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## CONGESTIVE CARDIOMYOPATHY IN THE WOODCHUCK, *MARMOTA MONAX*

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**ABSTRACT:** Congestive cardiomyopathy was diagnosed during post mortem examination in eight of 149 adult woodchucks from New York. The eight woodchucks, four males and four females, died spontaneously without clinical signs of heart failure having been detected. The primary lesion was a grossly enlarged and dilated heart. Histologic lesions consisted of multifocal myocardial degeneration and necrosis. Secondary lesions of congestive heart failure were observed.

### INTRODUCTION

Idiopathic cardiomyopathy, a primary disease of the myocardium of unknown cause (Goodwin, 1970; Goodwin and Oakley, 1972; Roberts and Ferrans, 1974, 1975; Factor and Sonnenblick, 1985) has been described in humans (Fowler, 1964; Goodwin, 1970; Roberts and Ferrans 1975), dogs (Liu et al., 1979; VanVleet et al., 1981), cats (Liu, 1970; Liu et al., 1970; Tilley et al., 1977), and turkeys (Noren et al., 1974).

The woodchuck, *Marmota monax*, has become an increasingly important laboratory animal (Snyder and Ratcliffe, 1969; Young and Sims, 1979; Snyder, 1985), especially for the study of liver disease (Summers et al., 1978; Summers, 1981). It has been suggested also (Snyder and Ratcliffe, 1969) that the woodchuck be used to study cardiovascular disease. This communication reports the natural occurrence of congestive cardiomyopathy in the woodchuck, a condition not described previously in this species.

### MATERIALS AND METHODS

One hundred forty-nine woodchucks, 1 yr old or greater, from the woodchuck colonies of

Cornell University were used to study the spontaneously occurring diseases of the woodchuck. Seventy-one were males and 78 were females. They were submitted for necropsy between July 1981 and August 1983. They had been in captivity between 1 day and 6 yr. In July 1981 there were 73 adult woodchucks in the woodchuck colonies. Thirty-one pups born in captivity in 1981 and 29 pups born in captivity in 1982 were added to the colonies. During this time 430 woodchucks trapped in Tompkins County and the surrounding counties of central New York state contributed to the population of the colonies. Following capture, woodchucks were transferred to facilities at Cornell University where they were anesthetized by intramuscular injections of xylazine hydrochloride (Rompun<sup>®</sup>, Haver-Lockhart, Bayvet Division, Miles Laboratories, Inc., Shawnee, Kansas 66201, USA) and ketamine hydrochloride (Ketaset<sup>®</sup>, Bristol Laboratories, Division of Bristol-Meyers Co., Syracuse, New York 13201, USA) and given a general physical examination. Their ages were estimated based on previously described criteria (Young and Simms, 1979). All woodchucks were maintained in wire cages with enclosed wooden nest boxes supplied with wood shavings and/or straw nesting and bedding material. They were fed pelleted rabbit chow (Big Red Rabbit Chow, Agway, Inc., Syracuse, New York 13201, USA) and tap water ad libitum.

Two of the 149 woodchucks were born in captivity and 147 were trapped in the wild. Eighty-seven woodchucks died spontaneously. Forty-seven woodchucks were euthanized because of obvious clinical disease or lesions. Fifteen apparently normal healthy woodchucks were euthanized.

Complete necropsies were performed on 149 woodchucks using standard techniques (King et al., 1979). Body weights and weights of major organs (liver and opened gall bladder, left kid-

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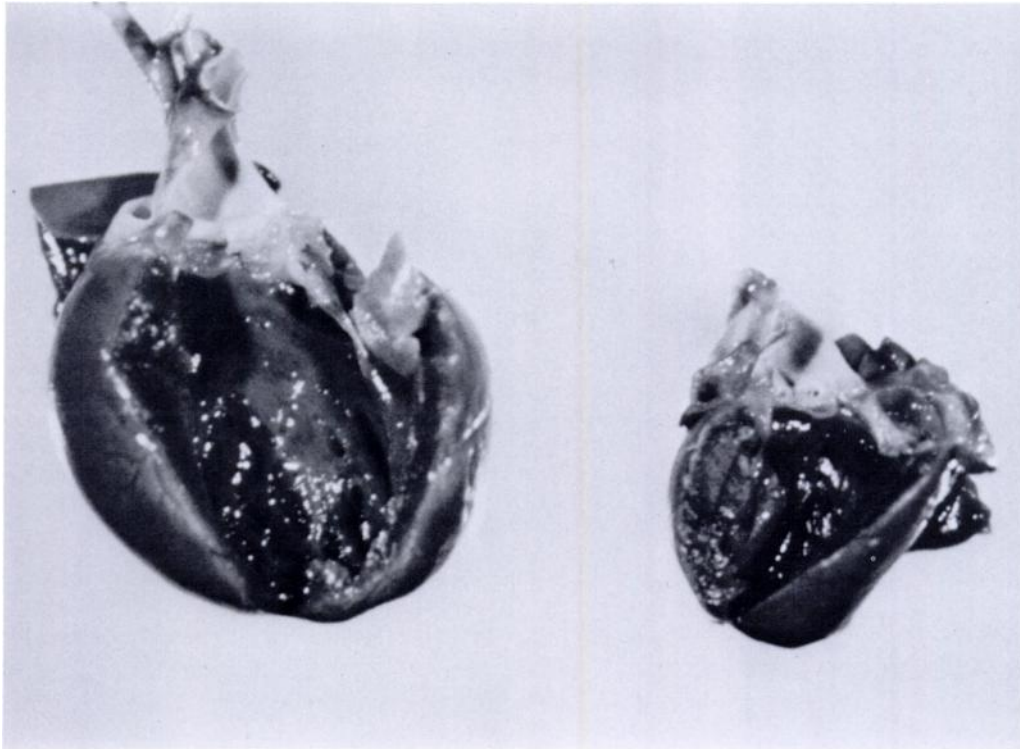


