form of a horizontal bony plate and a thinning of the tissue below it, indicating the future upper joint cavity (Fig. 3). Further differentiation proceeds in an anterior direction to reach, at the 72 mm stage, the level of the condyle (Fig. 4). As both blastemata keep growing in opposite directions, the joint is fully formed at the 190 mm stage (Fig. 5).

Full differentiation of all articular elements by the fourth fetal month is an amazing fact which, however, is in keeping with the general embryogenetic law that at this stage all vital organs have been formed. The temporomandibular joint, according to its early histodifferentiation, would appear to be a vital organ. The condylar cartilage represents a specific growth center which develops independently from the skeletal cartilage primordium which gives rise to epiphyseal plates and basicranial synchondroses.

L. J. BAUME

Institute of Dental Medicine, University of Geneva, Geneva, Switzerland

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Muscle Action Potentials: A Technique for Recording in situ

Abstract. Heart tissue in situ has been immobilized with a negative pressure device, and transmembrane potentials of one cell have been observed for more than 30 minutes.

The action potential of a contractile tissue begins before the associated mechanical event. This circumstance enables an investigator to use capillary microelectrodes to record and observe a portion of the transmembrane action potential. Continuous observation is often hindered after the onset of the mechanical event when the electrode begins to slip out of the cell, loses its tip, or tears the cell membrane. The impalement procedure must then be repeated.

Better records can be obtained by inhibiting tissue motion (*1*) or by permitting the electrode to move with the cell (*2*). A local area of the surface of cardiac muscle has been immobilized

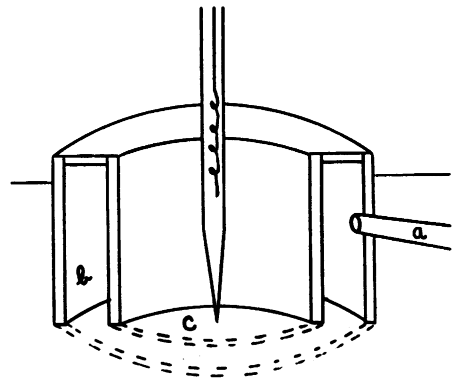

Fig. 1. Negative pressure holding device.

by a negative air pressure device, which restrains the tissue so that a standard microelectrode can then be maintained within a cell for more than 30 minutes. In the ring-shaped device, shown in Fig. 1, the central area *c* is open for penetration of a microelectrode from above. The holding ability varies directly with the total grasping area and with the degree of negative pressure introduced into the volume (*b*). The glass tube (*a*) is both the mechanical support and the negative pressure line. The diameter of the central area should be kept as small as possible. For the frog heart, a central diameter of less than 2 mm and a negative pressure of less than 10 cm of water was used.

A laboratory vacuum line was the source of negative pressure. A large capacity bleeder valve determined the degree of negative pressure developed at the tissue holder. The line between the bleeder valve and the holder was monitored by a water manometer. After preliminary adjustment of the pressure, the exhaust line was temporarily clamped shut while the device was brought firmly into contact with the heart, at which moment the line was opened. Intermittent grasping was reflected by movements of the water level of the manometer during the cardiac contraction cycle. The glass microelectrode was held in a Pfeiffer manipulator.

Figure 2 (*a* and *b*) shows the intracellular potentials recorded in situ from a ventricle of *Rana pipiens*. The reference electrode, a chlorided silver wire, was placed in the lower abdominal cavity. The dip in the base line between action potentials, usually present during recordings in situ, represents the effect of volume conductor currents on the reference electrode (*2*). At the end of 45 minutes, the action potential amplitude and duration have decreased, and the heart rate has become slower.

The negative pressure technique was used for transmembrane recordings from the heart of *Limulus polyphemus*, in situ. The upper trace of Fig. 2*c* is the microelectrode recording. The lower trace represents the motion of an adjoining area of heart. The motion transducer was a piezoelectric device loaded by the 1000 megohm input of a preamplifier (Bioelectronics). The time constant was greater than 5 seconds. Transient electrical activity began before muscle movement. The fast rising small waves are not motion artifact. Surface recordings made with a string galvanometer and liquid electrodes exhibit similar contours and the expected reverse polarity (*3*). Garrey has presented reasons for considering the small potentials to be biogenic and McCann agrees that these are bioelectric potentials (*4*).

