The negative results obtained by earlier authors could be explained to be due to the thyroxine dosage, since our experiments[11] have shown that in addition to the age of animals and the duration of treatment, also the amount of injected thyroxine strongly influences the response. Large doses of thyroxine even inhibited the metabolism.

The stimulated oxygen consumption could be explained by supposing that thyroxine activates certain enzymes of oxidative cell metabolism. Thus the effect of thyroxine treatment on the activity of succinic dehydrogenase of liver, thigh muscle and brain homogenates was studied. The results are presented in Figure 2. Three days' treatment with a dose of thyroxine 300 μg/kg day significantly increased the activity of this enzyme in the liver of rats at the age of 5 days ($p < 0.01$), although slight activation was already observed in 3-day-old rats. The effect was more pronounced in 8-day-old animals ($p < 0.001$) and was evident also in the muscle and brain homogenates. Older animals did not respond to the 3 day treatment period as strongly as the younger ones, but needed longer administration before the effect was equal. It is interesting to note that the activity in the brain tissue of the adult rats was not significantly increased, although this activation was evident in infant rats. The result corroborates previous observations which show that thyroxine administration increased the in vitro oxygen consumption of brain slices in infant rats but not in adults[12], and the succinate oxidation in liver and muscle but not in brain tissue[13].

There is much evidence that the pituitary secretion of TSH already begins during the prenatal development in various mammals[14], but in rats, for instance, TSH content in adenohypophysis and in blood is several times lower in infants than in adults[15,16]. LEVEY[15] concluded that the eventual elevation in thyroid activity in older rats results from increased production of TSH. In order to clarify this question in connection with the oxidative metabolism, the effect of TSH injections (10 IU/kg day for 3 days) on the activity of succinic dehydrogenase of liver homogenate was studied in 8-day-old rats. The results showed that the activation of this enzyme by TSH was almost the same as in thyroxine injected animals of the same age. The activity in the controls was 0.93 ± 0.04 and TSH-treated 1.23 ± 0.06 ($p < 0.001$, $N = 12 + 12$). The results are given as μg reduced TTC/mg 10 min. This indicates that the thyroid gland is functional in the control of oxidative metabolism in young rats if sufficient TSH is present[17].

Zusammenfassung. Die Behandlung 5 oder 8 Tage alter Ratten mit Thyroxin- oder TSH-Injektionen verursachte eine signifikante Stimulierung im Sauerstoffverbrauch und in der Sukzinodehydrogenase-Aktivität im Leber-, Muskel- und Gehirngewebe. Dies zeigt, dass die Inaktivität der Schilddrüse in metabolischer Kontrolle schon innerhalb von 8 Tagen nach der Geburt aufgehoben wird, wenn genügend TSH vorhanden ist.

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Disrupted Fertility of the Hidebeetle *Dermestes maculatus* (Deg.) due to Dietary Overdosage of Biotin

It has been known for some time that growth and reproduction of several insect species become inhibited upon excessive intake of certain vitamins. According to LEVINSON and BERGMANN 1959[1], fatal hypervitaminosis in pyridoxine, pantothenic, nicotinic or folic acid may be caused to housefly larvae, and AKOV and GUGGENHEIM[2] observed toxic effects due to dietary surplus in riboflavin on *Aedes aegypti*. Moreover, BENSCHOTER and PANIAGUA[3] demonstrated recently impeded reproduction of Mexican fruitflies (*Anastrepha ludens*) due to large biotin doses. Mortality in larvae of carpetbeetles was induced also by overdosage of vitamin K_1, K_2 or K_3[4]. This communication deals with a study on the influence of oversupply of B vitamins on growth and reproduction of the hidebeetle *Dermestes maculatus*. The nutritional requirements of larvae and adults are similar in this species and can be met by a semisynthetic diet[5].

Individual larvae as well as pairs of male and female beetles were maintained at 29 ± 0.5 °C and 60–70% relative humidity on diets[5] containing additions of 0.01, 0.1, 0.5 and 1.0% of single B vitamins. 15–20 larvae and adults of either sex were employed for testing each vitamin and dietary level. Rates of food consumption, development, emergence, fecundity and fertility were the criteria of these experiments.

As normal development was evident in presence of all vitamin levels, dietary excess of either nicotinic, pantothenic or folic acid, pyridoxine, biotin, thiamine, riboflavine, choline chloride or inositol has certainly no detrimental effect on growth of hidebeetle larvae. It is noteworthy, that the 5 vitamins listed first are indispensable for development of *D. maculatus*, whilst the 2 vitamins listed subsequently are needed only partly for this process[5].

However, adults were found to differ from larvae in their response to biotin overdosage. Although addition of 0.5% biotin to the control diet hardly affected the number of eggs laid, it permitted only a negligible proportion of larvae to hatch from the latter. Moreover, those larvae

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died within 24 h after hatching. In presence of 1.0% dietary biotin, fecundity became lowered considerably and larval hatch was completely wanting (see Figure). Mortality occurred during embryogenesis and the eggs, which appeared to have their normal shape at the time of oviposition, shrunk gradually due to dessication.

