through the rib bed and the diaphragm opened in the direction of its fibers. The intestines and stomach were packed away with moist tapes. The common bile duct was identified and mobilized for a distance of three to four cm. in its most distal portion. Two 3-0 Deknatel ligatures were then passed beneath the common

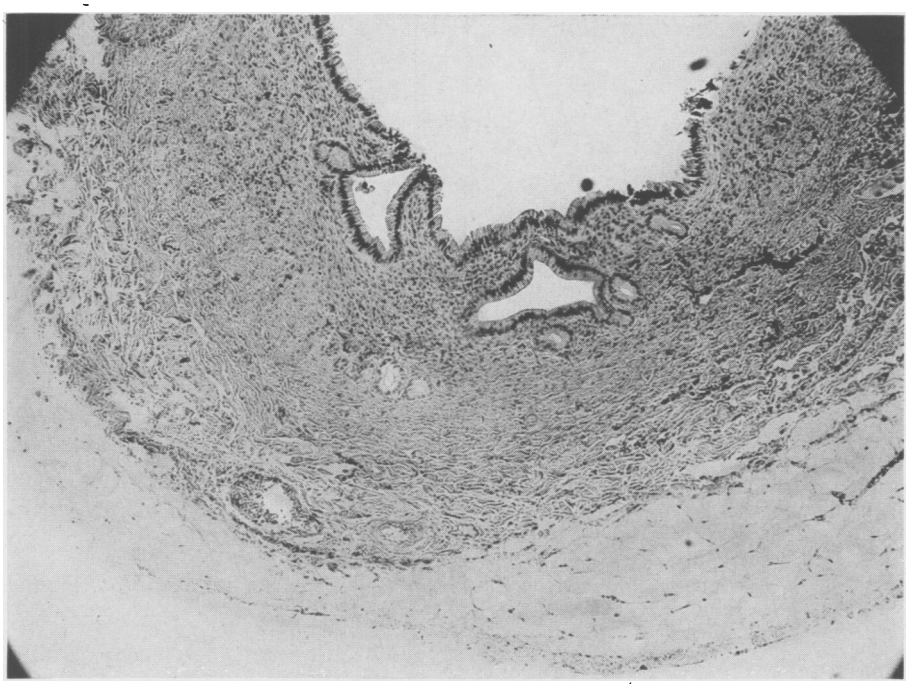

FIG. 5.—Photomicrograph (H & E stain). Histologic appearance of normal common duct of dog.

duct and the duct was then transected about 1.5 cm. for the duodenum, and with retraction of the duct ends, a defect 2 to 2.5 cm. in length was produced. The retracted ends of the duct were grasped with mosquito hemostats and triangulated. A curved hemostat was used to hold the free flange of the Blakemore-Lord tube, and the graft was introduced into the proximal end of the duct and secured with the previously placed ligature. An additional ligature was then placed proximally for security. A similar procedure was carried out in inserting and securing the graft in the distal portion of the duct (Fig. 1). In all instances a free flow of bile was observed at the distal end of the graft

before inserting it into the distal portion of the common duct. No attempt was made to bring omentum over the graft or to peritonize the operative site. The diaphragm was repaired with interrupted 3-0 Deknatel sutures and 100,000 units of penicillin were instilled into the pleural cavity after the partially collapsed lung was re-expanded. The skin was closed with continuous No. 38 stainless steel wire suture which was left in situ throughout the experimental period.

This particular operative approach was found to result in the most satisfactory exposure of the extrahepatic biliary system in the dog. The common duct of dogs of this weight is 3 mm. or less in diameter. In our total series there were no operative deaths.

It must be noted that in our earliest procedures we observed that a short segment of vein retracted in such a fashion as to cause over-riding of the

TABLE I.—*Experimental Data*

| No. of Dogs | Experimental Period (Days) | Patent Grafts | Ruptured Grafts | Visible Graft with Obstruction |
|---|---|---|---|---|
| 9 | 5-26 | 6 | 2 | 1 (a) |
| 5 | 34-57 | 3 (b) | 0 | 2 (c) |
| 2 (d) | 68-88 | 1 | 0 | 1 |
| 4 | 104-114 | 4 | 0 | 0 |
| 1 | 208 | 1 | 0 | 0 |
| Total 21 | | 15 | 2 | 4 |

(a) In one animal there was partial obstruction, although bile could be expressed through the system from the gallbladder with gentle pressure.

(b) One animal sacrificed at 56 days, another at 57 days. Vein graft was unidentifiable but patent channel was present and bile flowed freely into the duodenum.