FIGURE 1. Heart from a woodchuck with cardiomyopathy (left) compared to a heart from a normal woodchuck of similar body weight (right). The affected heart is enlarged, having dilated ventricles (the left ventricle is opened) and weighed 34 g. The normal heart weighed 12 g.

ney, right kidney, spleen, and heart) were recorded. Hearts were weighed after the chambers had been opened and residual blood was removed. Sections of tissue from 128 woodchucks were fixed in 10% neutral buffered formalin, embedded in paraffin, sectioned at 4–6  $\mu\text{m}$ , and stained with hematoxylin and eosin for light microscopic examination. Liver, kidney, lung, heart, tongue, adrenal, pancreas, spleen, and brain were examined histologically in 126 woodchucks. In two of the 128 woodchucks only the liver was examined histologically. Skeletal muscle was examined histologically in 40 woodchucks. Other tissues were examined histologically only if a lesion was grossly evident.

### RESULTS

Congestive cardiomyopathy was diagnosed at necropsy in eight of the 149 adult woodchucks. There was no sex predilection. Four affected animals were male and four were female. Six of the affected

woodchucks had been born in the wild. Two had been born in the laboratory. These woodchucks had been maintained in the laboratory for a variable period of time ranging from 2 wk to 6.5 yr. Clinical signs such as lethargy or dyspnea were not observed prior to death. All affected woodchucks died spontaneously. The primary lesion was a grossly enlarged and dilated heart (Fig. 1). The range of heart weights of the eight affected woodchucks was 25.7–41.1 g. The average weight was  $32.3 \pm 5.4$  g. The average heart weight in 25 adult woodchucks free of heart disease was  $11.6 \pm 2.8$  g. There was no correlation between heart weight and body weight ( $r = 0.11$ ). Six of the eight affected hearts had histologic lesions of focal myocardial degeneration characterized by fragmentation and mineralization of myo-

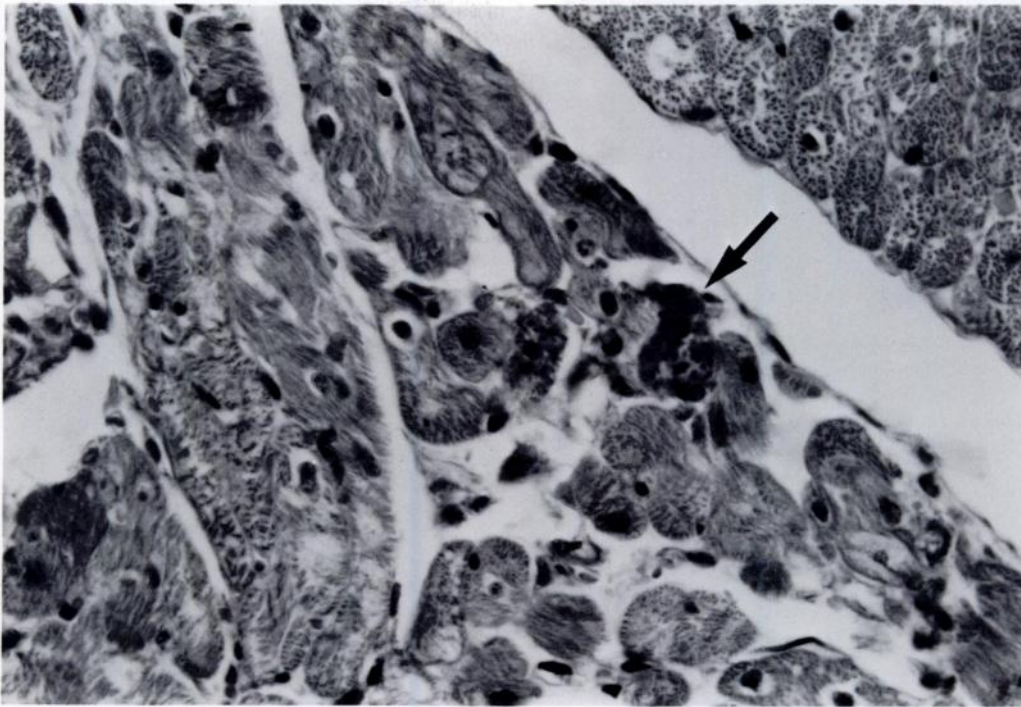


FIGURE 2. Focus of myocardial fiber mineralization (arrow) in a woodchuck. H&E stain.  $\times 630$ .

