decapitated and the thyroid in the hyoid region was removed along with some surrounding tissue, following the method of Gona[5]. The tissues were taken for a constant weight in all the experimental animals after autopsy and were extracted in alkali and counted thrice in a gamma-ray well type spectrometer. Results are expressed in per cent dose uptake. Correction was made for the background and also for any possible error resulting from radioactivity in the surrounding tissues. Results are summarized in Table I.

TABLE I

Group*	Snout to vent length mm	Body weight in grams	Thyroid uptake per cent value ± standard error
I	40–60	38 ± 3	5·107 ± 0·4185
II	61–75	,,	3·044 ± 0·3210
III	76–83	,,	2·821 ± 0·5122
IV	85–90	,,	0·979 ± 0·0315

* Groupings were made on the basis of results.

The above results indicate that thyroid is more active immediately after metamorphosis (40–60 mm S.V. Length) and then the activity gradually diminishes. Gorbman[6] observed a mild histological structure in the adult thyroid compared to a hyperactive picture in metamorphosing larvae. In neotenous Salamanders even though there is enough thyroxin secreted to elicit metamorphosis on other anurans, the larval tissues of the Salamanders are insensitive to thyroxin and undergo partial or no metamorphosis[7]. Growth hormone (STH) seems to serve no purpose in the adult human individual. Iwasawa[3] compared adult amphibian thyroxin to human growth hormone and says it is *hormone de luxe*.

In the light of the above findings it is concluded that in *Rana hexadactyla* the thyroid is active immediately after metamorphosis and this is followed by a sharp decline in the activity during subsequent stages of postmetamorphosis.

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CHANGES IN THE LEVELS OF AMINO ACIDS IN DEVELOPING *CORCYRA CEPHALONICA* STAINTON

INSECTS possess relatively high concentrations of free amino acids in their tissues and haemolymph[1]. Aspects of amino acid metabolism in insect development have been reviewed by several authors[2–4], and the variations in the levels of certain amino acids during development have been correlated with moulting, web formation, diapause, tanning etc. However, relatively little work has been done on the amino acid metabolism of insects, infesting stored grains. The present study has, therefore, been undertaken to obtain information on the changes in the concentrations of amino acids of *Corcyra cephalonica*, a pest of stored cereals, during larval growth and metamorphosis.

Corcyra cephalonica were reared on broken *Sorghum vulgare* grains[5]. Larvae weighing 10, 30, 40 and 55 mg, papae and freshly emerged adults were selected, and the amino acids were extracted from the insects with 3% (W/V) sulfosalicyclic acid[6]. The amino acid composition of the extracts were estimated in a Beckman Unichrom amino acid analyzer after hydrolysing them with 6 N HCl at 100° C for 24 hr. in vacuum sealed test tubes[5]. Web spun by the full grown (55 mg) larvae during 24 hr period was also collected, cleared of feacal pellets, weighed and used for acid hydrolysis.

Amino acid compositions of the whole body extract of the rice moth at different developmental period are shown in Table I. Glutamic acid and proline stand apart from the rest of the amino acids by virtue of their very high concentrations during larval growth period. The contents of these amino acids declined markedly during pupal period. The level of glutamic acid declined further at the adult stage. However, the level of proline was found to increase at the adult stage. The reduction in the concentrations of proline observed at the pupal period might be accounted in terms of its possible utilisation for the synthesis of

cuticular proteins. Participation of proline in the synthesis of such proteins is shown in many insects species[3]. Also it has been shown to serve as a reserve of oxidisable carbon source available to insects during periods of relative anaerobiosis.

Other amino acids such as aspartic acid, threonine, seriene, valine, leucine and isoleucine were present comparatively in low concentrations, whereas glycine, alanine, lysine, histidine and arginine occurred in fairly high concentrations. During larval growth, and the levels of these amino acids gradually increased, at pupal stage appreciable reduction in the titres of aspartic acid, threonine, glycine, alanine lysine, histidine and arginine occurred, with further decrease in the adult stage, suggesting their rapid metabolism during these depelopmental periods. Similar changes in the levels of free amino acids during the time of metamorphosis of *Phormia* and *Calliphora* were also reported[6,7]. Phenylalanine was present in trace amounts in the larvae, but rose to a measurable level prior to pupation, and decreased again to negligible amount in the adult. In addition to the above amino acids cysteine, methionine and β–alanine were also detected. Throughout the period of insect development their concentrations remained very low.

The changes in the level of tyrosine require special consideration. Ganti and Shanmugasundaram[8], on the basis of paper chromatographic analysis of insect extracts, reported marginal decline from the second week *Corcyra* larva to the third week larva. Contrary to this, the present study showed a gradual build up of tyrosine during larval development, and its accumulation was more pronounced as the larva approached pupation. The amount of tyrosine from a high value of 369 nmoles per larva at 55 mg stage decreased to 131 nmoles per insect at the pupal stage. Earlier, we had shown that tyrosine participated in the sclerotization of the cuticle of this insect, and its decline in the level at pupal stage could be attributed to the tanning of the puparium[5,10]. These observations were consistent with the findings of other workers who had found similar alterations in the tyrosine level during pupation[6,9].

