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SELECTED TRACE METALS IN PORPOISES (PHOCOENA PHOCOENA) FROM THE NORTH EAST COAST OF SCOTLAND

by

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Summary

Samples of brain, liver, kidney, heart and spleen were collected from 26 common porpoises (*Phocoena phocoena*) during 1974 and analysed for lead, cadmium and mercury. Residues of mercury and cadmium increased with increasing body length in some tissues. Methylmercury in liver varied between 5.2% and 66.7% of the total mercury, levels being greater in tissue of relatively low total mercury content.

Résumé

Des échantillons de cerveau, de foie de coeur et de rate, recueillis de 26 marsouins communs (*Phocoena phocoena*) au cours de l'année 1974 ont été analysés pour le plomb, le cadmium et le mercure. Dans certains tissus les résidus de mercure et de cadmium augmentaient proportionnellement à la longueur du corps. Le pourcentage de méthylemercure variait de 5.2 à 66.7, les niveaux étant plus élevés dans ces tissus où la teneur totale en mercure était relativement peu élevée.

Introduction

The use of marine mammals as potential indicators of environmental quality has been explored previously (eg Holden, 1975). However, this work has been largely associated with monitoring organochlorine residues in some species of seals. Very little information exists on trace metal levels in other marine mammals, particularly porpoises (Gaskin et al., 1972; 1979). Porpoises (*Phocoena phocoena*) are terminal carnivores in the food web, feeding predominantly on clupeoids and gadoids (Rae, 1965; 1972) and therefore have considerable attraction in accumulation studies as they may well contain high concentrations of potentially toxic trace elements.

This paper reports measurements of lead, cadmium and mercury in porpoises from the east coast of Scotland. Evidence for the accumulation of cadmium and mercury in some tissues with increasing body length is given, and an assessment of the relative value of porpoises as an indicator species is made.

Materials and Methods

26 common porpoises were collected during 1974, the majority having become tangled in cod nets. Brain, liver, kidney, heart and spleen tissues were sampled from each specimen and stored deep frozen at -20°C prior to analysis. After thawing, the samples were finely chopped and a subsample taken for trace metal analysis.

The samples were analysed for Cd and Pb by flame atomic absorption following digestion in nitric acid (Topping, 1973). Detection limits for Cd and Pb were 0.05 and 0.5 $\mu g g^{-1}$ respectively. Total mercury was determined by dry ashing in a silica lined furnace at 900°C followed by cold vapour atomic absorption as described by Topping et al., (1975). Methylmercury was determined by the method of Davies (1978) which employs an extraction by toluene, a back extraction into cysteine acetate reagent followed by oxidation to inorganic species by sulphuric acid/potassium permaganate solution. Total mercury is determined by a cold vapour atomic absorption procedure. The above analytical procedures have been successfully compared to methods used by other ICES laboratories in a recent ICES intercomparison exercise.

Results

Cadmium

Residues of Cd were highest in kidney tissue with a range of 0.17-2.91 $\mu g g^{-1}$ wet wt (average 1.09) in males and 0.24-7.42 $\mu g g^{-1}$ (average 2.75) in females. Levels in liver tissue of males ranged from 0.05-0.58 $\mu g g^{-1}$ (average 0.16), and in females from 0.06-0.94 $\mu g g^{-1}$ (average 0.32). Heart and spleen tissue had consistently low levels (<0.24 $\mu g g^{-1}$), while levels in brain tissue were below the detection limit for the method employed. Cd in both liver and kidney showed an accumulation with body length (Figures 1 and 2). There was no evidence for a similar pattern in the heart and spleen.