The amounts of fecal pellets produced by beetles receiving diets with or without excessive biotin reveal normal food consumption in presence of biotin surplus (Table I). It is interesting that the effects mentioned above could not be duplicated by dietary administration of 1.0% of desthiobiotin or pimelic acid to adult *D. maculatus*.

In order to clarify the influence of excessive biotin, beetles of either sex were overdosed with dietary biotin and crossmated with an equal number of untreated beetles of the opposite sex. It becomes evident from Table II that mating females receiving 1.0% dietary biotin with normally fed males results in the production of non-viable eggs, whereas matings between normally fed females and males dosed with 1.0% biotin have no adverse effect on fecundity. Those results are consistent with the observation that the spermathecae of biotin-overdosed beetles invariably contain mobile spermatozoa. The sterilizing effect of biotin surplus is therefore specific for female hidebeetles and resembles that of certain antimetabolites for the females of other insect species[6]. Since sterility can also be produced by excessive feeding of this vitamin to female *Ceratitis capitata*, the observed phenomenon is certainly not limited to one order of insects.

It is interesting that biotin-induced sterility could be reversed readily upon replacing the disbalanced diet by one containing 0.2 µg biotin/g. Yet, sterility could be promptly restored by returning the above females to diets containing 1.0% biotin. On the other hand, feeding biotin excess to larvae does not upset the reproductive capacity of the adults developing from them.

It may be concluded that feeding superfluous biotin to *D. maculatus* results in detrimental effects on oogenesis and embryogenesis, but appears to be harmless to the larvae and adults of this insect. It should be recalled, however, that the larvae of other species, e.g. *Tribolium confusum* and *Oryzaephilus surinamensis*, are notably less tolerant than hidebeetle larvae to excessive biotin in the diet[7]. The tendency of biotin to form complexes with animal proteins including those of eggs[8] may be related to the inhibitory influence of surplus biotin on embryonic development[9].

Table I. Production of feces by hidebeetles maintained on diets with different biotin levels

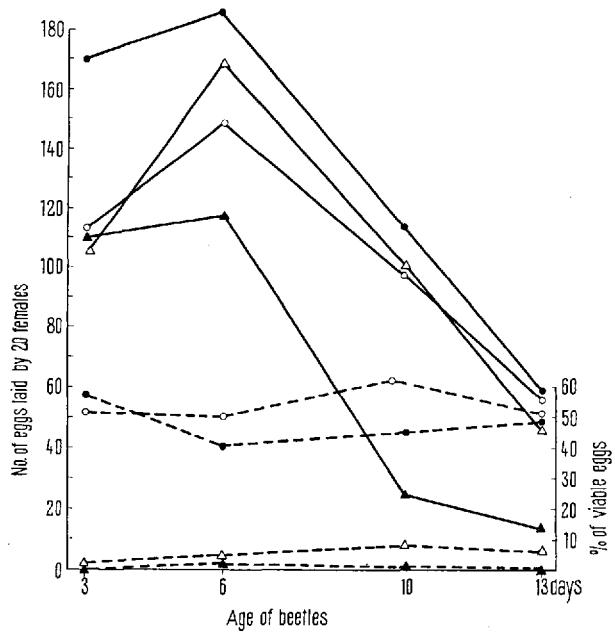
Concentration of biotin in diet, %	Volume of fecal pellets, ml
0.00002 (control)	0.70
0.01	0.90
0.1	0.65
1.0	0.70

The amount of fecal pellets passed by a total of 15 male and 15 female *D. maculatus* during 13 days is recorded for each diet.

Table II. Influence of dietary biotin overdosage on the reproductive capacity of male and female *D. maculatus*

Experimental group	Crossmatings[a]	No. of eggs[b]	% hatch
1	♀*b* × ♂*b*	217	3.2
2	♀*b* × ♂	201	3.5
3	♀ × ♂*b*	282	65.6
4	♀ × ♂	252	56.7

Each experimental group consisted of 15 male and 15 female beetles kept on test diets during 14 days. The beetles were allowed to copulate for approximately 3 h at intervals of 4 days. [a] The postscript *b* indicates insects receiving continuously 1.0% dietary biotin. [b] Total of 4 egg batches laid by 15 females.



Fecundity (solid lines) and fertility (broken lines) of *Dermestes maculatus* maintained on diets containing different biotin levels. ○— —○, 0.00002% biotin (control); ●— —●, 0.1% biotin; △— —△, 0.5% biotin; ▲— —▲, 1.0% biotin.

Zusammenfassung. Verabreichung übermässiger Biotindosen (0,5 und 1,0% in synthetischer Diät) an Speckkäfer (*Dermestes maculatus* Deg.) erzeugt Sterilisation der Weibchen und nicht der Männchen, ohne die Kopulation und Lebensdauer der Insekten negativ zu beeinflussen. Die embryozide Wirkung des Biotinüberschusses kann durch starke Herabsetzung des Vitaminspiegels in der Diät aufgehoben werden. Bei anderen B-Vitaminen, Desthiobiotin und Pimelinsäure konnte ein derartiger Einfluss nicht festgestellt werden. Andererseits schadet Verfütterung obgenannter Biotinmengen der Larvenentwicklung in keiner Weise.

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[9] The senior author (H.Z.L.) wishes to acknowledge the financial support rendered to him by grant No. FG-Is-213 of the U.S. Department of Agriculture.