The amino acid composition of web proteins of the rice moth was uniquely different from that of whole body amino acids pool (Table I). Serine, glycine and

TABLE I

Amino acids content of the whole body extract and web of Corcyra cephalonica

(nmoles of amino acid/insect)

Amino acid	Wet weight of the larva (in mg)				Pupa	Ecdysed adult	Web nmoles/mg
	10	30	40	55			
Aspartic acid	12	35	89	177	79	43	329
Threonine	10	36	72	116	62	20	60
Serine	19	43	82	127	91	50	1641
Glutamic acid	127	379	671	1040	471	84	207
Proline	96	406	642	916	242	313	200
Glycine	41	101	192	276	124	115	2062
Alanine	31	60	99	181	91	88	2117
Cysteine	..	Trace	Trace	62	29	Trace	..
Valine	14	27	51	91	61	32	83
Methionine	Trace	35	44	61	34	28	..
Isoleucine	Trace	14	24	38	29	11	69
Leucine	Trace	15	51	78	61	36	159
Tyrosine	31	53	211	369	131	Trace	106
Phenylolanine	Trace	Trace	Trace	29	16	Trace	Trace
β-Alanine	Trace	Trace	Trace	Trace	Trace	Trace	..
Lysine	61	121	139	191	121	59	222
Histidine	27	76	177	317	91	118	49
Arginine	48	90	107	217	87	56	37

The values are mean of three separate estimations.

alanine, which occurred in moderate amounts in the whole body extract of the larvae and varied marginally during metamorphosis, were present in high concentrations in the hydrolysate of web (ca. 80%). Presence of high amounts of glycine, alanine and serine in the silk proteins of several insects has been reported[1]. On the other hand, glutamic acid and proline, the principal components of body pool amino acids, together contributed merely 6% to the total content of web amino acids. Thus, the most abundant amino acids of the whole body extract, that underwent dramatic changes at the time of metamorphosis, were not utilised extensively for the synthesis of web proteins.

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PAPER CHROMATOGRAPHY OF METAL ION COMPLEXES WITH MORPHOLINE-4-CARBODITHIOATE

THE bidentate chelating system $>N-C\begin{matrix}S\\ \diagdown S^-\end{matrix}$ present in morpholine–4–carbodithioate was used for complexation with Fe(III), Co(III), Ni(II), Cu(II), Ru(III), Rh(III), Pd(II), Ir(III), Pt(IV) and Te(IV). The paper chromatographic detection and separation of above metal ions on paper strips was found quite successful. The coloured spots of the complexes were clearly visible without use of any spraying agent. Maximum three or four complexes could be identified and separated on paper strip.

The reaction of the ligand with metal ions is not selective, therefore the separation of complexes using masking agents and pH control requires more labour, steps and time. The chromatographic behaviour of morpholine–4–carbodithioate metal complexes have not been studied previously. Some references are available for the metal chelates[1–6] with this reagent. Present communication describes the paper chromatographic separation and identification of the complexes of Fe(III), Co(III), Ni(II), Cu(II), Ru(III), Rh(III), Pd(II), Ir(III), Pt(IV) and Te(IV) with morpholine–4–carbodithioate.

Experimental

Potassium salt of the reagent was prepared by mixing potassium hydroxide, morpholine and carbon–disulphide in 1 : 1 : 1 ratio in ether at 0° C, 1% (w/v) solution (KMCDT) was prepared in distilled water.

The complexes were isolated in aqueous medium by mixing solutions in stoichiometric ratios (ligand in slight excess). The chelates were filtered, washed with ether and dried at 110–120° C. In the case of $Co(mcdt)_3$ rapid oxidation of Co(II) into Co(III) takes place.

The complexes were analysed for carbon, hydrogen and nitrogen contents and their composition corresponded to M $(C_5H_8ONS_2)_n$. Spectral studies were also made in the range 200 cm^{-1}–4000 cm^{-1}. Conductivity measurements of the complex solutions in nitrobenzene were made on Toshniwal CLOI/OIA conductivity bridge using dip type cell (K = 0·74) (Table I).

For the purpose of putting spots, most of the complexes were dissolved in chloroform at room temperature. Owing to the insolubility of Pd(II) and Ni(II) the complexes were prepared on paper strips. The chromatographic chamber was saturated with the vapours of the developer for at least one day. Chromatography was carried out on Whatman No. 1 filter paper strips (3 cm × 15 cm) using the ascending technique. The sample solution was applied at a point 2 cm from the end, and the developer was allowed to travel for about 10 cm from the point of application of the spot. The time required for the different metal complexes was noted. The R_f values of the complexes in different solvents are recorded in Table II.