

mit größeren Teilen des Zentralnervensystems mehr hatten. Die Länge der Schwanzspitzen betrug nicht mehr als $\frac{1}{5}$ der Gesamtlänge der Tiere.

Wie aus der beigefügten Tabelle der Durchschnittsgrößen der Kerne ersichtlich ist, kommt es nach der Amputation zu einer recht bedeutenden Vergrößerung derselben. Diese Zunahme beträgt, bezogen auf den Kontrolldurchschnitt nach 20 Minuten, 52% und bleibt bis mindestens 16 Stunden erhalten. Zu diesem Zeitpunkt liegt sie bei 40%, also noch praktisch gleich hoch.

		Kon- trolle	20 Mi- nuten Holt- freter	16 Stun- den Holt- freter	25 Minu- ten Holt- freter + 0,5% Äther
Je Durchschnitt von 100 Kernen je eines Tieres in μ^2	1	216	344	299	187
	2	219	346	329	240
	3	244	378	336	242
	4	251	383	344	288
	5	278	385	369	291
Durchschnitt von je 500 Kernen von 5 Tieren . .		241	367	336	250
In % der Kontrollen . . .		100	152	140	104
Anzahl der Mitosen .					
zwischen je 500 Kernen .		10	12	3	6

Es ist zu vermuten, daß dieser Effekt durch die Wundsetzung hervorgerufen wird und demnach wahrscheinlich durch histaminähnliche Gewebs- bzw. Wundhormone bewirkt wird.

Von Bedeutung ist die Feststellung, daß bei Zugabe von kleinen Äthermengen der Vergrößerungseffekt praktisch ausbleibt, denn der Durchschnitt der 500 gemessenen Kerne liegt nur um 4% über dem der Kontrolle. Der zugleich feststellbare Abfall der Mitosezahl bei den mit Äther behandelten Tieren ist wohl als Narkosewirkung zu deuten¹.

In Anbetracht der aus der Histaminliteratur bekannten Befunde, wonach verschiedene Histaminwirkungen² (Drüsengewebe, Muskulatur) durch narkotische Stoffe abgeschwächt bzw. aufgehoben werden können, scheinen die hier mitgeteilten Beobachtungen dafür zu sprechen, daß die vom geschädigten Gewebe auf die Umgebung ausgehenden Wirkungen histaminartigen Charakter aufweisen.

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Summary

After cutting off the tail-tips of *Triton alpestris* larvae, the nuclei of the surviving tail-tips, placed in isotonic solution (Holtfreter), become considerably enlarged. This enlargement is approximatively the same after 20 minutes and 16 hours and does not appear after 25 minutes if one adds to the Holtfreter solution 0.5 volume % ether. The similarity of this phenomenon to narcosis-effects of histamin-experiments is pointed out.

¹ G. POLITZER, *Protoplasmamonograph.* 7, 190 (1934). – J. F. DANIELLI, *Cell Physiology and Pharmacology* (Elsevier Publ. Co. Amsterdam, 1950).

² W. FELDBERG und E. SCHILF, *Histamin*, Monographie aus dem Gesamtgeb. d. Physiol. d. Pflanz. und d. Tiere 20, 107 (1930).

Caste Determination in a Myrmicine Ant

Caste is trophogenic in *Myrmica rubra macrogyna*. Colonies of this ant hibernate as adults and third instar larvae, the latter being dormant until about mid-November, and later suspended by low temperature. The larvae vary in size considerably—from 0.3 to 3.0 milligrams, and differ structurally only sexually, or in ways that can be attributed to their stage of development. Thus, whilst all females have wing buds and undifferentiated ovaries, the larger ones have abundant eosinophil albuminoid granules in the trophocyte cytoplasm, but in the smaller ones, this material is still round the nucleus—if not actually within it. Under optimal culture conditions most female larvae greater than 1.5 milligrams yield queens, but it is possible by interfering in various ways, to produce workers, intercastes, or unusually small queens (Although often these fail to metamorphose completely).