The immobilizing devices were made of plastic tubing. For best results, the tissue holder dimensions should be appropriate for the particular type of

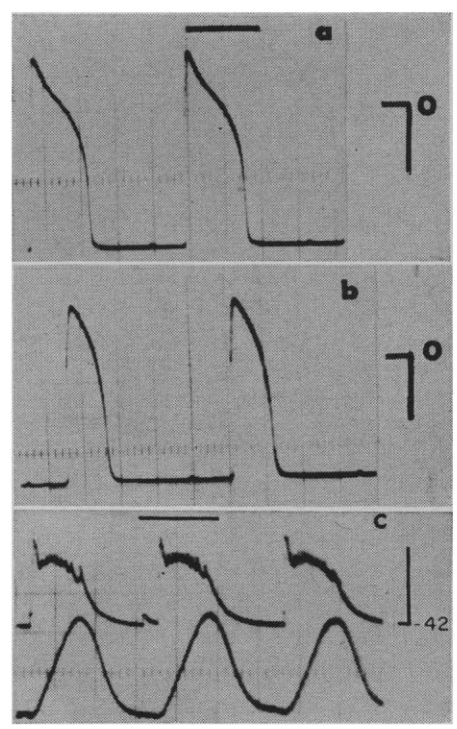

Fig. 2. In situ recordings: *a*, potentials from frog ventricle 5 minutes after impalement; *b*, 45 minutes after impalement; *c*, upper trace, transmembrane potentials from the heart of *Limulus polyphemus*; *c*, lower trace, motion of the cardiac surface. Calibration: *a* and *b*: vertical, 40 mv, horizontal, 1 sec; *c*: vertical, 20 mv, horizontal, 1 sec.

muscle to be studied. This device may also prove useful for local topical application or injection of small amounts of solutions into a cell by means of a micropipet.

JULIUS SCHAINBAUM*

Department of Pharmacology and Toxicology, Dartmouth Medical School, Hanover, New Hampshire

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* Present address: Institute of Neurological Sciences, School of Medicine, University of Pennsylvania, Philadelphia.

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Early Postglacial Beavers in Southeastern New England

Abstract. Wood cut by *Castor canadensis*(?) has been found at or near the base of five peat deposits studied in open exposure. Beavers apparently entered the region about 12,000 years ago and rapidly occupied most low-lying places. Many existing bogs may be the result of early dams. The disturbance of pond sediments by beavers probably affects pollen stratigraphy. Charred wood in early beaver structures indicates forest fires and the possibility that the climate was drier than it is today.

Beaver-cut wood is turning up with surprising regularity in the basal or lower parts of peat deposits in southeastern New England. I have examined five deposits in open exposure in recent years and all were rich in beaver-gnawed wood at or near the base of the postglacial organic sediments. These exposures have afforded a rare opportunity to examine the coarser features of peat deposits that are not seen in the usual method of study, by coring. Because of the scarcity of peat bodies exposed in cross section, the importance of beaver activity in the lower parts of peat deposits has been overlooked by palynologists and students of postglacial organic sedimentation. Three of the exposures that I examined were along the shore and were produced by marine erosion; two were in man-made excavations.

The characteristic signs of beaver are faceted and teeth-marked ends of logs, branches, and twigs; logs from which the small side branchlets have been neatly trimmed; and the absence of bark from many pieces of wood. At first glance the faceted ends and neatly severed branchlets resemble the work of a hatchet. Indeed, I am indebted to Douglas Byers, of the Robert S. Peabody Foundation for Archeology, Phillips Andover Academy, Andover, Massachusetts, who first pointed out to me the marks of the beavers' incisors on the cut surfaces and thereby prevented me from making an erroneous deduction as to the origin of the faceting. These teeth marks are generally delicate and show up only if the surface is washed and cleaned of peat adhering to it and viewed in raking light. In all five peat deposits that were studied, well over 50 percent of the wood found in the lower part of the peat showed signs of beaver work.