Mercury

Levels of mercury were considerably higher in liver (max 15.9 $\mu g g^{-1}$) than in other tissues, varying from 0.29-10.6 $\mu g g^{-1}$ wet wt in males and 0.28-15.9 $\mu g g^{-1}$ in females. The maximum level in kidney was 2.82 $\mu g g^{-1}$ (average 1.18); in brain 3.04 $\mu g g^{-1}$ (average 0.54); in heart 1.20 $\mu g g^{-1}$ (average 0.64);; and in spleen 1.85 (average 0.54). Concentrations in liver, kidney and heart showed an accumulation with body length (Figures 3, 4 and 5). Analysis of liver tissue for methylmercury showed that samples with the highest total mercury content had the least percentage methylmercury ($\sim$10%), while samples with relatively low total mercury had significantly more ($\sim$50%). The relationship between total mercury and percentage methylmercury is shown in Figure 6.

Lead

Concentrations of lead in all tissues were below the detection limit for the method employed.

Discussion

The Cd data in this report are the only existing published information on Cd in porpoises known to the authors. However, a comparison may be made with other marine mammals. McKie et al., (1980) showed that the highest concentrations of Cd in Grey Seals (Halichoerus grypus) from the east coast of Scotland were found in kidney and liver tissues ranging from 0.1-15.1 $\mu g g^{-1}$ and 0.05-8.47 $\mu g g^{-1}$ respectively. These data confirmed previous results from other workers (eg Caines, 1978; Heppleston and French, 1973) who reported highest levels of Cd in kidneys. Generally, there was a significant correlation between Cd in kidneys and livers with age. This can be compared with similar relationships in porpoises (Figures 1 and 2), body length being used as the best analogue of age, as determinations of age were not made.

Mercury levels in selected tissues from porpoises have previously been reported (Gaskin et al., 1972; 1979). This work revealed high levels (max 91.3 $\mu g g^{-1}$) in the livers of porpoises from the east coast of Canada. A clear correlation of increasing total Hg with age was observed in all tissues examined. The analysis of 6 liver samples for methylmercury showed that 17-52% of the total Hg was present in the organic form. Similarly, our study of 14 liver samples has revealed highest levels of Hg in liver (max 15.9 $\mu g g^{-1}$). The highest methylmercury concentrations found was 1.09 $\mu g g^{-1}$ in a sample with 10.6 $\mu g g^{-1}$ total Hg (ie 10%), while the lowest was 0.20 $\mu g g^{-1}$, in a sample with 0.60 $\mu g g^{-1}$ total Hg (ie 33%). Comparable results (2.5-41%) were obtained by Gaskin et al., (1972) in the livers of porpoises from eastern Canada. A similar pattern of methylmercury has been found in the livers of seals (eg Reijnders, 1979).

The most important uptake route of mercury to marine mammals is probably through the diet. Both seals and porpoises feed predominantly on fish; Hg in fish being present almost entirely as methylmercury (Holden, 1973). There is general agreement that a mechanism for the demethylation of organic mercury components exists in seals, probably in the liver (discussed by Roberts et al., 1976, and Reijnders, 1979). It may well be therefore, that a similar mechanism occurs in the common porpoise.

This report has shown changing levels of Cd and Hg with body length. The spread of data points in Figures 1-5 is such that a significant correlation between trace metal content and body length cannot be made. In view of this, and the fact that porpoises are a migratory species we question the use of these animals in trend monitoring of heavy metals and suggest that they are unsuitable as a monitoring species for metal concentrations in the marine environment.