This caste plasticity was first encountered when large larvae were cultured with workers in various ratios. Highest queen yields occurred with ratios Workers/larvae of unity or more, (in wild colonies ratios vary about a mean near to unity), but even then, a small proportion of workers were produced—due to discriminate biased feeding. As the ratio decreased, first fewer and smaller queens, and then (ratio 0.1) only workers were produced. It was later found, that if single larvae were cultured with ample nurses, and were subjected to a varying period of protein starvation (at the culture temperature, 25° C) before full culture, sometimes workers, and sometimes queens could be obtained. Larvae starved for less than 4 days yielded queens, for more than 4 days workers, and for exactly 4 days a mixture of both—not intercastes. The workers were in all cases smaller than the queens, ranging from 3.4 to 5.1 milligrams instead of 5.8 to 6.9 milligrams. There is reason to believe that the critical period of starvation varies with the temperature and duration of hibernation.

By studying the growth of individual larvae, it was found that queens resulted only from those able to exceed a certain size (about 6.5 milligrams), and that this was possible only if they reached it *before a certain time*. Artificial delay by starvation, although it did not reduce the specific growth rate over the actual growing period, had the same effect as sub-optimal feeding throughout (as under conditions of nurse shortage). Thus, under optimal conditions, two factors enabled larvae to achieve the critical size in time—large initial size (that is, size at hibernation), and normal specific growth rate. Small larvae were not queen-potential in this sense.

If larvae which had passed the critical size but not reached full queen size were starved, they produced either intercastes or small queens. Those in the range 6.5–7.0 milligrams yielded a mixture of intercastes and queens, those greater than 7.0 milligrams yielded queens of size proportional to their weight at the beginning of starvation (9.0 milligrams is the usual maximum in normal queens). Gonad development parallels this, for enlargement of the germarium and differentiation of ovarioles begins as the larva passes the critical size, and proceeds with subsequent growth.

These facts have led to the development of a hypothesis of caste determination along the lines advanced by SHULL¹ (1937) for aphids. Certain differences between ants and aphids must first be mentioned: thus, in ants, the workers which are apterous, without wing-muscles and without ocelli (as are the apterous aphids), are also smaller than the queens; caste mosaics are rare if not

¹ A. F. SHULL, *Biol. Bull.* 72, 259 (1937).

unknown in ants; intercastes are in nature rare, but easily produced experimentally, and are then intermediate in size as well as structure. If these facts are to be incorporated, the following hypothesis appears necessary: the duration of competence is brief and its onset dependent mainly on temperature; inductor concentration is proportional to size and has two significant thresholds, the lower initiating the development of queenness, and the higher completing it. To avoid natural intercastes and yet allow for their artificial production it is necessary to suppose that an extra impetus to growth is given to queen determined larvae and withheld or actually withdrawn from those which fail to secure induction. Intercastes would thus result from the metamorphosis of larvae with a concentration of inductor lying between the two thresholds.

Caste on this hypothesis would be determined as a result of a race between two processes, and it is encouraging to find, therefore, that in the related *Myrmica scabrinodis* temperature interferes differentially, for significantly more queens are produced in cultures at 18°C than at 25°C (in this respect these ants show a further resemblance to aphids). Failure of induction prevents additional increase in size and further differentiation. The worker is thus a form arrested before full potentiality is realised. Although it has no wing buds, it is not because they degenerate for they are extruded during metamorphosis, but are so small in their undeveloped state that they become merged with cuticular wrinkles by the time the adult form is reached (but are quite perceptible in the pupa). Degeneration does occur however in the ovariole rudiments.

So far, only the potentialities of hibernated larvae have been considered—and this accounts for half their full growth. The pre-dormancy factors relevant to caste, are not yet fully understood, but it seems that both dormancy and a period of "vernalisation" at low temperature are necessary for larvae to produce queens. Hibernation may thus be suitably construed as a period of quiescence in which the growth potentiality needed on regaining warmth, is built up. The size of larvae at dormancy is a function of nutrition in the preceding instars—not of egg-size, for this shows negligible variation. The fact that queens are only produced from hibernated larvae in *Myrmica* is part of a socio-ecological adaption which ensures that in the existing temperature-ontogeny relationship, sexuals are ripe for mating at the most suitable time of year. Queens are produced by large colonies in warm situations with abundant food supply, and in which the input of female brood is small in comparison with the vast labour force available to tend it.

