Preliminary research on thiamin deficiency in captive sea-birds

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Internal report

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I. Introduction

It has often been mentioned in literature that birds in captivity may suffer from thiamin deficiency. Lack of thiamin (= vitamin B_1 = aneurin) may be caused by food which does not contain a sufficient amount of thiamin, but also by food containing thiaminase, an enzyme which breaks down thiamin.

Thiamin is a vitamin, needed in the co-enzyme thiamin-pyrophosphate (TPP), which takes part in three enzymatic reactions viz: in both the non-oxidative and the oxidative decarboxylation of α-ketonic acids and in the formation of α-ketols (MAHLER & CORDES, 1968). Therefore thiamin plays an important part in the breakdown of carbohydrates and, if deficient, pyruvic acid will accumulate especially in cells with an intensive carbohydrate metabolism, such as nerve cells and the heart-muscle.

glucose ⟶ pyruvic acid $\xrightarrow{\text{thiamin}}$ acetyl and carbondioxide

Thiamin deficiency causes paralysis and similar symptoms of beri-beri and polyneuritis and may eventually lead to the death of the animal concerned. Thiaminase occur in various plants, invertebrates and fishes.

Thiamin deficiency has been reported for animals fed with food containing thiaminase, viz: fishes (HARRINGTON, 1954), domestic fowl (SPITZER et al, 1941), carnivores such as mink, fox and cat (GREEN et al, 1942, LONG & SHAW, 1943, Ceh et al, 1964, JUBB et al, 1956), seals (GERACI, 1972), whale (WHITE, 1970) and man (MELNICK et al, 1945).

Therefore it appears that the use of thiaminase containing fish as food entails a severe risk. NAVIAUX (1972) even thinks that such food is responsible for the death of guillemots in a bird's hostel.

Thiaminase-containing fishes comprise a.o. herring (Clupea harengus L.) and smelt (Osmerus mordax Mitchill) (GERACI, 1972). Both species had been considered as a staple diet, to be stored in a deep-freezer, for the Alcidae to be kept in our Institute, so that it seemed advisable, before the birds were introduced, to find out whether any thiamin-deficiency was likely to occur when one of these fish-species was used exclusively for food. Another problem was whether the time relapsing between the thawing of the frozen fish and the actual feeding might be of influence. The latter assumption was made because it could be imagined that during the process of deep-freezing - when the cells are ruptured - and the succeeding thawing process, the thiaminase has a chance of spreading all through the food and reacting with the thiamin.

Therefore it was checked whether, after a certain period during which some seabirds were fed with deep-frozen (Osmerus eperlanus (L.) (=Osmerus mordax) the pyruvate content in the blood increased appreciably pointing to thiamin deficiency.

II. Material and methods

The experiments was carried out with 15 black-headed gulls, Larus ridibundus L., caught in the field. Immediately after capture blood-samples were taken from 3 birds. From 2 other birds blood samples were

taken about two hours after they had been given 1 gram of glucose (orally). The other ten birds were kept in captivity for twelve days (This seemed ample, because according to RAUEN (1964) hens show thiamin deficiency within 3-6 days when receiving only 25% of their optimal requirement of thiamin). Five of them were fed with deep-frozen smelt and five with smelt which after thawing, has been kept at 10° C for 24 hours. Of these last five birds two were given an oral dose of thiamin, one day before blood samples were taken. Two hours before sampling the blood all ten birds were given an oral dose of 1 gram of glucose. Pyruvate was determined in the blood sample according to the method of BOEHRINGER, MANNHEIM, Germany.

III. Results and discussion

The Tables show the results of pyruvate determinations. Table I shows the results with the newly-captured birds and Table II those with birds given a special diet in captivity. Of the first group the blood-sample of one bird got lost and of the second group one bird, given thiamin, died prematurely. So that only 13 birds contributed to the results.

Table I

Pyruvic acid content in mg per 100 ml blood of black-headed gull (Larus ridibundis)

newly captured birds	2.88
	1.58
average	2.23 ± 0.92
newly captured birds	2.94
with additional glucose	1.88
average	2.41 ± 0.75
Total average	2.32 ± 0.69

Table II

Pyruvic acid content in mg per 100 ml blood of captive birds on different diets.

fed with	2.49
deep-frozen smelt	2.23
	2.19
	3.97
	2.60
average	2.70 ± 0.73
fed with smelt	2.26
kept at 10° C after	3.51
thawing	2.21
average	2.66 ± 0.74
fed with 10° C smelt and thiamin	2.67 ± 0.03
Total average	2.67 ± 0.60

Captured birds which were not kept in captivity show a pyruvate content in the blood of 2.32 ± 0.69 mg/100 ml. Addition of glucose did not show any appreciable increase of pyruvate in the blood. With the captive birds the average pyruvate content is slightly higher: 2.67 ± 0.60. It does not make any difference whether they have been fed with deep-frozen smelt or with smelt kept at 10° C for 24 hours, or with additional thiamin. If any thiamin deficiency should occur, it was expected to be apparent in the birds fed with the smelt kept at 10° C, in which the thiaminase might be most active. Given the statements about domestic fowl showing thiamin deficiency after 3-6 days (see above) it was to be expected that, after more than 10 days in captivity and on a diet, the pyruvate content in the blood might give some indication about a possible thiamin deficiency. The bird which was given thiamin with the food did not show any decrease in pyruvate content in the blood. The

value, determined in triplicate, happens to be equal to the average of the nine captive birds. Therefore the found pyruvate contents do not sustain the assumption that smelt as a food for birds in captivity will cause thiamin deficiency.

No explanation for this negative result can be given. Osmerus eperlanus is so closely related to O. MORDAX, in which thiaminase has been proved to occur, that many taxonomists consider the two names as synonyms. Therefore it is to be expected that the fishes used contain thiaminase. In a former experiment, in which 100 chicks of black-headed gulls were reared on a diet of exclusively deep-frozen Osmerus five birds showed, after some time, symptons of paralysis, which in retrospect may be ascribed to thiamin deficiency. The other birds, however, did not show these symptoms. Moreover, it must be remarked that thiaminase-containing fishes also comprise herring (Clupea harengus) and Capelin (Mallotus villosus) (CEH et al, 1964). Both species however, for a long time from the staple diet of Alcidae and other fish-eating species in some areas (BELOPOLSKI, 1957; KARTASCHEW, 1960) and, as far as known to us, no thiamin deficiency has ever been recorded for these species in the field.

IV. Summary

On behalf of sea-bird research at the NIOZ, in which it is necessary to keep and rear birds in captivity, a preliminary research on thiamin deficiency was carried out. Pyruvate contents of blood of 13 black-headed gulls were determined. In 4 birds this took place immediately after capture and in 9 birds after they had been on a special diet in captivity for over 10 days. A diet of smelt did not result in an increase in the pyruvate content of the blood to an extent permitting any conclusions on thiamin definciency.

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