(c) One animal was normal until 36 days after operation when jaundice appeared. At autopsy, seven days later, the vein graft was obstructed due to swelling at the proximal tube, but had remained elastic and viable.

(d) Both vein grafts were intact, viable and elastic. One animal became jaundiced and at autopsy dilatation of the common duct proximal to the graft was observed, due to swelling of the graft within the proximal tube.

flanges of the vitallium tubes and a resulting mechanical biliary obstruction. To obviate this, tubes with smaller flanges were used with success. With larger defects to bridge, and with the utilization of longer vein segments, this complication was absent.

## RESULTS

Twenty-one dogs comprise this series and in each a vein graft over Blakemore-Lord vitallium tubes was used to repair a defect of the common duct. Autopsy was performed on all the animals at death or when sacrificed at the end of the experimental period. In each case the extrahepatic duct with the graft in situ was tested for patency by gently perfusing the common duct proximal to the graft with physiologic saline and observing whether the perfusion fluid flowed readily from the ampulla of Vater. At autopsy it was noted that in all dogs that had survived an experimental period of 10 days or more, the previously denuded site of operation and the graft itself were completely covered by peritoneum.

The results are grouped in Table I, according to the experimental period in which the graft was in situ.

In the total series, there were four animals which we considered failures. Early in the series two animals developed absolute biliary obstruction due to swelling of the vein graft within the proximal vitallium tube which in these instances was of 2 mm. size. One dog died as a result of necrosis and rupture of the graft when one vitallium tube became kinked upon the other. The fourth animal developed necrosis and rupture of the graft, along with acute suppurative peritonitis, concomitant with distemper.

We can only consider the result as equivocal in three of the animals. In two instances death occurred as a result of severe distemper on the 16th and 22nd postoperative days, respectively, and it was felt that this experimental period was inadequate. We did observe, however, that these two animals had patent and viable vein grafts, although one showed slight dilatation of the proximal biliary tract. Bile expressed from the gall bladder, however, flowed freely from the ampulla of Vater. A third animal survived 88 days; on the

TABLE II.—*Experimental Results*

| No. of Dogs | Excellent | Equivocal | Failures | Per Cent |
|---|---|---|---|---|
| 21 | 14 | | | 66.7 |
| | | 3 | | 14.3 |
| | | | 4 | 19.0 |

68th postoperative day this animal developed severe distemper followed by profound jaundice. At autopsy there was severe swelling and obstruction of the graft at the proximal vitallium tube.

Fourteen animals lived 10 to 208 days before being sacrificed. In each, at autopsy, there was a patent channel between hepatic ducts and duodenum.

Nine of these 14 animals still utilized the original free vein graft (Fig. 2). The remaining five animals developed a patent, pliable channel lined with biliary epithelium. The vein segment, in the meantime, had lost its identity and contiguity in the fibrous growth. (Figs. 3, 4.)

## SUMMARY

A series of 21 animals is presented (Table II) in which a common duct defect was repaired with a free vein graft over Blakemore-Lord tubes. In 14, or 66.7 per cent, of these animals, the resulting bridging channels remained functionally patent and a free flow of bile was maintained. Three, 14.3 per cent, developed severe distemper and the experimental period was considered inadequate, although the vein graft remained viable and elastic. Four, 19 per cent, were described as failures and a discussion of each is presented.

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## REFERENCES

[1] Eliot, E., Jr.: Ann. Surg., **194**: 668-701, 1936.

[2] Pearse, H. E.: Ann. Surg., **115**: 1031-1042, 1942.

[3] Pearse, H. E.: Surgery, **10:** 37-44, 1941.
[4] Cole, W. H., C. Ireneus, Jr., and J. T. Reynolds. Ann. Surg., **122:** 490-521, 1945.
[5] Pearse, H. E.: Ann. Surg., **124:** 1020-1029, 1946.
[6] ———: Connecticut State M. J., **9:** 507-710, 1945.
[7] Bettman, R. B., and W. J. Tannenbaum: J.A.M.A., **129:** 1165, 1166, 1945.
[8] Allen, A. W.: Ann. Surg., **121:** 412-424, 1945.
[9] Lord, J. W., and A. I. Chenoweth: Arch. Surg.:**46**, 245-252, 1943.
[10] Blakemore, A. H., and J. W. Lord: Ann. Surg., **121:** 435-453, 1945.
[11] Neibling, H. A. and W. Walters: Proc. Staff Meet. Mayo Clinic, **22:** 424-432, 1947.
[12] Cattell, R. B.: Lahey Clin. Bull., **4:** 98-102, 1945.
[13] Crile, G. W.: Hemorrhage and Transfusion. New York, Appleton and Co., 1909.