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Zusammenfassung

Bei Ameisen (*Genus Myrmica*) ist Kastenbestimmung rein trophisch. Königindetermination hängt davon ab, daß die weiblichen Larven vor einer bestimmten Zeit eine gewisse Größe erreichen und einen zusätzlichen Wachstumsanstoss zur Folge haben. Dieser Mechanismus erinnert an die für die Aphiden beschriebenen Vorgänge.

Biosynthesis of Cholesterol from Isobutyrate¹

The utilization of the branched chain of isobutyric acid by the intact rat has been described in a previous

paper¹. At that time, the radioactivity incorporated into the various liver fractions was reported. It has now been demonstrated that an appreciable amount of radioactivity is incorporated into the carcass cholesterol and carcass fatty acid. In feeding experiments with deuterium-labeled isobutyrate, RITTENBERG and SCHOENHEIMER² and BLOCH³ reported that little or no deuterium was incorporated into cholesterol.

The method of injection and other experimental details have already been described¹. After sacrifice of the rat, the carcass was homogenized and dried by lyophilization. The dried carcass was extracted with ether-alcohol 1:3 for 100 hours and the fatty acid and nonsaponifiable fractions were separated in the usual manner.

In the first case a total of 19.6 μ C of isobutyrate were injected. Cholesterol, m. p. 147–148°, was isolated through the digitonide. The infra red spectrum of the extracted cholesterol was identical with that of an authentic sample⁴. In chromatography on "Quilon" treated paper⁵, the cholesterol showed an R_f of 0.55 when methanol was the developing solvent. A radioautograph⁶ showed that no other radioactive material was present.

The specific activity of the cholesterol was found to be 1500 disintegrations/min/mg C⁷. The specific activity of the carcass fatty acids was 1000 dis/min/mg C.

In two similar experiments in which 19.6 μ C and 40.5 μ C of isobutyrate were injected, cholesterol was isolated as the digitonide and assayed for radioactivity in this form. The specific activities, calculated for cholesterol, were 800 dis/min/mg C and 1800 dis/min/mg C respectively.

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Radiation Laboratory, University of California, Berkeley, February 9, 1951.

Zusammenfassung

Es wird der Beweis erbracht, daß die Methyl-Gruppen der Isobuttersäure in das Cholesterin der Ratte einverleibt werden.

¹ I. Gray, P. ADAMS, and H. HAUPTMANN, *Exper.* 6, 430 (1950).

² D. RITTENBERG and R. SCHOENHEIMER, *J. Biol. Chem.* 121, 235 (1937).

³ K. BLOCH, *J. Biol. Chem.* 155, 255 (1944).

⁴ We are indebted to Dr. N. K. FREEMAN and Mr. YOOK NG OF DONNER Laboratory for determination of these spectra.

⁵ D. KRITCHEVSKY and M. CALVIN, *J. Amer. Chem. Soc.* 72, 4330 (1950).

⁶ A. A. BENSON, *et al.*, *J. Amer. Chem. Soc.* 72, 1710 (1950).

⁷ All measurements of radioactivity on "Nucleometer" windowless counter.

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Zur Bausteinanalyse des Clupeins

In ihren letzten Mitteilungen «Über Clupein» haben K. FELIX und Mitarbeiter¹ über die Feststellung berichtet, daß in dem von ihnen untersuchten Präparat von Clupeinmethylester-hydrochlorid neben Arginin, Alanin, Valin, Serin und Prolin als den schon bekannten Haupt-

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¹ K. FELIX, H. FISCHER, A. KREKELS und H. M. RAUEN, *Z. physiol. Chem.* 286, 67 (1950). – K. FELIX, H. M. RAUEN, W. STAMM und G. ZIMMER, *ebenda* 286, 199 (1950).