Acknowledgements

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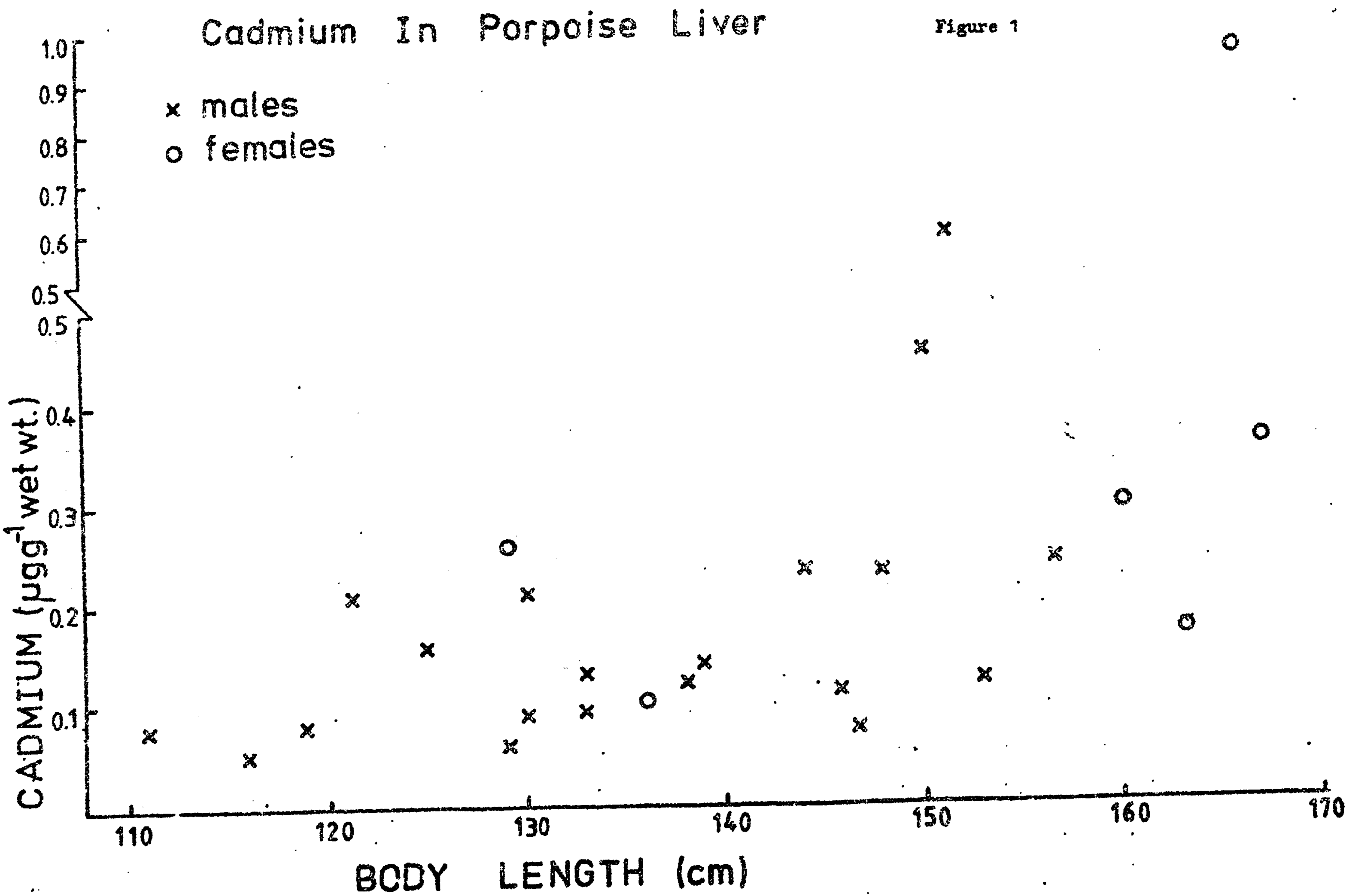
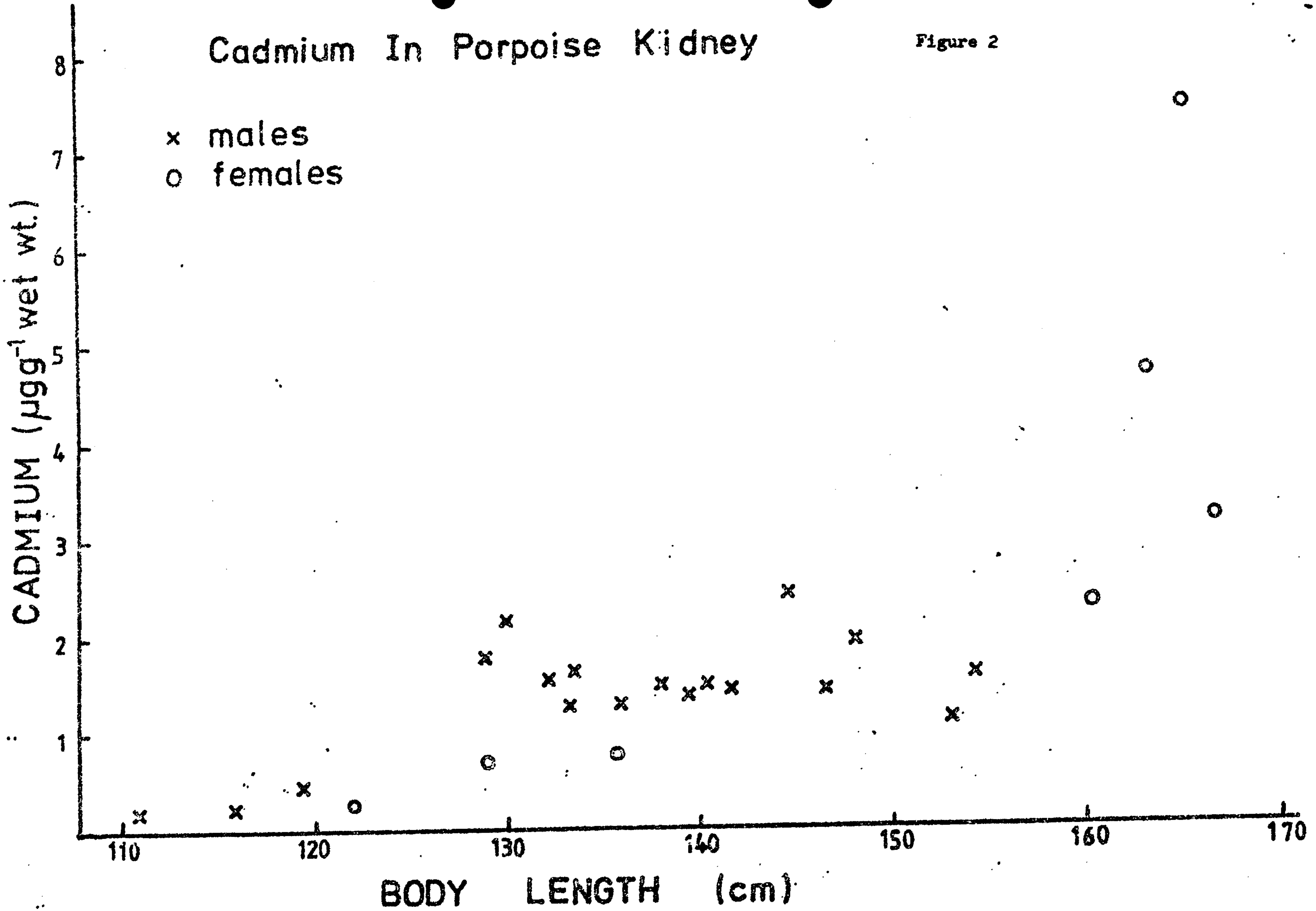
Figure 1