Squibnocket bog, on Martha's Vineyard, Massachusetts, is exposed in the upper part of the sea cliff at Squibnocket Point, on the southwestern part of the island, a few miles southeast of Gay Head. At this point the cliff is about 35 feet high and the bog is exposed for about 125 feet along the cliff, attaining a maximum thickness of 10 feet. The organic sediments rest on very compact till. The sediments are divisible into the following units, from the base up: (i) diatomaceous gyttja, 5 inches; (ii) brown fibrous peat with beaver-cut wood in the lower part, 48 inches maximum; (iii) black gyttja, 16 inches maximum; (iv) dark-brown fibrous peat, 40 inches maximum; (v) windblown sand, up to about 24 inches maximum. The pollen stratigraphy of this exposure has been studied independently by Gail A. Boyan and by J. Gordon Ogden III, but their findings have not yet been published. Leaves of small arctic-type willows and the cones of black(?) spruce occur in the lower part of unit ii. The pollen of unit i is predominantly nonarboreal.

The beaver-cut wood consists mostly of saplings lying parallel to the beds and flattened to various degrees. It forms a dense mat of interlaced branches about 30 inches thick at the western end of the exposure. This probably represents a collapsed beaver lodge rather than a dam, for the topography of the site suggests that most of the bog, and the original beaver dam with it, has long since gone out to sea because of cliff erosion. An age determination of 11,650 ± 250 years for one beaver-cut pine sampling (*1*) was made by the radiocarbon method (*2*). A determination of 12,700 ± 300 years was made for a thin sample from the base of unit i (*3*). It is interesting to note that some logs in the beaver structure are partly charred, undoubtedly as a result of forest fires.

The hurricanes of 1954 exposed a small bog in a low sea cliff on the east coast of Block Island, Rhode Island. The bog is about 0.4 mile south of The Harbor, at the place where the road takes a sharp turn and skirts the shore for a few hundred feet. The peat rests on light-gray silt with cobbles, possibly a postglacial solifluction deposit. From the bottom upward the bog contains (i) brown woody fibrous peat with logs, 10 inches; (ii) brown gyttja, 21 inches; (iii) reddish-brown gyttja with wood, 12 inches; (iv) black gyttja, 5 inches; (v) interlaminated fine sand and organic silt, 16 inches; (vi) brown sandy loam (buried soil), 17 inches; and (vii) windblown very fine sand, 12 inches. An age determination of 12,090 ± 200 years for small twigs from the base of unit i was made by the radiocarbon method (*4*).

In 1954, when I first studied this exposure, I was not aware of the beaver-wood problem and made no attempt to withdraw wood from the peat with sufficient care to preserve the ends. I returned to the site in 1960 to check the wood, with this problem in mind, and found that in the interim most of the exposure had been covered by large stone riprap. However, several pieces of wood were extracted from a small patch of the basal layer that was still uncovered by stone, and these showed beaver cutting. It is quite possible, therefore, that most of the wood in the lower part of this peat deposit is the result of beaver activity.

A small patch of peat was discovered by J. P. Schafer at intertidal level at the western end of the beach fronting Breakwater Village, a settlement of small summer cottages one-fourth mile west of Point Judith, Rhode Island. I examined the deposit and found beaver-cut wood embedded in brown gyttja overlying a thin, gray, medium-coarse sand. This in turn overlies compact, stratified dark-gray till (*5*). Several small spruce cones were found in the brown gyttja, along with the beaver-cut wood. This is a freshwater deposit formed when sea level was lower than it is at present. The small patch of peat is probably the remnant of a once larger and thicker deposit. This deposit has not been investigated further, but because of the close agreement of the brown gyttja and the beaver-cut wood with the gyttja and wood of other deposits that have been dated, and be-