cardiac fibers. In some foci there was myocardial fibrosis characterized by loss of myocardial fibers with connective tissue replacement. The fibrosis was considered a later stage in the development of the lesion. Both degeneration and fibrosis were observed in four of the six hearts with histologic lesions. Only foci of degeneration were observed in one heart and only areas of fibrosis were observed in one heart (Fig. 2). No histologic lesions were observed in the hearts of the other two woodchucks. These woodchucks had other lesions of heart failure including subcutaneous edema, ascites, and passive congestion of the liver and lung. One woodchuck had developed collateral circulation of mesenteric vessels to the vena cava to attempt to bypass a severely and chronically congested liver.

The cardiac lesions observed in the 149 woodchucks are summarized in Table 1. Forty of the 149 woodchucks had cardiac

lesions. Two unrelated lesions were not observed in the same heart. Cardiac tamponade occurred in six woodchucks as a result of recent heart puncture. Ten other woodchucks had scars or epicarditis related to heart puncture some time in the past. Cardiac lesions of capture myopathy when present were always associated with degenerative lesions in the skeletal muscles. Cardiac lesions in these woodchucks consisted of multifocal degeneration. There was no cardiac enlargement. Three additional cases of capture myopathy only involved skeletal muscle. Vegetative endocarditis, observed in one woodchuck, was associated with repeated intravenous blood sample collection. The etiology of one case of nonsuppurative multifocal myocarditis was not determined. Myocardial thinning was considered a congenital defect of no significance. Consistently located in the free right ventricular wall near its attachment to the intraventricular septum, it was

TABLE 1. Heart conditions in 149 adult woodchucks from New York.

Condition	Number affected
Cardiomyopathy	8
Capture myopathy	4
Cardiac tamponade	6
Vegetative endocarditis	1
Myocarditis	1
Scar/epicarditis	10
Myocardial thinning	4
Non-patent subaortic septal defect	1
Granuloma, parasitic, <i>Baylisascaris</i> sp.	3
Granuloma, parasitic, <i>Taenia mustelae</i>	1
Sarcocystosis	1

a triangular shaped focus, devoid of muscle. Histologically, there was a gradual reduction in the number of muscle bundles forming the ventricle wall until the epicardial and endocardial layers were adjacent to each other. This lesion, epicardial scarring, and the other cardiac lesions not described here in detail, were considered to be incidental findings.

#### DISCUSSION

This report is the first to describe congestive cardiomyopathy in the woodchuck. In other surveys of diseases in this species (Snyder and Ratcliffe, 1969; Young and Sims, 1979; Snyder, 1985) this condition was not recognized.

Congestive cardiomyopathy is a sporadic disease of mature woodchucks, affecting animals in this series that were 1 yr old or greater. In humans (Roberts and Ferrans, 1974), cats (Tilley et al., 1977), and dogs (VanVleet et al., 1981) congestive cardiomyopathy is primarily a disease of young mature individuals and although the very young are less frequently affected, they may be affected soon after birth.

Only the congestive form of cardiomyopathy was observed in the woodchuck. Congestive and hypertrophic cardiomyopathy have been described in dogs (Liu

et al., 1979; VanVleet et al., 1981) and cats (Tilley et al., 1977). These two forms of cardiomyopathy have been described in humans (Roberts and Ferrans, 1974; Olsen, 1979; Goodwin, 1981; Factor and Sonnenblick, 1985). A third type of the disease, constrictive or obstructive cardiomyopathy, has been described also by some authors (Goodwin, 1970; Goodwin and Oakley, 1972).

Thorough daily clinical examination of the laboratory woodchuck is difficult and subtle alterations of behavior and attitude are often undetected. All eight woodchucks in this series that had lesions of congestive cardiomyopathy and heart failure died unexpectedly, without the detection of clinical abnormalities. At necropsy the presence of subcutaneous edema, ascitic fluid with fibrin, passive congestion of the liver and lung, and the development of collateral circulation in one woodchuck indicated that the circulatory failure that resulted from heart disease was of days to weeks duration.

The lesions of cardiomyopathy in the woodchuck, both gross and microscopic, are similar to those described in other species (Liu, 1970; Noren et al., 1974; Roberts and Ferrans, 1974, 1975; Tilley et al., 1977; Liu et al., 1979; Olsen, 1979; VanVleet et al., 1981). Additional lesions such as aortic or atrial thrombosis (Liu et al., 1970; Factor and Sonnenblick, 1985) were not observed in the woodchucks in this series. A male predilection as observed in humans (Roberts and Ferrans, 1974), dogs (VanVleet et al., 1981), and cats (Tilley et al., 1977) was not observed in woodchucks. As in other species (Factor and Sonnenblick, 1985) the etiology of the disease in woodchucks was unknown.

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