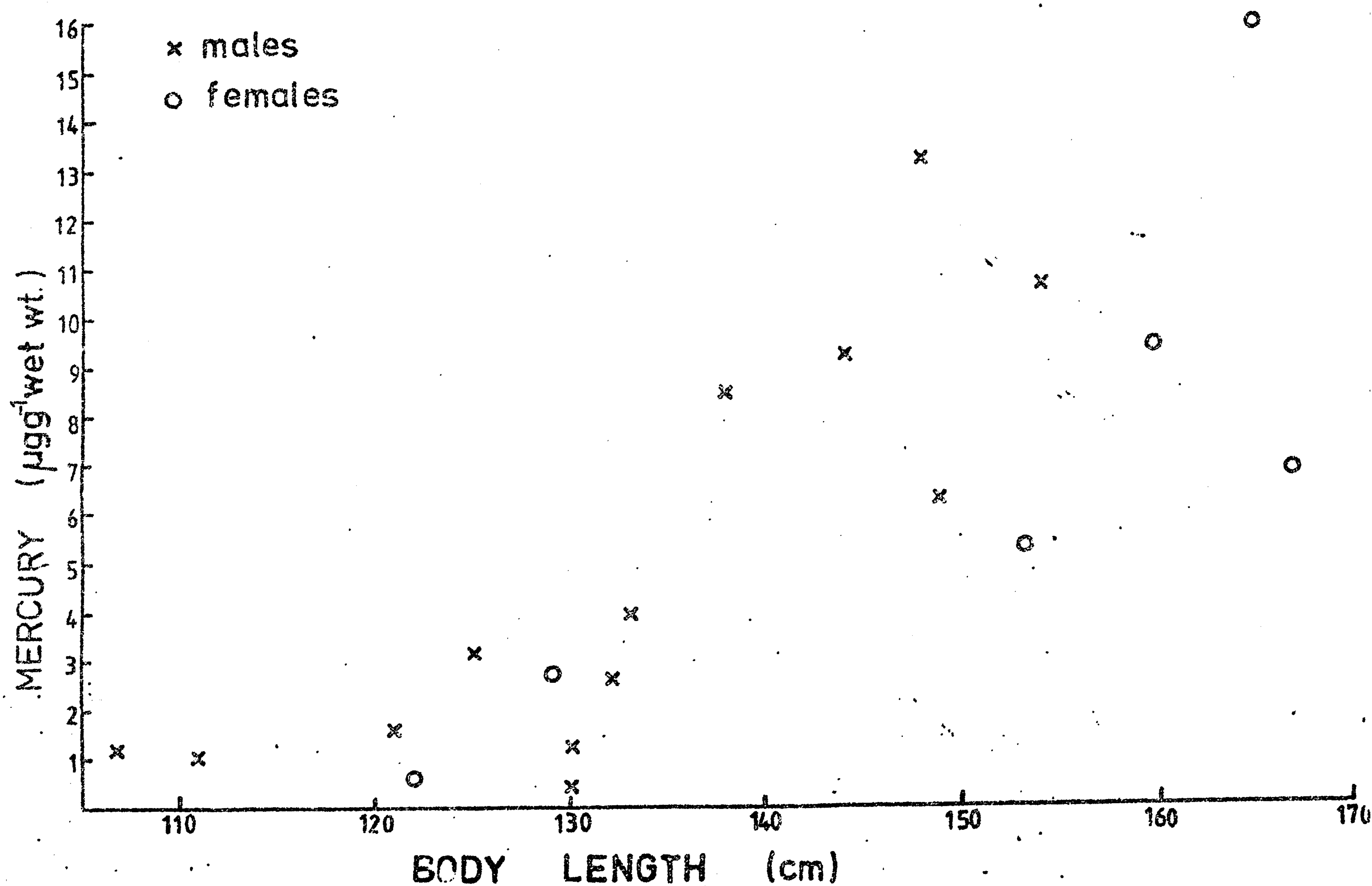


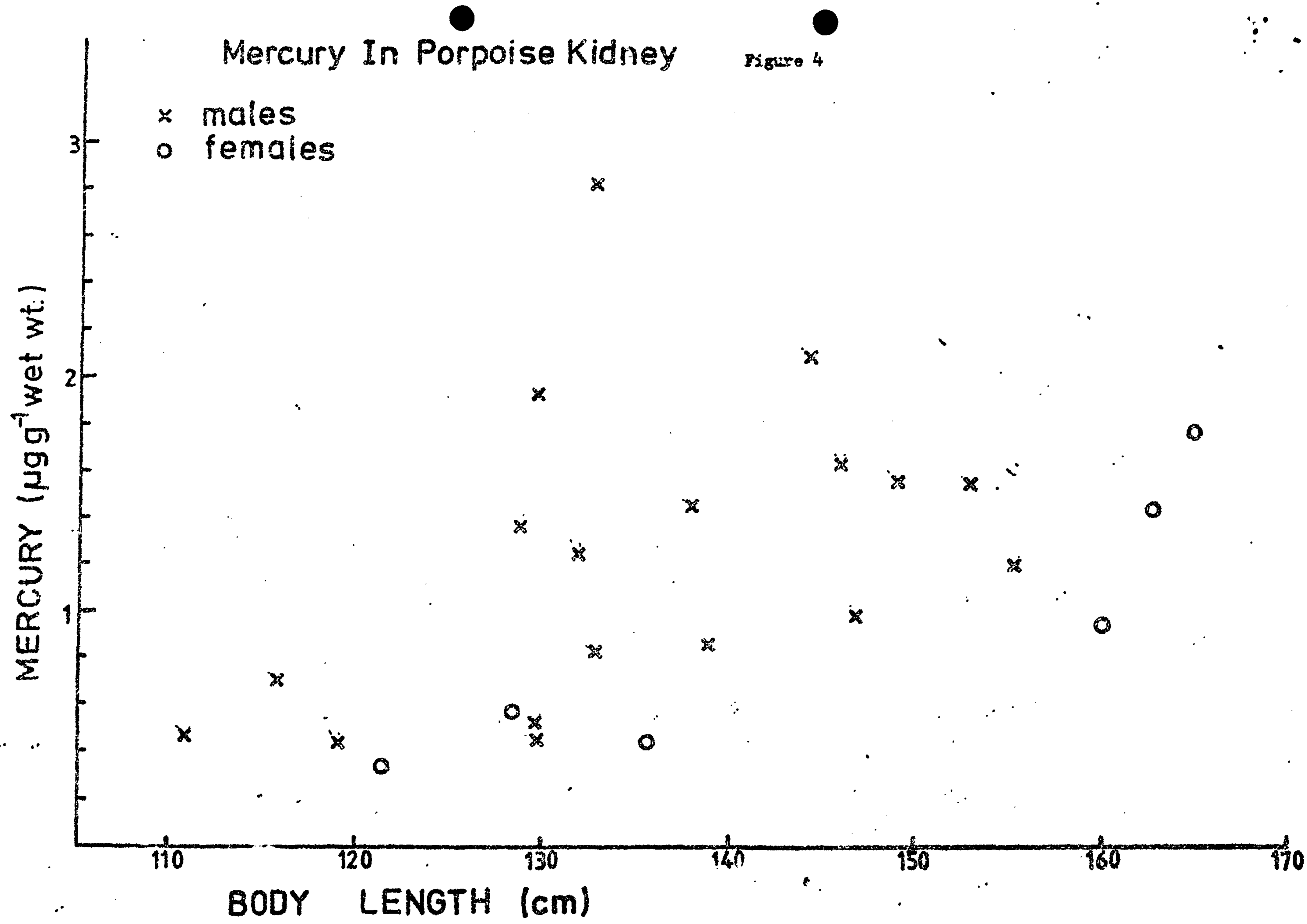
Cadmium In Porpoise Liver
x males
o females
1.0
0.9
0.8
0.7
0.6
0.5
0.5
0.4
0.3
0.2
0.1
CADMIUM (μgg⁻¹ wet wt.)
110
120
130
140
150
160
170
BODY LENGTH (cm)


Cadmium In Porpoise Kidney
Figure 2
x males
o females
CADMIUM (µgg⁻¹ wet wt.)
1
2
3
4
5
6
7
8
110
120
130
140
150
160
170
BODY LENGTH (cm)

Mercury In Porpoise Liver

Figure 3





Mercury In Porpoise Kidney
Figure 4
× males
o females
MERCURY (μg g⁻¹ wet wt.)
3
2
1
110
120
130
140
150
160
170
BODY LENGTH (cm)

Figure 5

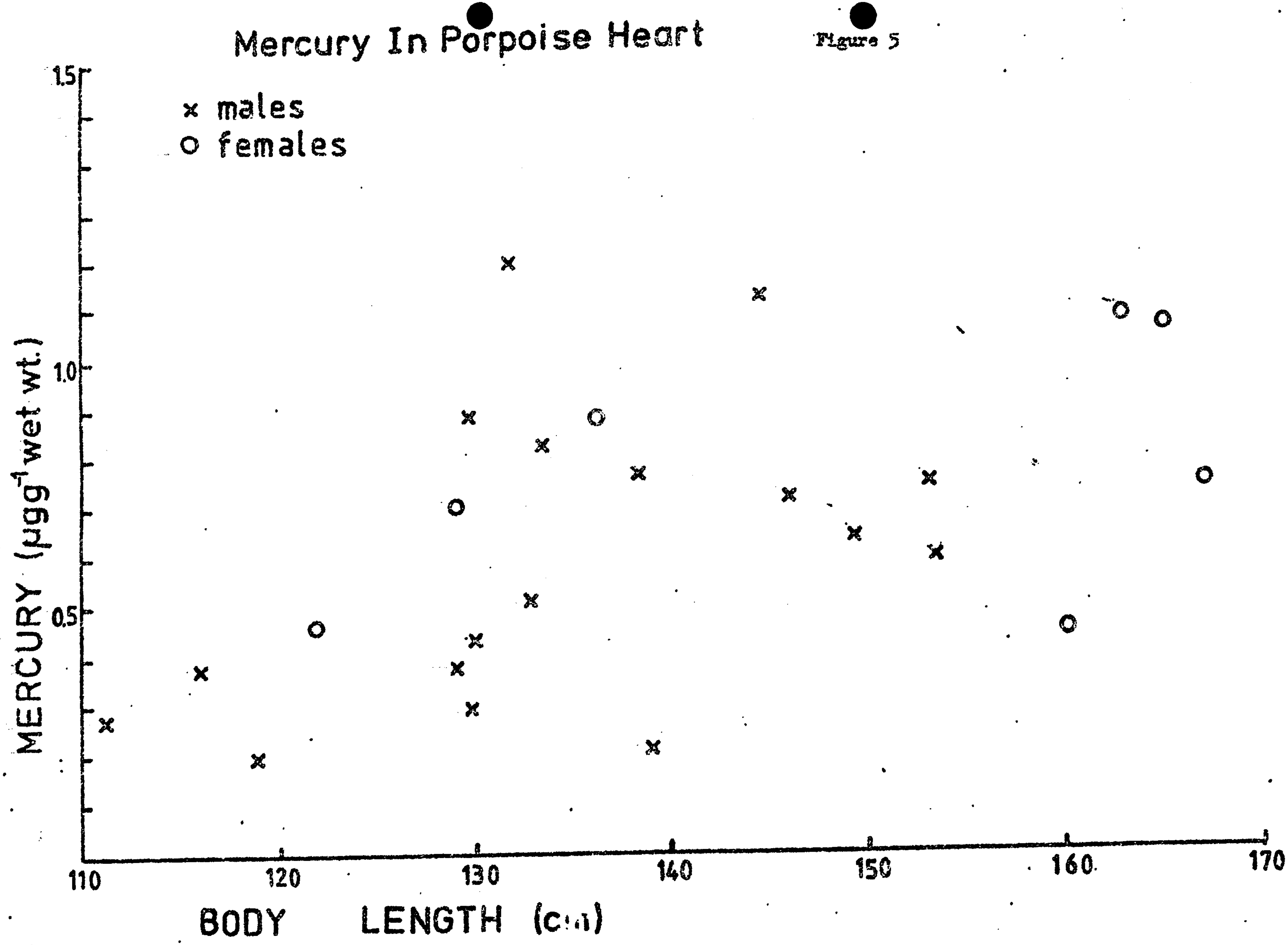
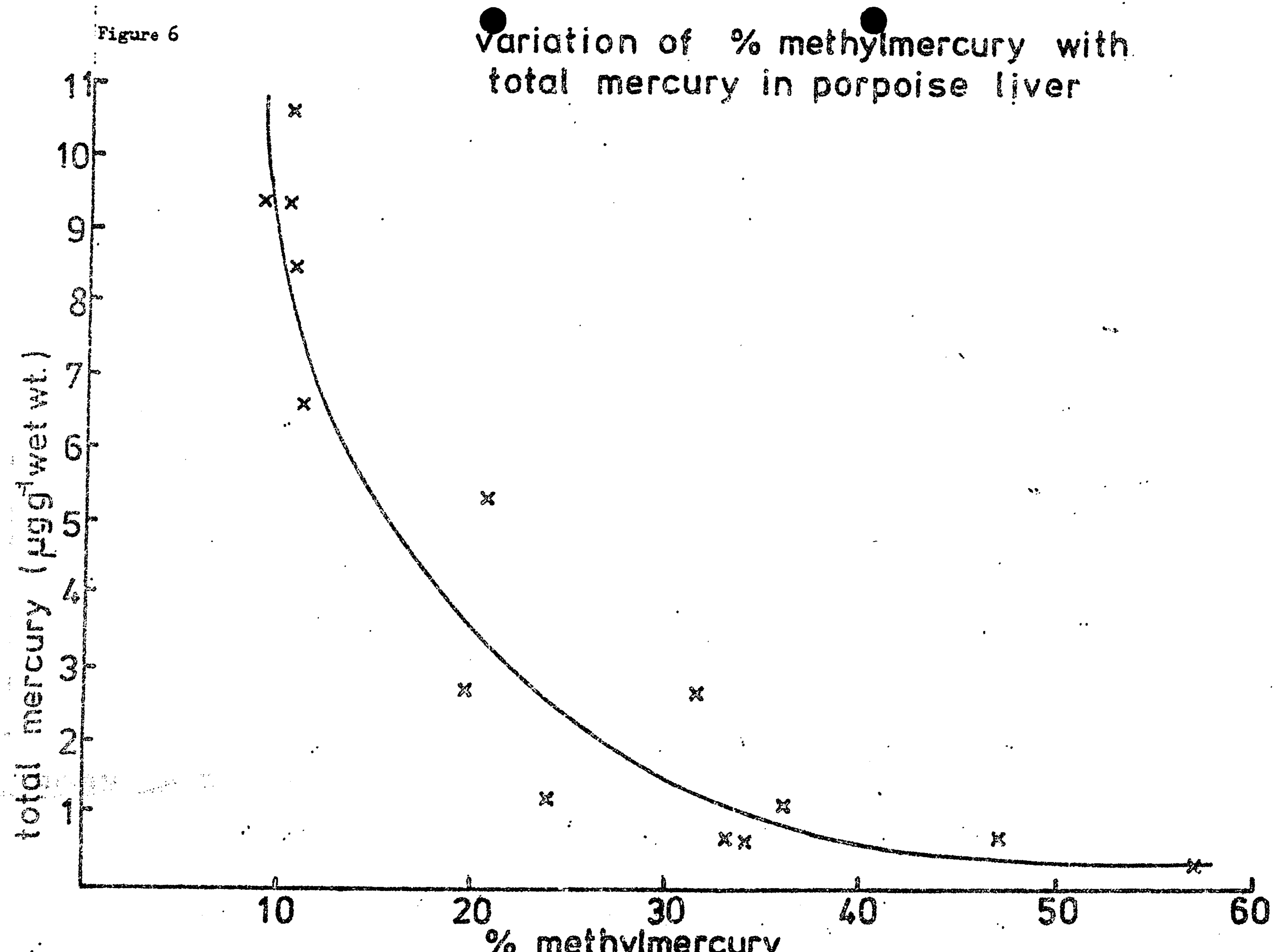

Mercury In Porpoise Heart
x males
o females
MERCURY (μgg⁻¹ wet wt.)
1.5
1.0
0.5
110
120
130
140
150
160
170
BODY LENGTH (cm)

Figure 6



Variation of % methylmercury with total mercury in porpoise liver
total mercury (μg g⁻¹ wet wt.)
11
10
9
8
7
6
5
4
3
2
1
10
20
30
40
50
60
% methylmercury